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AND

I. A CATALOGUE OF THE WORKS ALREADY PUBLISHED;

II. A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED, IN COURSE OF PUBLICATION, AND IN PREPARATION, WITH THE NAMES OF THEIR RESPECTIVE AUTHORS;

III. THE DATES OF ISSUE OF THE ANNUAL VOLUMES;

IV. A GENERAL SUMMARY, SHOWING THE NUMBER OF THE PAGES, PLATES, FIGURES, AND SPECIES IN EACH MONOGRAPH;

V. A STRATIGRAPHICAL LIST OF THE BRITISH FOSSILS FIGURED AND DESCRIBED IN THE YEARLY VOLUMES.

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Showing the ORDER *of publication; the* YEARS *during which the Society has been in operation; and the* CONTENTS *of each yearly Volume.*

Vol. I. Issued for the Year	1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood, 21 plates.
„ II. „	1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell, 38 plates. The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards, 9 plates.
„ III.* „	1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones, 7 plates. The Permian Fossils, by Prof. Wm. King, 29 plates. The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen, 18 plates. The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime, 11 plates.
„ IV. „	1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood, 12 plates. The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett, 15 plates. The Fossil Brachiopoda, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson, 13 plates.
„ V. „	1851	The Reptilia of the Cretaceous Formations, by Prof. Owen, 39 plates. The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime, 19 plates. The Fossil Lepadidæ, by Mr. Charles Darwin, 5 plates.
„ VI. „	1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Brachiopoda, Part I, Tertiary, by Mr. Davidson, 2 plates. The Fossil Brachiopoda, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates. The Fossil Brachiopoda, Part III, No. 2, Oolitic and Liassic, by Mr. Davidson, 5 plates. The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates. The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates.
„ VII. „	1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime, 10 plates. The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates. The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates. The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates. The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates. The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen, 9 plates.

* The volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850.

CATALOGUE OF WORKS—Continued.

Vol. VIII.	Issued for the Year *1854	The Fossil Brachiopoda, Part II, No. 2, Cretaceous, with Appendix and Index to Vol. I, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen, 20 plates. The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates. The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates. The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates. The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates.
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„ XII.	„ 1858	The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright, 7 plates. The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards, 6 plates. The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen, 7 plates. The Reptilia of the Purbeck Limestones, by Prof. Owen, 1 plate. The Fossil Brachiopoda, Part V, No. 3, Carboniferous, by Mr. Davidson, 10 plates.
„ XIII.	„ 1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson, 20 plates. The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen, 6 plates. The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen, 1 plate. The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood, 13 plates.
„ XIV.	„ 1860	The Fossil Brachiopoda, Part V, No. 5, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen, 11 plates. The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen, 1 plate. The Fossil Estheriæ, by Prof. Rupert Jones, 5 plates. The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell, 11 plates.
„ XV.	„ 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright, 13 plates. Supplement to the Great Oolite Mollusca, by Dr. Lycett, 15 plates.

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CATALOGUE OF WORKS—Continued.

Vol. XVI.	Issued for the Year	1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright, 11 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter, 6 plates. The Fossil Brachiopoda, Part VI, No. 1, Devonian, by Mr. Davidson, 9 plates. The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood, 7 plates. The Reptilia of the Cretaceous and Wealden Formations (Supplements), by Prof. Owen, 10 plates.
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* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous volumes are not in separate parts.

CATALOGUE OF WORKS—Continued.

Vol. XXIV.*	Issued for the Year 1870	The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright, 10 plates. The Fossil Brachiopoda, Part VII, No. 4, Silurian, by Mr. Davidson, 13 plates. The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood, 5 plates. The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen, 4 plates.
,, XXV*	,, 1871	The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney, 6 plates. The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward, 5 plates. Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer, 7 plates and map. Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen, 3 plates The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs W. Boyd Dawkins and W. A. Sanford, 2 plates. The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins, 5 plates.
,, XXVI.*	,, 1872	Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan, with an Index to the Tertiary and Secondary Species, 7 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright, 5 plates. The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward, 10 plates. The Fossil Trigoniæ, No. I, by Dr. Lycett, 9 plates.
,, XXVII*	,, 1873	The Fossil Echinodermata, Cretaceous, Vol I, Part VI, by Dr. Wright, 8 plates. Supplement to the Fossil Brachiopoda, Part I (Tertiary and Cretaceous), by Mr. Davidson, 8 plates. Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood, 5 plates. Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen, 2 plates. Supplement to the Reptilia of the Wealden (Hylæochampsa) No. VI, by Prof. Owen. The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen, 2 plates.
,, XXVIII*	,, 1874	The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, 16 plates. The Carboniferous Entomostraca, Part I (Cypridinadæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady, 5 plates. The Fossil Trigoniæ, No. II, by Dr. Lycett, 10 plates.
, XXIX*	,, 1875	The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright, 10 plates. The Fossil Trigoniæ, No. III, by Dr. Lycett, 8 plates. The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen, 20 plates.
,, XXX.*	,, 1876	The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady, 12 plates. Supplement to the Fossil Brachiopoda, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson, 8 plates. Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen, 6 plates.
,, XXXI.*	,, 1877	Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates. The Fossil Trigoniæ, No. IV, by Dr. Lycett, 13 plates. The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood, 1 plate. The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair, 7 plates. The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen, 2 plates. The Fossil Elephants (E. antiquus), Part I, by Prof. Leith Adams, 5 plates.

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CATALOGUE OF WORKS—Continued.

Vol. XXXII.*	Issued for the Year 1878	The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright, 8 plates. Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright. The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson, 13 plates. The Lias Ammonites, Part I, by Dr. Wright, 8 plates. The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall, 6 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen, 6 plates. The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins.
„ XXXIII*	„ 1879	The Eocene Flora, Part I, by Mr. J. S. Gardner and Baron Ettingshausen, 5 plates. Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood, 6 plates. The Fossil Trigoniæ, No. V (*Conclusion*), by Dr. Lycett, 1 plate. The Lias Ammonites, Part II, by Dr. Wright, 10 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen, 4 plates. The Fossil Elephants (E. primigenius), Part II, by Prof. Leith Adams, 10 plates.
„ XXXIV*	„ 1880	The Eocene Flora, Part II, by Mr. J. S. Gardner and Baron Ettingshausen, 6 plates. The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright, 3 plates. Supplement to the Fossil Brachiopoda, Part III (Permian and Carboniferous), by Mr. Davidson, 8 plates. The Lias Ammonites, Part III, by Dr. Wright, 22 plates. The Reptilia of the London Clay, Vol. II, Part I (Chelone) by Prof. Owen, 2 plates.
„ XXXV*	„ 1881	The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright, 6 plates. Supplement to the Fossil Brachiopoda, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson, 5 plates. The Fossil Trigoniæ (Supplement), by Dr. Lycett. The Lias Ammonites, Part IV, by Dr. Wright, 10 plates. The Reptilia of the Liassic Formations, Part III (*Conclusion*), by Prof. Owen, 13 plates. The Fossil Elephants (E. primigenius and E. meridionalis), Part III (*Conclusion*), by Prof. Leith Adams, 13 plates.
„ XXXVI*	„ 1882	The Eocene Flora, Vol. I, Part III (*Conclusion*), by Mr. J. S. Gardner and Baron Ettingshausen, 2 plates. Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood, 1 plate. The Fossil Echinodermata, Cretaceous, Vol. I, Part X (*Conclusion*), by Dr. Wright, 5 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part V (*Conclusion*), by Dr. Davidson. Supplement to the Fossil Brachiopoda, Vol. V, Part I (Devonian and Silurian), by Dr. Davidson, 7 plates. The Lias Ammonites, Part V, by Dr. Wright, 22 plates.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope.

§ II. LIST OF MONOGRAPHS

Completed, in course of Publication, and in Preparation.

1. MONOGRAPHS which have been Completed, and which may be bound as separate Volumes:—

The Eocene Flora, Vol. I, by Mr. J. S. Gardner and Baron Ettingshausen. *Complete in the Volumes for the years* 1879, 1880, *and* 1882. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1882.)

The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady. (*Complete in the Volume for the year* 1876.)

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime. (*Complete in the Volumes for the years* 1849, 1851, 1852, 1853, *and* 1854. *The Title-page and Index, with corrected explanations of Plates XVII and XVIII, will be found in the Volume for the year* 1854.)

The Polyzoa of the Crag, by Mr. G. Busk. (*Complete with Title-page and Index in the Volume for the year* 1857.)

The Tertiary Echinodermata, by Professor Forbes. (*Complete with Title-page in the Volume for the year* 1852.)

The Fossil Cirripedes, by Mr. C. Darwin. (*Complete in the Volumes for the years* 1851, 1854, *and* 1858. *The Title-page will be found in the Volume for the year* 1854, *and the Index in the Volume for the year* 1858.

The Post-Tertiary Entomostraca, by Mr. G. S. Brady, the Rev. H. W. Crosskey, and Mr. D. Robertson. (*Complete, with Title-page and Index, in the Volume for the year* 1874.)

The Tertiary Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1855.)

The Cretaceous Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1849.)

The Fossil Estheriæ, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1860.)

The Fossil Merostomata, by Dr. H. Woodward. (*Complete in the Volumes for the years* 1865, 1868, 1871, 1872, *and* 1878. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1878.)

The Fossil Brachiopoda (Tertiary, Cretaceous, Oolitic, and Liassic), Vol. I, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1850, 1852, 1853, *and* 1854. *The Index will be found in the Volume for the year* 1854, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Permian and Carboniferous), Vol. II, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1856, 1857, 1858, 1859, *and* 1860. *The Index will be found in the Volume for the year* 1860, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Devonian and Silurian), Vol. III, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1862, 1863, 1865, 1866, 1868, *and* 1870. *The Title-page and Index will be found in the Volume for the year* 1870.)

The Fossil Brachiopoda, Vol. IV. Supplements: Tertiary, Cretaceous, Jurassic, Triassic, Permian, and Carboniferous. *Complete in the Volumes for the years* 1873, 1876, 1878, 1880, 1881, *and* 1882. *The Title-page and Index, with directions for the binding will be found in the Volume for the year* 1882.)

The Eocene Bivalves, Vol. I, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volumes for the years* 1859, 1862, *and* 1870. *The directions for the binding will be found in the Volume for the year* 1870.)

Supplement to the Eocene Bivalves, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1877.)

The Eocene Cephalopoda and Univalves, Vol. I, by Mr. F. E. Edwards and Mr. S. V. Wood. (*Complete in the Volumes for the years* 1848, 1852, 1854, 1855, 1858, *and* 1877. *The Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1877.)

The Mollusca of the Crag, Vol. I, Univalves, by Mr. S. V. Wood. (*The Text, Plates, and Index, will be found in the Volume for the year* 1847, *and the Title-page will be found in the Volume for the year* 1855.)

The Mollusca of the Crag, Vol. II, Bivalves, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1850, 1853, 1855, 1858, *and* 1873. *The Title-page will be found in the Volume for the year* 1873, *and Index will be found in the Volume for the year* 1855, *and a Note in the Volume for the year* 1858).

The Mollusca of the Crag, Vol. III, Supplement, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1871 *and* 1873. *The Title-page and Index will be found in the Volume for the year* 1873.)

Second Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1879.)

Third Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1882.)

The Great Oolite Mollusca, by Professor Morris and Dr. Lycett. (*Complete in the Volumes for the years* 1850, 1853, *and* 1854. *The Title-page and Index will be found in the Volume for the year* 1854.)

The Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1872, 1874, 1875, 1877, *and* 1879. *The directions for the binding will be found in the Volume for the year* 1879.)

The Oolitic Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1855, 1856, 1857, 1858, *and* 1878. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1878.)

The Oolitic Echinodermata, Vol. II, Asteroidea, by Dr. Wright. (*Complete in the Volumes for the years* 1861, 1864, *and* 1880. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1880).

The Cretaceous Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, *and* 1882. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1882.)

The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe. (*Complete in the Volumes for the years* 1853, 1854, *and* 1855, *but wants Title-page and Index.*)

The Fossils of the Permian Formation, by Professor King. *Complete, with Title-page and Index, in the Volume for the year* 1849. *Corrected explanations of Plates XXVIII and XXVIII* will be found in the Volume for the year* 1854.)

The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), Vol. I, by Professors Owen and Bell. (*Complete in the Volumes for the years* 1848, 1849, 1856, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Cretaceous Formations, by Prof. Owen. (*Complete in the Volumes for the years* 1851, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations, by Professor Owen. (*Complete in the Volumes for the years* 1853, 1854, 1855, 1856, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Liassic Formations, by Professor Owen. (*Complete in the Volumes for the years*, 1859, 1860, 1863, 1869, *and* 1881. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1881.)

The Fossil Mammalia of the Mesozoic Formations, by Professor Owen. (*Complete, with Title-page and Table of Contents, in the Volume for the year* 1870.)

The Fossil Elephants, by Professor Leith Adams. (*Complete in the Volumes for the years* 1877, 1879, *and* 1881. *Title-page and Index will be found in the Volume for the year* 1881. *Directions for the binding will be found in the Volume for the year* 1881.)

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2. MONOGRAPHS in course of PUBLICATION:*—

The Eocene Flora, by Mr. J. S. Gardner.

The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.

Supplement to the Fossil Corals, by Dr. Duncan.

The Carboniferous Entomostraca, by Messrs. T. Rupert Jones, J. W. Kirkby, and G. S. Brady

The Trilobites of the Mountain-Limestone, Devonian, and Silurian Formations, by Mr. J. W Salter.†

Supplement to the Fossil Brachiopoda, by Mr. T. Davidson.

The Ammonites of the Lias, by Dr. Wright.

The Belemnites, by Professor Phillips.‡

The Sirenoid and Crossopterygian Ganoids, by Professor Miall.

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* Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

† Unfinished through the death of the Author, but will be continued by Dr. H. Woodward.

‡ Unfinished through the death of the Author, but will be continued by Mr. R. Etheridge.

2. MONOGRAPHS in course of Publication—*continued:*

The Fishes of the Carboniferous Formation, by Prof. Traquair.

The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, and Professor Traquair.

The Reptilia of the Wealden Formation (Supplements), by Professor Owen.

The Reptilia of the Kimmeridge Clay, by Professor Owen.

The Reptilia of the Mesozoic Formations, by Professor Owen.

The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.

The Cetacea of the Crag, by Professor Owen.

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3. MONOGRAPHS which are in course of Preparation:— *

The Fossil Cycadeæ, by Mr. W. Carruthers.

The Fossil Sponges, by Mr. W. J. Sollas.

The Rhizopoda of the Chalk, Chalk Marl, Gault, and Upper Greensand, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.

The Foraminifera of the Lias, by Mr. H. B. Brady.

The Polyzoa of the Chalk Formation, by Mr. G. Busk.

Supplement to the Tertiary and Cretaceous Entomostraca, by Prof. T. Rupert Jones.

The Wealden, Purbeck, and Jurassic Entomostraca, by Messrs. T. R. Jones and G. S. Brady.

The Cretaceous Mollusca (exclusive of the Brachiopoda), by the Rev. Prof. T. Wiltshire.

The Purbeck Mollusca, by Mr. R. Etheridge.

The Inferior Oolite Mollusca, by Mr. R. Etheridge.

The Rhætic Mollusca, by Mr. R. Etheridge.

The Carboniferous Bivalve Mollusca, by Mr. R. Etheridge, junr.

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* Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

§ III. Dates of the Issue of the Yearly Volumes of the Palæontographical Society.

Volume	I	for	1847	was issued	to	the Members,		March, 1848.
„	II	„	1848	„		„	„	July, 1849.
„	III	„	1849	„		„	„	August, 1850.
„	IV	„	1850	„		„	„	June, 1851.
„	V	„	1851	„		„	„	June, 1851.
„	VI	„	1852	„		„	„	August, 1852.
„	VII	„	1853	„		„	„	December, 1853.
„	VIII	„	1854	„		„	„	May, 1855.
„	IX	„	1855	„		„	„	February, 1857.
„	X	„	1856	„		„	„	April, 1858.
„	XI	„	1857	„		„	„	November, 1859.
„	XII	„	1858	„		„	„	March, 1861.
„	XIII	„	1859	„		„	„	December, 1861.
„	XIV	„	1860	„		„	„	May, 1863.
„	XV	„	1861	„		„	„	May, 1863.
„	XVI	„	1862	„		„	„	August, 1864.
„	XVII	„	1863	„		„	„	June, 1865.
„	XVIII	„	1864	„		„	„	April, 1866.
„	XIX	„	1865	„		„	„	December, 1866.
„	XX	„	1866	„		„	„	June, 1867.
„	XXI	„	1867	„		„	„	June, 1868.
„	XXII	„	1868	„		„	„	February, 1869.
„	XXIII	„	1869	„		„	„	January, 1870.
„	XXIV	„	1870	„		„	„	January, 1871.
„	XXV	„	1871	„		„	„	June, 1872.
„	XXVI	„	1872	„		„	„	October, 1872.
„	XXVII	„	1873	„		„	„	February, 1874.
„	XXVIII	„	1874	„		„	„	July, 1874.
„	XXIX	„	1875	„		„	„	December, 1875.
„	XXX	„	1876	„		„	„	December, 1876.
„	XXXI	„	1877	„		„	„	February, 1877.
„	XXXII	„	1878	„		„	„	March, 1878.
„	XXXIII	„	1879	„		„	„	May, 1879.
„	XXXIV	„	1880	„		„	„	May, 1880.
„	XXXV	„	1881	„		„	„	May, 1881.
„	XXXVI	„	1882	„		„	„	June, 1882.

§ IV. SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JUNE, 1882): *showing in the* FIRST *column whether each Monograph hitherto published* be complete, *or in the* course of completion; *in the* SECOND *column, the yearly volumes which contain each particular Monograph (as a guide to binding the same); and in the* FOURTH *and following columns, the number of pages, plates, figures, and species described in the different Monographs.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
The Flora of the Eocene Formations, by Mr. J. S. Gardner and Baron Ettingshausen. Vol. I, COMPLETE	1879, 1880, 1882	1879, 1880, 1882	87	13	151	23
The Flora of the Carboniferous Strata, by Mr. E. W. Binney, *in course of completion*	1867, 1870, 1871, 1875	1868, 1871, 1872, 1875	147	24	141	16
The Crag Foraminifera, by Messrs. T Rupert Jones, W, K. Parker, and H. B. Brady, *in course of completion*	1865	1866	78	4	211	43
The Carboniferous and Permian Foraminifera (genus Fusilina excepted), by Mr. H. B. Brady, COMPLETE	1876	1876	166	12	266	62
Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, COMPLETE (*k*)	1849, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1855	406	72	800	319*g*
Supplement to the Fossil Corals, by Prof. Duncan, *in course of completion*	1865, 1866, 1867, 1868, 1869, 1872	1866, 1867, 1868, 1869, 1870, 1872	232	49	797	149
The Polyzoa of the Crag, by Mr. G. Busk, COMPLETE	1857	1859	145	22	641	122
The Tertiary Echinodermata, by Prof. Forbes, COMPLETE	1852	1852	39	4	144	44
The Oolitic Echinodermata, by Dr. Wright. Vol. I, COMPLETE (*l*)	1855, 1856, 1857, 1858, 1878	1857, 1858, 1859, 1861, 1878	491	43	724	120*h*
,, ,, Vol. II, COMPLETE	1861, 1864, 1880	1863, 1866, 1880	207	22	232	35
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, COMPLETE	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882	1864, 1868, 1870, 1871, 1872, 1874, 1875, 1878, 1881, 1882	390	87	1119	113
The Fossil Cirripedes, by Mr. C. Darwin, COMPLETE	1851, 1854, 1858*a*	1851, 1855, 1861	137	7	320	54
The Fossil Merostomata, by Dr. H. Woodward, COMPLETE	1865, 1868, 1871, 1872, 1878	1866, 1869, 1872, 1872, 1878	265	36	365	51
The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, COMPLETE	1874	1874	237	16	515	134
The Tertiary Entomostraca, by Prof. Rupert Jones, COMPLETE	1855	1857	74	6	233	56
The Cretaceous Entomostraca, by Prof. Rupert Jones, COMPLETE	1849	1850	41	7	176	27
The Carboniferous Entomostraca, by Prof. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady, *in course of completion*	1874	1874	56	5	285	50
The Fossil Estheriæ, by Prof. Rupert Jones, COMPLETE	1860	1863	139	5	158	19*i*
		CARRIED FORWARD...	3337	434	7278	1437

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JUNE, 1882)—*continued.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m.* Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	3337	434	7278	1437
The Trilobites of the Mountain-limestone, Devonian, Silurian, and other Formations, by Mr. J. W. Salter (incomplete through the Author's death)	1862, 1863, 1864, 1866	1864, 1865, 1866, 1867	216	31	703	114
The Malacostracous Crustacea (comprising those of the London Clay, Gault, and Greensands), by Prof. T. Bell, *in course of completion*	1856, 1860	1858, 1863	88	22	215	50
Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, COMPLETE	1850, 1852, 1853, 1854	1851, 1852, 1853, 1855	409	42	1855	160
,, ,, Vol. II. The Permian and Carboniferous Brachiopoda, COMPLETE	1856*d*, 1857, 1858, 1859, 1860	1858, 1859, 1861, 1861, 1863	331	59	1909	157
,, ,, Vol. III. The Devonian and Silurian Brachiopoda, COMPLETE	1862, 1863, 1865, 1866, 1868, 1870	1864, 1865, 1866, 1867, 1869, 1871	528	70	2766	321
,, ,, Vol. IV. Supplements, Tertiary to Carboniferous, COMPLETE	1873, 1876, 1878, 1880, 1881, 1882	1874, 1876, 1878, 1880, 1881, 1882	383	42	1664	215
,, ,, Vol. V. Supplements, *in course of completion*	1882	1882	134	7	355	26
The Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1872, 1874, 1875, 1877, 1879	1872, 1874, 1875, 1877, 1879	246	41	446	115
Supplement to the Fossil Trigoniæ, by Dr. Lycett, *in course of completion*	1881	1881	3	0	4	0*h*
The Mollusca of the Crag, by Mr. S. V. Wood:—						
Vol. I. (Univalves), COMPLETE	1847, 1855*b*	1848, 1857	216	21	581	244
Vol. II. (Bivalves), COMPLETE	1850, 1853, 1855, 1858*c*	1851, 1853, 1857, 1861	344	31	691	253
Supplements to the Crag Mollusca, No. I and II, by Mr. S. V. Wood, COMPLETE	1871, 1873, 1879	1872, 1874, 1879	322	18	517	232
,, ,, No. III ,, COMPLETE	1882	1882	24	1	29	13
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, continued by Mr. S. V. Wood. Vol. I, COMPLETE	1848, 1852, 1854, 1855, 1858, 1877	1849, 1852, 1855, 1857, 1861, 1877	361	34	625	275
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood. Vol. I, COMPLETE	1859, 1862, 1870	1861, 1864, 1871	182	25	531	191
Supplement to the Eocene Mollusca, by Mr. S. V. Wood (Bivalves). Vol. I, COMPLETE	1877	1877	24	2	66	30
The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, COMPLETE	1850, 1853, 1854	1850, 1853, 1855	282	30	816	419
,, ,, ,, Supplement by Dr. Lycett, COMPLETE	1861	1863	129	15	337	194
The Liassic Ammonites, by Dr. Wright, *in course of completion*	1878, 1879, 1880, 1881	1878, 1879, 1880, 1881	400	72	600	67
The Belemnites, by Prof. Phillips, *in course of completion*	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	128	36	622	69
		CARRIED FORWARD...	8087	1033	22,640	4585

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JUNE, 1882)—*continued.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	8087	1033	22,640	4585
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, COMPLETE	1853, 1854, 1855	1853, 1855, 1857	67	27	319	79
The Fossils of the Permian Formation, by Prof. King, COMPLETE	1849, 1854*e*	1850, 1855	·287	29	511	138
The Sirenoid Ganoids, by Prof. Miall, *in course of completion*	1878	1878	32	6	61	6
The Fishes of the Carboniferous Formation, by Dr. Traquair, *in course of completion*	1877	1877	60	7	58	5
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, *in course of completion*	1867, 1869	1868, 1870	62	14	195	21
The Reptilia of the London Clay [and of the Bracklesham and other Tertiary Beds], by Profs. Owen and Bell, Vol. I, COMPLETE ‡	1848, 1849, 1856*f*	1849, 1850, 1859	150	58	304	39
,, ,, Vol. II, Part I, by Prof. Owen, *in course of completion*	1880	1880	4	2	4	1
The Reptilia of the Cretaceous Formations, by Prof. Owen, COMPLETE‡	1851, 1857, 1858, 1862	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden and Purbeck Formations, by Prof. Owen, COMPLETE ‡	1853, 1854, 1855, 1856, 1857, 1858, 1862	1853, 1855, 1857, 1858, 1859, 1861, 1864	155	62	251	17
The Reptilia of the Wealden Formations (Supplements) *in course of completion*	1871, 1873, 1876, 1878, 1879	1872, 1874, 1876, 1878, 1879	81	21	175	15
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, *in course of completion*	1859, 1860, 1868	1861, 1863, 1869	16	6	23	3
The Reptilia of the Liassic Formations, by Prof. Owen, COMPLETE	1859,‖ 1860,‖ 1863, 1869, 1881*n*	1861, 1863, 1865, 1870, 1881	174	50	276	20
The Reptilia of the Mesozoic Formations, by Prof. Owen, *in course of completion*	1873, 1875, 1877	1874, 1875, 1877	97	24	165	17
The Crag Cetacea, by Prof. Owen, *in course of completion*	1869	1870	40	5	43	7
The Fossil Elephants, by Prof. Leith Adams, COMPLETE	1877, 1879, 1881*n*	1877, 1879, 1881	265	28	216	3
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and W. A. Sanford, *in course of completion*	1864, 1867, 1868, 1871, 1878	1866, 1868, 1869, 1872, 1878	304	32	253	7
The Mammalia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1870	1871	115	4	247	30
		TOTAL............	10,180	1467	26,260	5019

a Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian. *e* Two corrections of Plates. *f* Supplement.
g Many of the species are described, but not figured. *h* British species only reckoned. *i* British species only reckoned. *k* A Supplement is now in course of publication.
l Index will be found in 1878 vol. *m* Useful for establishing the dates of new species. *n* Contains title-pages and directions for binding.
‡ Title-pages and Index will be found in the 1861 Volume, or may be had separately. ‖ Marked on outside label 'Reptilia of Oolitic Formations.'

§ V. Stratigraphical Table *exhibiting the* British Fossils *already figured and described in the* Annual Volumes (1847—1882) *of the* Palæontographical Society.

	PLANTS.	PROTOZOA.		RADIATA.		ARTICULATA.					
		Sponges.	Foraminifera.	Corals.	Echinodermata.	Cirripedes.	Cypridæ, Cytherinæ, &c.	Estheriæ.	Merostomata.	Trilobites.	Malacostracous Crustacea.
Pleistocene	...	...	...	...	......	......	1874				
Crag	...	...	1865	1849	1852	1851 1854					
Eocene	1879 1880 1882	...	...	1849 1865	1852	1851 1854	1855	...	......	......	1856
Cretaceous.........	...	...	...	1849 1868 1869	1862 1867 1869 1870 1872 1873 1875 1878 1881 1882	1851 1854	1849	...	......	......	1860
Wealden	...	...	...	...	......	......	...	1860			
Oolitic	...	...	...	1851 1872	1855, 1856, 1857, 1858, 1861, 1878, 1880	1851	...	1860			
Liassic	...	...	...	1851 1866 1867	1855, 1856, 1858, 1861, 1864						
Triassic	...	...	...	...	1880	......	...	1860			
Permian	1849	1849	1849 1876	1849 1852	1849	......	1849	1860			
Carboniferous...	1867 1870 1871 1875	...	1876	1852	......	......	1874	1860	1872 1878		
Devonian	...	...	...	1853	......	......	...	1860	1865 1868 1872 1878	1862	
Silurian............	...	...	...	1854	......	......	...	...	1868 1871 1872 1878	1862, 1863 1864, 1866	
Cambrian	...	...	...	...	......	......	...	...	......	1864	

Note.—The numbers in the above List refer to the Volumes issued for those Dates.

STRATIGRAPHICAL TABLE *exhibiting the* BRITISH FOSSILS *already figured and described in the* ANNUAL VOLUMES (1847—1882) *of the* PALÆONTOGRAPHICAL SOCIETY (*continued*).

	MOLLUSCA.				VERTEBRATA.		
	Polyzoa.	Brachiopoda.	Monomyaria, Dimyaria, and Gasteropoda.	Cephalopoda.	Fishes.	Reptiles.	Mammalia.
Pleistocene	...	1873	......	...	...	......	1864, 1867, 1868, 1871, 1877, 1878, 1879, 1881
Crag	1857	1852, 1873, 1879	1847, 1850, 1853, 1855, 1871, 1873, 1879, 1882	...	...	......	1869, 1881
Eocene	...	1852, 1873	1852, 1854, 1855, 1858, 1859, 1862, 1870, 1877	1848	...	1848, 1849, 1856, 1880	
Cretaceous.........	...	1852, 1854, 1873	1872, 1875, 1877, 1879	1853, 1854, 1855	...	1851, 1857, 1858, 1862	
Wealden	...	... ..	......	...	...	1853, 1854, 1855, 1856, 1857, 1862, 1871, 1873, 1875, 1876, 1878, 1879	
Oolitic	...	1850, 1852, 1876, 1878,	1850, 1853, 1854, 1872, 1874, 1875, 1877, 1879	1850, 1861, 1868, 1869	...	(Purbeck) 1853, 1858 (Kim. Clay), 1859, 1860, 1868, 1873, 1875, 1877 (Great Oolite) 1875	1870
Liassic	...	1850, 1852, 1876, 1878	1874, 1877, 1879	1863, 1864, 1866, 1868, 1878, 1879, 1880, 1881, 1882	...	1859, 1860, 1863, 1869, 1873, 1881	
Triassic............	...	1876, 1878	1879	......	1878	......	1870
Permian	1849	1849, 1856, 1880	1849	1849	1849	1849	
Carboniferous ...	...	1856, 1857, 1858, 1859, 1860, 1880	......	......	1877		
Devonian	...	1862, 1863, 1881, 1882	......	......	1867, 1869		
Silurian...........	...	1865, 1866, 1868, 1870, 1881, 1882					
Cambrian							

NOTE.—The numbers in the above List refer to the Volumes issued for those Dates.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLXXIX—MDCCCLXXXII.

BRITISH EOCENE FLORA.

DIRECTIONS TO THE BINDER.

The Monograph on the British Eocene Flora (Volume I) will be found in the publications of the Palæontographical Society issued for the years 1879, 1880 and 1882.

Cancel the Title-pages in the volumes for the years 1879 and 1880, and *substitute* the Title-page now provided, and follow the order of binding given in the accompanying table of pages, plates and dates.

ORDER OF BINDING AND DATES OF PUBLICATION OF VOLUME I.

	PAGES	PLATES	ISSUED IN VOL. FOR YEAR	PUBLISHED
PART III	Title-page ; Contents	—	1882	June, 1882
,, I	1—38	I—V	1879	May, 1879
,, II	39—58	VI—XI	1880	May, 1880
,, III	59—86	XII, XIII	1882	June, 1882

A MONOGRAPH

OF THE

BRITISH

EOCENE FLORA.

BY

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AND

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VOL. I

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1879—1882.

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CONTENTS OF VOLUME I.

The preceding table[1] is full of suggestive interest and contains new evidence bearing upon questions of the highest physical importance.

In conclusion the principal types are recapitulated, in order to include details of distribution and relationship to other recent and fossil Ferns omitted in the specific descriptions.

---

1. Gleichenia Hantonensis, *Wanklyn*. (Page 43.)

The only *Gleichenia* yet met with in the Eocene closely resembles *G. dichotoma,* the sole existing representative of a well-defined subsection of the genus. The agreement between them is striking, and extends to some minute details; thus, the primary veins are grouped and divided identically, the sori are identical in form, and, like in *G. dichotoma,* although usually situated on the upper or left hand secondary vein only, sometimes occur on both the secondary veins. This duplication of the normal single sorus to each primary vein characterises De Bey and Ettingshausen's genus *Didymosorus,* a genus which can hardly now be sustained since *G. dichotoma* has sometimes more than one sorus to each primary vein. From the very fragmentary condition of the few specimens figured by De Bey and Ettingshausen, it cannot yet be said that the possession of two sori to each primary vein is a constant character. But were the fixity of this character apparent there might now be hesitation in attaching specific value to it. The stipes, rachis, and even the leaves in vernation were glabrous.

Specimens of *Gleichenia dichotoma* from Sydney and East Australia appear less rigid and more membranous in character than those from elsewhere, and the Eocene species

[1] We have but to consider the almost complete absence of any records of other herbaceous plants, the difficulty with which mountain species, which form a large proportion of fern-floras, or species with such habits as *Ophioglossum, Asplenium ruta-muraria, A. Ceterach,* &c., could find their way into these deposits, to realise that we are probably only acquainted with those ferns whose habits favoured their preservation.

But as nearly the whole of them have been found at Bournemouth, almost on one spot, and as repeated search has brought no new forms to light, there can be little doubt but that we possess a nearly complete knowledge of the Eocene lowland forest fern-flora of at least this locality, and probably no existing area would furnish a greater variety of types under similar conditions. Although, therefore, the number is small compared to other orders of plants, we cannot help believing the fern-flora to have been extremely rich, considering, as we have said, the complete absence of genera even as cosmopolitan as Asplenium, whose habits are less favorable to preservation.

The British and foreign Ferns provisionally placed together in this table were united, in some cases, from a comparison of illustrations and descriptions only, and the grouping is therefore to a certain extent but an indication of useful work still to be carried out.

seems more closely to agree with them in this, as well as in the undulation and frequent crenation of the margin of the longer pinnules.

In spite of so many points of resemblance the specific difference between the fossil and its existing ally is extremely well marked. The fossil form appears to have possessed a longer and more repeatedly branching stem. In the recent form the pinnæ are dichotomous, and, as I interpret the fossil species, it also was dichotomous, for the hook or short tendril at the base of the single pinna represents the aborted second pinna converted into this singular form. This highly specialised condition may have been induced by the comparative length and weakness of the rachis, the want of rigidity in which is indicated in the fossil by the somewhat sinuous midribs of the pinnæ.

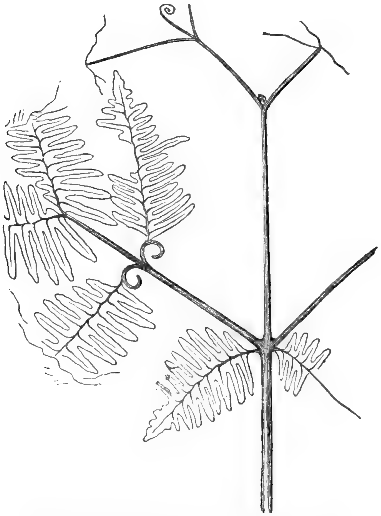

FIG. 28.—Habit of *Gleichenia Hantonensis* restored.

The conversion of these pinnæ into tendril-like supports appears to have been compensated by the former development of the now rudimentary buds, always present between the forking of the stem, into a third pinna or smaller pair of pinnæ.[1] With the disappearance of the tendrils in the existing plant this central bud has ceased to expand, or exceptionally becomes a barren adiantoid bract. Pl. VI, fig. 3, may represent one of the simple pinnæ from the base of the forked branches, characteristic of the section of *G. dichotoma*. The position of these in the existing plant is shown in fig. 28.

Remains of this fern were formerly so abundant at Bournemouth that it is to be

[1] The restoration shows a pair of terminal pinnæ, taken from Plate X, fig. 2.

regretted that no collector should have secured specimens exhibiting its growth in a more satisfactory manner. Remains of forked stems, 3 to 5 mm. in width, associated with the pinnæ, are doubtless the thicker parts of the rachis, and show that these and the fronds were of large size.

This description, although differing in some respects from the former one, is, I believe, more correct, being based upon a larger number of fragments.

G. dichotoma is almost universally distributed in Tropical and sub-Tropical regions, but varies much in habit. The characters given above and the glabrous leaves in vernation and the stipes bring the fossil more distinctly near to the Australian than to any other of the representative types of the species.

Although rare or absent in the Eocenes, *Gleichenias* are abundant in the supposed Neocomian and Upper Cretaceous rocks of Greenland. Heer has separated the fragments into sixteen species, although the greater part, when compared with *G. glauca*,[1] their nearest existing representative, seem to come well within the limits of variation of that species at the present day, even if specimens from one locality only are examined. The presence of the genus in these high latitudes is repeatedly alluded to by Heer as indicating a former approach to a tropical climate in the Arctic regions. Yet *Gleichenias* now flourish in the rigorous climates of the Magellan and Falkland Isles, S. lat. 53°, which have an isotherm of 45°, and are also found on the mountains of Tasmania and on the Andes at an altitude of 10,000 feet, which Humboldt places at the level of gentians and near the limit of arborescent vegetation. It is instructive to notice that while the fossil *Gleichenia* of the Eocene of our latitude has its nearest ally in the distinctly tropical *G. dichotoma*, the living representative of all the Arctic forms should be the only one still ranging into the northern temperate regions in China and Japan.

2. Adiantum apalophyllum, *Saporta*. (Page 42.)

The British fossil examples are detached pinnæ of small size, like those found at Sézanne, but preserving in some instances the arrangement of the sori. They differ from the existing European species in the linear instead of obversely reniform arrangement of the sori, and in being dimidiate, yet no species bears a greater general resemblance to them than *A. Capillus-Veneris*. *A. formosum*, from the Arctic Neocomian, supposed by Heer to be an *Adiantum* with small simple reniform fronds, has the stem and appearance of one of the Ginkgos, which are everywhere characteristic of the secondary rocks in those regions, nor was anything advanced to support his view. No certain *Adiantum* is known from the Polar Tertiary flora, and but mere indications of it from the Miocenes of Europe. The Oligocene of Armissan has, however, yielded a portion of a frond with nearly fifty cuneate

[1] *G. longissima*, Hooker, 'Synop. Filicum.'

segments, bordered along their upper margin with sori, which Saporta sees reason to refer to Lindsaya.[1]

3. Hewardia regia, *Ett. & Gard.* (Page 42.)

This is perhaps the most remarkable form obtained from Bournemouth, and is quite distinct from any other Eocene Fern. The largest specimen measures 5 inches across, and is probably an entire frond. The only existing Fern resembling it is *Hewardia Wilsoni*, from Guatemala, belonging to a section of *Adiantum* characterised by anastomosing venation. There are but four species of *Hewardia* known, all of them almost peculiar to the Equatorial and Central America. The fossil differs enough, however, from even its nearest known ally to entitle it to be considered an extinct type.

4. Pteris eocænica, *Ett. & Gard.* (Page 32.)

This form, widely spread in beds of Tertiary age, in the temperate regions of Europe and America, resembles *Pteris cretica* and other existing allied forms of *Pteris*. Fossils from other localities falling into this group have received many separate names upon such characters as the toothing of the margin and the angle and forking of the veins,[2] yet may possibly belong even to the same species.

P. eocænica is, perhaps, the best type of the species, which should, under whatever name, include all the forms with pinnæ, whether entire or toothed, which have veins running for the most part at a rather obtuse angle with the midrib, simple to twice-forked, and not too crowded together. Other distinct Tertiary species are known, such as *P. gladifolia* of Ludwig, with extremely closely-set parallel veins, resembling *P. pellucida* of the Philippines, but the group needs revision. No examples, it is important to notice, of this type seem ever to have existed in any Arctic flora, although they are so abundant everywhere in the beds approximating to the same ages in temperate zones.

[1] Gervais, 'Mém. de l'Acad. de Montpellier,' vol. v, p. 311, pl. x, fig. 1.

[2] In the 'Flora Tert. Helvetica' the same form appears as *P. parschlugiana*, *P. Gaudini*, and *P. pennæformis*, the first being separated on account of its occasionally twice-forked veins, notwithstanding that the figure of *P. pennæformis* has also twice-forked veins, and because its pinnæ are partially denticulated. The value of the second specific character is shown by the fact that, while in China and Japan, *P. cretica* is generally deeply toothed, it is found in many other regions with a perfectly smooth margin. *P. Gaudini* is only separated because it is somewhat smaller. There are many other forms which, judging by the published illustrations and descriptions, may possibly have to be included, such, for instance, as *Osmunda eocænica*.

5. Pteris Bournensis, *Ett. & Gard.* (Page 33.)

This is rather an unsatisfactory species, and should be included with a large number of other so-called species from the Tertiaries. These forms when united would be an even more extensive group than the last, and, unlike it, are met with fossil in the far north. It seems to figure under at least five names in the 'Flora Helvetica,' and is almost equally well represented in Austria and France. By omitting a trifling character, Heer unites a specimen from Atane with one of the Swiss forms. The living *P. aquilina*, to which it is allied, is found, not only in all temperate zones and in the Tropics, but, like the fossil, passes into the Arctic Circle. Owing to the variability of the pinnæ the living Fern also has an extensive synonomy.

6. Woodwardia ? venosa. *Ett. & Gard.* (Page 41.)

The British fossil species is founded upon a small fragment, barely sufficient to show that, if truly belonging to Woodwardia, it differs completely from the better-known fossil form and falls into the group of *Lorinseria*, Pres., of which *W. areolata*, Moore, a native of the United States, from Massachusetts to Florida, and *W. Harlandii*, Hk., from Honkong, are the only existing types. Unger's Aquitanian species, *W. Rœssneriana*, from Austria and Switzerland, is known from fine specimens with venation and sori beautifully preserved, and, together with very similar forms from the Lignitic Eocene of America, belong to the monotypic group of *Euwoodwardia*. They agree almost precisely with *W. radicans*, which still inhabits Southern Europe, Northern India, Java, Japan, California, Mexico, and Guatemala. The same species has been found in the Pliocene of Meximieux and in the Quarternary of Madeira. *Woodwardites arcticus*, of Heer, from Greenland, is transferred to *Onoclea* (page 68).

7. Goniopteris Bunburii, *Heer.* (Page 38, under name Phegopteris.)

This species represents a type which appeared in Europe in the Middle Eocene, and survived until the Miocenes,[1] but has not yet been met with in any of the Arctic or American fossil floras. It is distinguished from the next and far commoner type by its angulated and much anastomosing veins. It apparently closely approaches some of the varieties of *G. diversifolium* and *G. tetragonum*, of Brazil, but the persistent absence of sori

[1] *G. polypodioides* and *G. Oeningense* appear identical with it.

renders it more probable that it may belong to *Struthiopsis,* a section of *Onoclea,* with similar venation, in which the fertile fronds are separate and of a kind not easily preserved. The venation is also met with in *Acrostichum* and *Nephrodium,* one species of the latter, *N. amboinense,* resembling the fossil almost as much as the *Goniopteris* mentioned.

8. Goniopteris stiriaca, *Unger.* (Page 39.)

This and a number of similar species, most of which need not have been separated, are distinguished by their pinnatifid or distinctly crenate pinnæ, and by curved, instead, as in the former species, of angular secondary veins. In the Bovey and some other instances all the secondary veins anastomose, in others fewer, or the lower pair only. The attachment of the pinnæ to the rachis and the sori to the pinna is remarkably constant, even in small fragments. In England it has only been collected at Bovey Tracey,[1] but in Switzerland, Austria, Italy, France, and America, numerous specimens have been found and sometimes described as distinct species. On the other hand, it may be doubted whether the specimens from the extreme north, as Cape Lyell and Atanekerdluk, are really the same.

The venation is of a type common to many genera among Ferns, and, like that of *G. Bunburii,* occurs in *Acrostichum* and *Nephrodium,* but in the present case the arrangement of the sori lends support to our determination. Unger considered that it most resembled *G. proliferum,* but there are species which even more nearly approach it, and the form and venation recur in several genera.

9. Phymatodes polypodioides, *Ett. & Gard.* (Page 29, under genus Podoloma, *Ett.*)

No Polypodium with reticulated venation has previously been met with fossil in such excellent preservation. It is strictly confined at Bournemouth to a local bed, in which the pinnæ abound, lying flat and in layers, having been articulated and deciduous. They so resemble dicotyledonous leaves as to have induced some scepticism with regard to their classification, but comparison with existing Ferns, especially with those indigenous to Tropical America, such as *P. geminatum, P. stigmaticum, P. lycopodioides,* and *P. persicariæfolium,* places its position beyond all reasonable doubt, and also shows the genus *Podoloma* to be unnecessary. It appeared especially remarkable from the fact that the reticulations converge round the sori (Pl. XII, fig. 10), but an examination

[1] The same species may be represented at Bournemouth by the pinna described as *Phegopteris præcuspidata.*

of the upper surfaces of the fronds above the sori of *P. geminatum* and the other species named, shows that this peculiarity is shared by them in an identical manner. In texture and every other comparable character they are the same. Only slight traces of this group have been met with elsewhere. The form named *Glossochlamys* appears also, from more perfect specimens (Pl. XII, figs. 8, 8 *a*), to be an *Acrostichum*, allied perhaps to *A. Preslianum*, Hk., *A. variabile*, Hk., and *A. nicotianæfolium*, Swz.

10. Chrysodium Lanzæanum, *Visiani*. (Page 26.)

The species is one of the most distinctly characterised of all the Eocene Ferns, and so closely resembles *C. aureum* as to be indistinguishable from it, except that in luxuriant fronds from the Middle Eocene the pinnæ are sometimes more decurrent than has been observed in the living species. It has been found abundantly in the Lower, Middle, and Upper Eocenes, or Oligocene in England, and in similar beds in France and Austria. The existing species is spread over almost the whole coasts of the Tropical and sub-Tropical World and prefers sea air. The pinnules seem to decrease in size from Lower to Upper Eocene, but no good specific distinction is apparent.[1]

11. Osmunda Heerii, *Gaudin*. (Page 53.)

This species may be said to be almost indistinguishable from *O. regalis*. It has not been found fossil in England unless *Osmundites Dowkeri*, from the Thanet Sands, be its stem. It appears as early as in the supposed Neocomian Komeschichten of Greenland, as *O. petiolata*, and may probably be united with Ferns of even older rocks. It next occurs in the supposed Upper Cretaceous of Atanekerdluk, as *O. Heerii* and *O. Obergiana*.[2] It has also been found in the Eocene Lignitic of America, the Aquitanian of Switzerland, the supposed Miocene of Manchuria and Greenland (?), and the Quartenary of Madeira.

1 The late M. Watelet's collection from the Grès du Soissonnais having come into my possession, I am able to state that *Lygodium crassicostatum*, Wat., and *L. capillare*, Wat., figured, Plate xiii, 'Plantes foss. du Bassin de Paris,' appear to be merely fragments of *C. Lanzæanum*. The indistinctness of the specimens, which are in a coarsely-grained matrix, and the possession of a dried frond of a Lygódium with anastomosing venation and somewhat similar outline, doubtless led to their otherwise unaccountable reference to that genus.

2 There seems a possibility, from the figures and descriptions published by Heer, that *Asplenium Boreyana*, *A. Nordstrœmi*, and *Pecopteris Pfaffiana*, may be but a smaller variety of it, since the only supposed marks of sori mentioned among any of the latter were found on a single small specimen, and stated to be very indistinct.

The present range of *O. regalis* is from Sweden to Siberia, Japan, Azores, Bombay, Cochin, Hong-kong, Africa, and from Canada to Rio. Unlike *O. javanica*, the fronds of *O. regalis* attain their greatest luxuriance in moist, temperate regions, such as Ireland, and decrease in size towards the Tropics. Its absence from our Eocene beds (except possibly from the Thanet Sands) is very significant.

12. Osmunda lignitum, *Giebel*. (Page 49.)

This is a species of somewhat limited vertical range common in the Middle Eocenes of Central Europe, France, and England, where specimens have been found in profusion. It is indistinguishable by any specific character from the existing *O. javanica*, and the expediency of giving it a separate name is very doubtful.

Osmunda javanica is a magnificent species inhabiting the East Coast of Asia, from Kamschatka to Java and Sumatra; more than sixty degrees. It attains in the latter countries a luxuriance unknown elsewhere, some pinnæ collected by Beccari in Sumatra measuring 9 inches in length, by $1\frac{1}{4}$ inch broad, while the pinnæ of plants from farther north, especially from Kamschatka, do not exceed 4 inches in length, and are only $\frac{1}{4}$ of an inch broad. It is in the more average-sized pinnæ from Formosa, latitude 24°, that we meet with the most absolute identity, as far as the fragments admit of comparison, with our fossil form.[1] If the size of the pinnæ actually decreases progressively with the isotherm, as appears to be the case in the large series at Kew, this fossil, from its identity with the existing species, may be of use in determining our Eocene temperature. It is remarkable that the most luxuriant fronds from Java and Sumatra have simple margins, while the smaller northern forms become usually more or less deeply serrated. The greater luxuriance attained by it in southern habitats shows it to be an essentially tropical form, while as fossil it has never been found in northern latitudes: nor either recent or fossil in any part of America. It seems to be met with in Europe in Middle Eocene and Oligocene times, and no case is yet known to me of its occurrence in beds of much later date, notwithstanding that Saporta places its horizon in the Miocene.

[1] The longest pinna in my collection, an imperfect one, measures nearly six inches and nine-tenths in length.

13. Anemia subcretacea, *Saporta*. (Page 45.)

Anemia subcretacea is very abundant and well preserved, and in one instance nearly an entire frond was obtained from Bournemouth. It seems essentially characteristic of the older Eocene, and even pre-Eocene Rocks, and has never been found in horizons higher than that of Bournemouth in Europe, and the lowest stage of the Great Lignitic in America. To the same group belong, without doubt, the Fern described as *Asplenium Johnstrupi* and *A. Dicksonianum*, Heer, from the Cretaceous Komeschichten of Greenland, and *Asplenium Försteri*, from Aix-la-Chapelle. They possess the same strength and peculiar dichotomy in the stipes and vernation, the same graceful cutting in the leaves and easy flowing venation, the same universal absence of sori, plainly indicating that they could not belong to Asplenium. *A. Nordenskiöldi* and *A. hyperborea* may be smaller species belonging to the same genus, and *Sphenopteris eocenica* of Europe and America should certainly be linked with it.

These varieties might be united into at most two or three species. The larger, a singularly well-marked form, ranged from the South of France to the Arctic regions, though, perhaps, not synchronously, and first appears in the Cretaceous, and somewhat suddenly disappears in the Middle Eocene. It bears no very striking resemblance to any existing Fern, but the one most like it is *Anemia adiantifolia*, indigenous to America from Florida to Mexico and Bahia. The fossil form appears to have attained its greatest luxuriance in the Eocenes of temperate latitudes, and there is a marked difference in this respect between the average of our specimens and those from the Arctic regions.

14. Lygodium Kaulfussi, *Heer*. (Page 47.)

The fossil is found in Central Europe, France, England, and the United States, and is essentially a Middle Eocene Fern. A smaller and somewhat modified form seems to have preceded it in the Cretaceous rocks of Aix-la-Chapelle. *L. palmatum*,[1] indigenous to Massachusetts and Florida, approaches it closely in some respects, but the Eocene form was very much larger in the barren pinnæ, and the fertile pinnæ were much smaller and even more deprived of parenchyma. While possessing several characters of *L. palmatum*, it far more resembles Tropical species, such as *L. dichotomum* in size and general mode of growth. No species of Lygodium have been met with among the Arctic fossil flora.

[1] It is remarkable that all the fossil Lygodia belong to the section of *L. palmatum*. The barren fronds of the species found at Bournemouth are large compared to those from other Eocene, Oligocene, and Miocene localities, yet no differences are perceptible between any of them in the fertile fronds.

The discovery, subsequent to the publication of our description, of fertile fronds of Lygodium with very short and completely separated pinnules, closely resembling in their appearance and disposition the specimen described with some doubt as *Asplenites præ-allosuroides*, has convinced me that this supposed species is only an example of the fertile frond of Lygodium, with exceptionally abbreviated pinnules. The thick carbonized substance and consequent indistinctness of this and of the original *Asplenites allosuroides* from Sotzka, is entirely in favour of this view, and both species must, I think, be referred to this species.

15. Marattia Hookeri, *Ett. & Gard.* (Page 54.)

Marattia Hookeri has only been detected at Alum Bay, where it is by no means rare (Pl. XII, figs. 1—6). It appears to be closely allied to *M. Kaulfussii*, of the West Indies, Columbia, and the Brazils; more particularly resembling it when the fronds are not fully developed. *M. Kaulfussii* is the only species belonging to the group Eupodium, separated on account of its shortly stalked synangia without an involucre. No fossil Marattia was known previously, and no other Fern is known from Alum Bay, unless it be *Anemia subcretacea*, which Heer states to have been found there.[1]

16. Onoclea hebraidica (*Forbes*). Plate XIII, figs. 5 and 6.

Filicites hebraidicus, *Forbes*. Quarterly Journal Geological Society, vol. vii, p. 103, pl. ii, fig. 2, 1851.
Onoclea sensibilis, *L.*, *Newberry*. Ann. Lyc. Nat. Hist., N. Y., vol. ix, April, 1868.
Woodwardites arcticus, *Heer*. Flora fossilis arctica, vol. i, p. 86, 1868.

O. fronde pinnata, pinnis oblongis vel linearibus, pinnatifidis, lobis rotundatis, denticulatis vel integerrimis; nervatione Dictyopteridis compositæ exappendiculatæ, nervo primario subrecto prominente, nervis secundariis tenuibus flexuosis, angulo acuto egredientibus; nervis tertiariis brevissimis dictyodromis, maculis Dictyopteridis 2—3 *seriatis, inæqualibus.*

From the Ardtun Beds, Mull.

The material upon which the description of this Fern is based consists of the apex of

[1] This and *C. Lanzæanum* are given in Baron Ettingshausen's list of the Alum Bay flora, I think in error, as neither Keeping nor myself have, after years of collecting, ever come across them, and no specimen of either Fern from that locality is now preserved in the national collections.

a frond and numerous smaller fragments. The section *Euonoclea*, of the small genus *Onoclea*, L., with which we have identified it, is represented by a single species, *O. sensibilis*, a large herbaceous dimorphic Fern, with copiously anastomosing veins, belonging to the tribe Dicksonieæ of the sub-order Polypodiaceæ.

The pinnæ in fig. 5 are simple and not divided to the rachis, the lobes bluntly rounded and but slightly cleft, the margins undulated as in the existing fern; their full length is not preserved, the breadth is three quarters of an inch.

To judge from existing species, the frond may have been of large size, with the pinnæ simple, decurrent near the apex, and slightly stalked towards the base. The membranaceous fronds seem to have been quickly destroyed by maceration, for, with one exception (fig. 5), only fragments (fig. 6) are known. They occur in a black shaly matrix, and are therefore not easy to trace out, while the undulations of the pinnæ have become pressed into folds in places, rendering the venation confused.

The rachis is moderately thin, the midribs of the pinnæ slender, and the veinlets fine and decided. The venation of fig. 5, accurately enlarged at 5 *a*, is the less common type, and anastomoses less than is usual in the existing species. The primary veins are seen to leave the midrib at an angle of about 60°. The veinlets are unequal and are more numerous and important above the primary vein, or nearer the apex of the pinna than below it. The lower veinlets start from near the base of the primary vein of each group and unite with the next, forming a series of angulated areolations on each side of the midrib. Nearly all fork once, sometimes twice, and are continuous to the margin which is slightly denticulate. Some veinlets unite with those of the same, and others with those of contiguous groups for short distances, and then again diverge, forming oblong, angulate, or ovate meshes, which vary greatly in size. In fig. 6 *a* the anastomosis is more frequent and complicated, the veinlets on the lower side of the primary vein being almost entirely absorbed in the system of meshes proceeding from the upper side. This, by far the more abundant type of venation, is reproduced exactly in the existing species. Similar variations were noticed among the American fossils.

Known from Mull, from the Fort Union group of Dakotah, and from Greenland,[1] this Fern differs strikingly from others of the European Tertiaries. It is found everywhere in a lacerated condition, and presents great variability in its venation. Specimens brought by Mr. Whymper from Greenland were also figured by Heer,[2] and should now be in the British Museum, though I am unable to find them. Their identity with the Mull Fern is considered certain by Saporta;[3] and if, as the plates show them to be, the

[1] 'Flora fossilis arctica,' 1868, vol. i, p. 86, described as *Woodwardites arcticus* from Atanekerdluk.

[2] 'Phil. Trans.,' 1869, pl. xl, fig. 6.

[3] The Marquis de Saporta, in a letter received since the text was in type, points out its resemblance to *Pleocnemia*, a group of Aspidieæ.

"Votre Fougère de Mull *Filicites hebraidicus* est effectivement identique avec le *Woodwardites arcticus* de Heer; il suffit pour s'en convaincre de comparer les figures du 'Flora fossilis arctica' avec les veinlets are in groups they cannot be placed in *Woodwardia*. Another and more abundant Fern, bearing a resemblance to it when figured, has been described in the same work as *Pecopteris, Hemitelites,* and *Osmunda Torellii,* but the specimens themselves show the Fern to have been of stronger and coarser growth.

Onoclea hebraidica is, as pointed out by Newberry, almost identical with the existing species. This is a monotypic form inhabiting the United States from Florida to Canada; Northern Asia, Amur, Japan, and Manchuria. It also somewhat resembles the more tropical genus *Pleocnemia.*

The specimen (Pl. XIII, fig. 5) had already been figured by the Duke of Argyll in the 'Journal of the Geological Society,' and briefly described by Prof. E. Forbes as "part of a frond, probably that of a Fern, but presenting some anomalous features which future specimens will probably explain. For the present it may be called *Filicites* (?) *hebraidicus.*" Our etching represents the venation in a clearer manner than the lithograph referred to, but conveys the undulating habit less accurately. Fig. 6, selected from a large number of specimens in the Hunterian Museum of the Glasgow University, was found by Mr. Koch in 1880.

The preceding notes embrace all the distinctly characterised species except *Meniphyllum elegans,* on which no additional light can yet be thrown, and therefore even its claim to be considered a Fern seems doubtful. On the other hand, one of the forms, very imperfectly figured (Pl. II, fig. 6), and placed among the "*Filices incertæ sedis,*" may prove a fragment of a coniferous leaf, possibly of Dammara.

The Ferns already mark the distinction that exists between the floras from above and from below the London Clay, the few fragments from the latter belonging to quite different forms. The Bournemouth flora alone has furnished examples of every Fern met with in England from above the London Clay, except the Marattia, that is supposing

votres. Vous pouvez donc les identifier et tirer de cette identification les résultats qu'elle comporte. Elle pourrait entrer dans les genres Aspidium et Phegopteris, et presqu' au même titre; mais il faut remarquer que les Phegopteris ne sont réellement que des Aspidium dont le tégument avorte, et, sans fructification vous ne pouvez arriver à une détermination plus précise.

"Vous avez d'une part l'*Aspidium Leuzeanum,* Kunze (*A. coadunatum,* Wall., 'Ett. Farnkraüter,' pl. 128, fig. 6), d'autre part vous avez le *Phegopteris macrodonta,* Mett., et le *P. Brongniarti,* Mett.; avec ces derniers le rapprochement est encore plus frappant à cause de l'extrème analogie du réseau veineux. J'ajouterai encore comme indice que parmi les espèces inédites des Gypses d'Aix (éocène supérieur) je possède une belle empreinte de penne de Fougère qui me parait se ranger fort naturellement dans ce même genre Phegopteris, non pas précisement à côté de la vôtre mais tout auprès du *Phegopteris prolifera,* Mett. La figure de cette espèce dans l'ouvrage d'Ettingshausen, tab. cix, fig. 2, est une réproduction presque exacte de mon échantillon, que je nomme *Phegopteris provincialis,* mais que je n'ai encore ni décrit ni figuré."

the pinna described as *Phegopteris præ-cuspidata* to be identical with *Goniopteris stiriaca*, which I now think probable, and setting aside *Pteris (?) Hookeri* (Heer. sp.), which may be but the drawing of the enlarged lateral pinna of *Pteris eocænica*. It is very remarkable that of all these only one is found passing either into the Lower Bagshot or the Upper Eocene. Only three species are met with in the older beds at Bournemouth, six are added in the middle beds, five of which disappear in the upper beds and are replaced by three others.

It appears as if we had now a nearly complete knowledge of at least the Ferns of the Bournemouth stage, whose stations were woodland or marsh, for, though work during the past two years has multiplied, and in some cases produced finer specimens, no new type has been brought to light. This concluding part of the monograph on 'British Eocene Ferns,' though enabling several corrections to be made, only adds one species, and this, not because it has been newly discovered, but in view of the extreme probability that the Scotch and Irish Tertiary plants are of Eocene age.

We are able, in addition, to figure some more perfect and larger specimens of *Osmunda*, Plate XIII, figs. 1, 2, 3, 4, a dwarf frond of *Lygodium* (fig. 8) from the same, and a specimen of *Goniopteris Bunburii* (fig. 7) from Lough Neagh.

The Ferns already published furnish data of considerable value, and indicate how much we may expect to learn from the remainder of the flora. Among them, three are peculiarly important through the ease with which they can be identified, for each is scarcely distinguishable from an existing and widely distributed species, yet like no other in the world. There is thus absolutely no shade of doubt about either the authenticity of their determination or the close relationship they bear to a sharply defined existing species. No more definite data could well be imagined, and it may be instructive, even at this early stage, to reflect upon what these and other Ferns teach, before commencing a new subject. One of these cannot be separated by any specific character from the existing *Chrysodium aureum*, a magnificent plant with dark glossy foliage, inhabiting preferably swampy places, and almost confined to tropical or sub-tropical regions. A description by Mosely[1] of its growth in Bermuda reads like a restoration of the Eocene period at Bournemouth. "The most refreshing and beautiful vegetation in Bermuda is that growing in the marshes and caves. The marshes or peat bogs lie in the inland hollows between two ranges of hills. These bogs are covered with a tall, luxuriant growth of Ferns, especially two species of *Osmunda* (*O. cinnamomea* and *O. regalis*). Some Ferns are restricted to particular marshes. In some *Acrostichum aureum* grows[2] densely to a height of from four to five feet. Together with the Ferns grow the juniper, which thrives in the marshes, and a palmetto, which gives a pleasing variety to the foliage."

The species seems to have arrived with the sudden increase of temperature apparent in the London Clay period, for its pinnæ are massed together in the Lower Bagshot at

[1] 'A Naturalist on the Challenger,' p. 23.

[2] A name preferred to *Chrysodium*, in Hooker's 'Synopsis Filicum.'

Studland. It maintained its ground during the physical changes of the Middle and Upper Eocene and Lower Oligocene ages, and only migrated away during the lower temperature that accompanied the deposition of the Hempstead beds. Its absence from Alum Bay and the older Bournemouth beds shows that these stations were unsuited to it, probably through want of moisture, while it was excluded from the otherwise suitable swamps of Bovey[1] through the higher elevation of that district during the Eocene, and from the swamps of Hempstead, where a palmetto still grew, by decrease in temperature. The localities from which it is absent, no less than those in which it is present, show that this part of England must have been almost on the confines of its range, and the minimum temperature of our Middle Eocene and Lower Oligocene may be gauged to some extent from it.

The second Fern is so completely identical with the existing *Osmunda javanica*, that it seems merely misleading to continue to use a separate specific name for the fossil pinnæ. Notwithstanding its abundance in both a recent and fossil state, its identity remained unrecognised for twelve years by Heer, who speaks of it in 1869 as *Hemitelites*, closely allied to *H. Torelli*, of Greenland. There is little to add to our former description, though its late arrival and speedy migration from England are both remarkable. Its present range from Kamschatka to Java shows that it might have withstood, better perhaps than most tropical species, a change of temperature, and, indeed, the relatively small size of the pinnæ at Bovey, prove that it supported there a lower temperature than in the swampy tracts at Bournemouth, where the pinnæ reach nearly twice the size. Its occurrence from the oldest to the newest beds at Bournemouth, shows that it existed throughout our Middle Eocene and was not specially localised, so that its absence at Hordwell, Gurnet Bay, and Hempstead, where many of the associated plants of Bournemouth and Bovey survived, seems a reality. Like the *Chrysodium* it must, with its Cycas-like growth, have formed a conspicuous feature in the swamp vegetation of Bournemouth. Though apparently strictly a Middle Eocene Fern with us, Saporta states that it is confined to the Oligocene in the South of France, a dryer atmosphere and soil doubtless excluding it from the Eocene of Aix in Provence, while farther east, the strata in which it is found seem even newer. From this visible migration eastward it might almost be inferred that it reached its present habitat, the extreme east of Asia, and the islands to the south, from the westward, and incidentally that it failed to penetrate into Hindustan[2] on its route on account of some impassible barrier. It seems likely that this Fern may be useful in fixing the age of plant remains in England, and perhaps also in the South of France, though it must not be inferred from its presence that deposits in different countries are contemporaneous, since, as a still existing species, it might occur in any tertiary or quarternary deposit where

[1] Bovey-Tracey is eighty miles distant from Bournemouth, and situated among hills, whence some of the Eocene river sediment was probably derived.

[2] It is only met with in southern India.

sub-tropical plants are found. From a comparison of the relative size of recent pinnæ from different latitudes with those of Bournemouth and of Bovey, the difference in temperature and consequently of elevation between the two stations might be gauged the more safely from the persistency with which the average size is maintained at each locality. Want of heat evidently excluded it, like the *Chrysodium*, from the Scotch, Irish, and all Northern Eocenes, though in a stunted form it is now acclimatised in Kamschatka, while the absence of both from the entire series of Swiss Tertiaries, shows that unsuitable conditions continuously prevailed there.

A third Fern, *Onoclea hebraidica*, from the basalt formation of Mull, is equally identical with a living species. A discovery made during the progress of this work, while still leaving the true age of this formation somewhat a matter of doubt, shows so conclusively that the North British and Irish Tertiary floras are a continuation of the Eocene floras to the south, that to omit them in this work would be to omit a clue which may render possible the solution of the most interesting problems connected with past and present plant distribution.

The floras from the Eocenes below the London Clay are remarkably homogeneous in England, and present relatively few species. They are, as long since pointed out by Sir J. Hooker in the case of the Reading plants, of remarkably temperate aspect, the leaves and fruits of *Platanus* being conspicuous, among a number of undetermined prevailing types. This flora is sufficiently similar to that from the Greenland Tertiaries collected by Mr. Whymper, and different to other Tertiary floras, to show that a close relationship must have existed between them. The inference from this is obviously that as temperature increased during the London Clay period the old temperate indigenous flora of our latitudes was driven as far north as Greenland, where it must have remained until a diminution of heat again enabled it to descend. The effect of the convergence for so long a time, of perhaps very dissimilar floras from different longitudes towards the land areas of the pole, consequent on a general rise of temperature in the northern hemisphere in Eocene time, would be to mingle the floras of three continents; so that when they redescended, quantities of new forms would almost certainly appear in each area. During nearly the entire Eocene period they were probably continuously modified in the direction of existing trees, and in that sense species no doubt did originate near the pole, as Saporta claims, and when they reoccupied the temperate latitudes of Europe it was as a Miocene flora. The recognition of an Eocene temperate flora in our latitudes, and consequently of a period when arctic conditions prevailed at the Pole similar to those of the present day, explains the universal break in the sequence of floras between Cretaceous and Tertiary, noticed all round the Arctic circle, and is also a considerable step towards a comprehension of the past and the existing plant distribution of the northern hemisphere. It fixes for the first time the ages of the Arctic Tertiary floras, and limits the period during which they could possibly have grown there to between the London Clay and the close of the Oligocene. The Mull and the Antrim floras are intermediate between the closely-allied English Lower Eocene and Greenland Middle Eocene floras, and they possess species in common, not only with these but with the warmer Middle Eocene flora of the South of England, and therefore must be assigned on plant evidence to an age intermediate between these periods. They must, in fact, be relics either of the passage of the Lower Eocene flora north, or of the descent of the Miocene flora south, or else the permanent Middle Eocene flora of those latitudes. Against the former supposition we have the occurrence of the flora in many localities in both Ireland and Scotland, rendering it unlikely that they all were deposited in so limited a period as that in which the change in temperature can be proved to have taken place, even if the mixture of Middle Eocene forms from the south among them were not conclusive. Against the second supposition we have the appearance of immense antiquity presented by the basalts, and the dissimilarity of these floras to those of the European Miocenes. It must be remembered that there is no stratigraphical or other evidence whatever, except the floras, as to the ages of the Scotch, Irish, Icelandic, or Greenlandic plant deposits, though the colossal denudation of the basaltic formations in which they are enclosed, had led many independent observers to assign to them a far greater antiquity than the plant evidence has hitherto seemed to warrant.

Onoclea hebraidica occurs fossil at Mull, at Greenland, and in the Fort Union group of Dakotah, and it still exists unchanged as *Onoclea sensibilis* in the United States and on the temperate east coast of Asia. It might therefore be found among any Tertiary or more recent assemblages of fossil plants in countries in which it still lives without affording a clue to their age, and it would therefore be useless to endeavour to make its presence a test of the real age of the Fort Union group. Professor Newberry, however, made its occurrence in the American Tertiaries the basis of speculation which it now seems desirable to challenge, as the more recently ascertained distribution may be equally well read in a different sense. He considered that since this and other species, at that time common to the Old and New Worlds, have disappeared from Europe, while they continue to flourish in America, it would follow that these were *American* types which had colonised Europe by migration, and that when their connection with the mother country was severed they were overpowered and exterminated by the present flora of Europe, which Prof. Gray has shown to be mainly of north Asiatic origin. The occurrence of *Onoclea sensibilis* on the Island of Mull, while it has not been found in the Tertiary beds of other parts of Europe, indicated he believed not only an American connection during the Miocene period, but an American origin for that species. We need not here follow Prof. Newberry further, as the remainder of his essay is based on the community of American and European Miocene genera, a question not directly connected with the present subject, but it is only necessary to point out that if the *Onoclea* occurs in older rocks in Europe than in America, as well as in the intervening Greenland, the evidence, so far as it goes, favours the theory of its migration north from Europe to Greenland during the warmer Eocene, and south from Greenland to America during the cooler Miocene, thus giving it a European origin. Its existing distribution in Asia and America entirely favours the theory that it spread from the Greenlandic centre, and its occurrence at Mull only traces its origin still farther back to Eocene Europe.

The following very valuable remarks by Prof. Newberry[1] supplement our knowledge of this Fern:—"The collection of Dr. Hayden contains a great number of examples of this beautiful Fern, showing the upper and under surface of the frond, the variation of form of the pinnæ of different fronds, and different parts of the same frond. The robust habit of this plant, the strong, waved and reticulated nervation, and broadly waved rachis, which seem to distinguish it at a glance from all known fossil species, suggested a comparison with some of the strong-growing tropical Ferns; and it was only after a laborious examination of all the genera of exotic Ferns contained in the herbaria to which I had access, or described by authors, that I was led to turn my eyes nearer home. The common form *Onoclea sensibilis* grows abundantly in all parts of our country, and is one of the first plants collected by the youthful botanist. In this we have the rachis of the frond more or less winged, and a nervation on the same general plan with that of the fossil before us, but more distinctly reticulated. By this I was at first misled, but in examining Dr. Torrey's var. *obtusilobata,* I found in some specimens the exact counterpart of our fossil in the lobation of the pinnæ and nervation. The gradation of characters in this variety is very great and interesting. In some specimens we have a distinctly bipinnate frond; the pinnæ composed of numerous remote, even obovate, pinnules, and the nervation not reticulated, the nerves of the pinnules radiating and forked, but never joining." The agreement in character with our fig. 5 is very remarkable, and but for these remarks I should have remained ignorant of the existence of a living representative of this variety of our fossil species, for no examples are preserved in the Kew Herbarium. Prof. Newberry continues:—"This is the extreme form, but even here the rachis of the frond is more or less winged. In an intermediate form we find the rachis winged, the pinnæ deeply lobed, and precisely the nervation of the fossil. Even in the common form the nervation is similar in plan, and the elongated spaces, destitute of nerve branches, on either side of the rachis of the pinnæ, form a noticeable feature in both. There is little room for doubt, therefore, that during the Miocene age a species of *Onoclea* flourished in the interior of our continent, of stronger habit than either of the living varieties, and holding a middle position between them. This fact suggests the question, whether they could not have been differentiated from it."

"Varying, as the living *Onoclea* does, in the size, outline and nervation of the sterile frond—from six inches to three feet in height, from a finely reticulated to an open, dichotomous nervation; from a bi-pinnate frond with remote, obovate pinnules to a pinnate form with wave-margined pinnæ and broadly alate rachis—it plainly includes all the characters of the fossils before us, and I therefore find it impossible to separate them."

[1] 'Ann. Lyc. Nat. Hist. N.Y.,' vol. ix, p. 39, April, 1865.

This description applies equally to the Mull form, about fifteen specimens of which I have examined. They, except fig. 5, were all found by Mr. Koch in 1880, and include facsimiles of the forms of lobation and venation seen in the existing species, while their texture and preservation led me to anticipate a living representative with membranaceous fronds and fine, distinct black veins. The fertile fronds, as in nearly all Ferns in which these are separate and unexpanded, are unknown fossil, and we have here the only pretext which can possibly be held to justify the continued separation of the Tertiary forms of at least the *Chrysodium, Osmunda* and *Onoclea* just described, from the surviving species.

The distribution of the Bournemouth *Gleichenia* is at present the most restricted of any fossil Fern that has been met with at all plentifully, for it is absolutely confined to the small local patch near which it grew. Its peculiar climbing growth has been sufficiently described and is no longer met with in living *Gleichenias.* The *Anemia*, a graceful and well-marked Fern, seems a survival from the Cretaceous period, since extinct, and to have been descended from a northern pre-eocene group. From the plants with which it is associated at Bournemouth, it appears to have been epiphytal, occupying the same position that the not very dissimilar *Davallia* does in the moist and luxuriant forests of Madeira at the present day. The *Lygodium,* associated with it at Bournemouth, undoubtedly occupied similar stations. It possessed larger and more variable fronds than the American species most resembling it, and which seems to have become but recently acclimatised to the temperature it now supports in the United States, since it would probably otherwise have been found in some of the more northern Eocene floras. The much smaller size of the fronds in the Swiss Miocene show, perhaps, that a change was even then in progress. The *Hewardia,* a remarkable form of *Adiantum* with anastomosing venation, probably possessed habits analogous to those of *A. reniforme* at present. It, like the *Anemia, Lygodium, Marattia, Phymatodes,* and several others, can only be looked upon as extinct species, whose resemblance to tropical American, rather than to any other living species, is a fact that acquires significance through the accumulation of instances.

The only Ferns among them resembling existing European species are *Pteris eocænica, P. Bournensis,* and *Adiantum apalophyllum,* but the wide range and the number of species contained in the corresponding types at the present day, render it difficult with our material to identify them more definitely with one than another. The *Goniopteris* section of the *Polypodieæ,* of which three species were described, would perhaps be more correctly represented by two, through the union of *G. præ-cuspidata* and *G. stiriaca.* The latter had apparently a northern range, though the remains are not very distinct, and from the variation among them it is possible that several species or genera are included under the same name. The British species was able to thoroughly establish itself at Bovey-Tracey, but not, so far as we yet know, elsewhere in either England or France, though it abounded in Switzerland. *G. Bunburii* is easy to identify notwithstanding that the venation is of a usual type. From its restricted vertical range at Bournemouth, and its presence at Bovey, it might be inferred that the former locality marks almost its extreme southern range at that time, while northward it reached to Antrim, which may also have been near its limit, since it is apparently absent at Mull. It was evidently a woodland and not a marsh Fern, and its exclusion from Hordwell and Hempstead on this supposition is natural. The importance of the discovery of the Irish locality lies in the fact that it helps to link the Bournemouth Eocenes with those of Antrim, which are themselves linked to the Greenland Tertiaries. I have re-engraved (Pl. XIII, fig. 7) the original specimen figured by Mr. Baily in the 'British Association Reports' for 1880, pl. 2 fig. 1. It was found in an ironstone pebble among silicified wood on the shores of Lough Neagh, and though undescribed, the name of *Hemitelites Fraseri* is attached to it.

All these species are obviously divisible, through the plants associated with them, into marsh Ferns and woodland Ferns, while some which have the greatest range were evidently not entirely excluded from either station. Examples of the latter are the *Chrysodium* and *Osmunda,* remains of which occur in the greatest profusion, mingled with palmettos and other swamp plants, but which are also found with distinctly forest vegetation. Examples of woodland Ferns are the *Lygodium, Anemia,* the two *Adiantums,* &c. *Goniopteris Bunburii,* a purely woodland Fern at Bournemouth, existed perhaps in a lower temperature with a damper station at Bovey, while *G. stiriaca* luxuriated as a marsh Fern at Bovey, but has only been met with once among forest leaves at Bournemouth. It will perhaps be safer, however, to defer these and other inferences until more plants have been described. With the exception of the last-named Fern and the *Osmunda,* which we have seen shows evidence of relatively lower temperature, the higher elevation at Bovey seems to have excluded the contemporary Bournemouth Ferns, or rendered them rare.

While we apparently know much respecting the Ferns of the British Eocenes, compared with what is known of those from the Tertiaries of other countries, several considerations tend to show how insufficient and how incomplete is our grasp of the subject. The present inability to explain the restricted range of so many Eocene Ferns, such as *Phymatodes,* for which there is no apparent reason, the absence of any trace of such widely distributed and ancient forms as *Dicksonia, Asplenium, Lomaria,* and *Todea,* throughout almost the whole Tertiary period; the failure to detect any trace of the fertile pinnæ of so many and such comparatively abundant Eocene Ferns, and the vague knowledge possessed of some other forms, renders the present portion of our work far from satisfactory, and has shown the necessity of a more attentive consideration than it has received.

In comparing our fossils with those of other countries in Europe, we see that even the Ferns may afford some clue to the relative sequence of many of the plant-bearing beds, whose ages cannot be ascertained stratigraphically. The presence, in the Cretaceous series of Aachen, of Jurassic types, now confined to distant isles, indicates their relative antiquity. The presence of a portion of the least archaic of the Aachen types at Sézanne, and the absence of all but the oldest of the Bournemouth types, mark out roughly the age of a deposit, further distinguished, alone among Eocene floras, by the presence of tree Ferns, referred by Saporta to the genera *Hemitelia* and *Cyathea*,[1] and interesting because existing tree Ferns do not penetrate farther north than the moist valleys of the Himalaya. The flora of Gelinden contains no Ferns common to our Middle Eocene, but may be found to present affinities with our Lower Eocene flora. The Grès du Soissonnais posssesses a flora approching that of Alum Bay, and *Chrysodium Lanzæanum* is common to it and to our Lower Bagshot. The distinctly Middle Eocene types first appear in France in the Eocene of Aix, many of them, however, being kept away, probably through a dry climate, until the beginning of the Oligocene. Without pursuing these comparisons further, it is evident that our Eocene and Oligocene Ferns appeared in a definite order, and are, when contrasted with those of the rest of Europe, singularly tropical and luxuriant, suggesting, indeed, that England was then situated in the line of some warm current or under exceptionally favorable meteorological conditions.

In comparing the Eocene Ferns with those of the Arctic regions, the absence there of all the sub-tropical types met with in England is very striking. The absence of *Adiantum*, for there is nothing in the *Adiantites* of Heer to prove affinity with *Adiantum*, shows the nature of the climate, for one species now ranges as far north as the Jura, Tyrol, and south-west of England, where it withstands considerable frosts, while others are found at a height of 6000 to 8000 and even 9000 feet in the Himalayas. Equally significant is the absence of the type of *Pteris eocænica*, for it is present in nearly all similar beds in Europe and America, and is now but little less hardy than *Adiantum*, standing even severe frost, and extending, according to Hooker, to 9000 feet in the Himalayas. Another instance is seen in *Woodwardia radicans*, a type of which abounded in the Tertiaries of Austria, Switzerland, and America. The gradations in temperature were then, in fact, as pronounced as they are in some equally separated temperate latitudes at the present day.

In comparing them with the Tertiary American Ferns, we find two even among the very few yet described from the Great Lignitic series, which are certainly specifically identical with our own, and these are the two oldest types. They are also accompanied by representative, if not identical, species of the following European Tertiary Ferns:—*Sphenopteris eocænica*, *Pteris pennæformis*, *Woodwardia Rössneriana*, *Goniopteris stiriaca*, and *Osmunda Heerii*. It is thus remarkable that the Eocene Ferns of America are much less tropical in aspect than those of Europe at the same period, and consequently more resemble those of the Miocene of Europe. The temperature of the western hemisphere seems to have remained colder throughout the Tertiary period than ours, and hence its floras seem to have preceded ours, and present a relatively newer facies. While it is just possible that these Ferns may have passed over, or descended

[1] A pinna of *Osmunda lignitum* was figured, 'Ann. Mag. Nat. Hist.,' ser. 4, Jan., 1869, vol. iii, pl. i, fig. 5, by Mr. A. Wanklyn, with the remark that it seemed allied to some genus of *Cyatheæ*.

from, northern latitudes, the knowledge we already possess of the Arctic and North American fossil floras effectually takes away every ground for supposing that the strong relationship between the Neo-tropical Fern flora of the present day and that of our Eocene could have been due to any land communication north of latitude 50°.

The relationship of our own Eocene Ferns to the present subtropical American flora is apparent from the fact that of seventeen types all but one are known in it. A connection less in degree is seen between them and the Ferns of Eastern Asia and Java, where six only of the types are absent. Scarcely any of the Middle Eocene types have remained in Europe, except *Pteris cretica* and *Adiantum*, for those related to *Osmunda regalis* and *Woodwardia radicans* seem only to have reached Central Europe from the north during the Miocene. The Eocene forms of *Marattia*, *Anemia*, *Gleichenia*, *Phymatodes*, and *Hewardia* were the first to disappear, and it is remarkable that these happen to differ most widely from their living representatives. Few of the present European Ferns can be traced back to fossil ancestors, even among those of the Arctic regions, while they seem so closely connected with the living Ferns of North America, that of our thirty-six British species, all except three of *Nephrodium* and *Asplenium lanceolatum* and *A. germanicum*, also exist there.

No more is sought for than to claim for such inferences and conclusions as have been arrived at, that they seem warranted by the results of the work so far. There are, however, in all probability living Ferns still undiscovered, and we are as yet certainly acquainted with but a fraction of the Eocene Fern world. Still, however incomplete the data for interpretation may be, the possibility that something may come to light in the future to change or modify views based upon our present knowledge, does not deprive them of current value. The interest attaching to these Ferns is increased by the fact that while the higher orders of plants from the Tertiaries have formed the basis for much speculation as to former temperatures, distribution, &c., the inferences to be drawn from Ferns have hardly been taken into account.

Amidst inference and hypothesis, the fact at least is certain, that there is no real break between Eocene and Miocene floras when they are traced over many latitudes. The supposed Miocene floras of the Arctic Circle are, we shall see, but modified temperate Eocene floras which had migrated north when warm conditions set in, and which redescended south, still further modified, when the decrease of warmth during the Miocene again permitted them to do so. The results that followed the forced convergence towards the land areas of the Pole of perhaps very dissimilar floras from long separated lands of different longitudes, through a general increase in the Eocene temperature of the Northern hemisphere are as yet faintly sketched and perplexing, but with patience they can be unravelled. At present it can only be stated that when they redescended as Miocene floras, they were greatly modified and enriched in genera and species.

INDEX OF FOSSIL SPECIES.

(The accepted British fossil species are in italics, the rest are synonyms or closely allied foreign species.)

INDEX OF LIVING FERNS.

GENERAL INDEX.

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PLATE XII.

FROM THE LOWER BAGSHOT, ALUM BAY.

Figs. 1—6. *Marattia Hookeri,* Ett. and Gard. (British Museum[1]).

2 *a* and 4 *a*. Apices of pinnæ enlarged.

4 *b*. Part of pinna enlarged.

6 *a*. Enlargement from a specimen showing secondary venation.

FROM THE MIDDLE BAGSHOT, BOURNEMOUTH.

7. *Adiantum apalophyllum,* Saporta (British Museum).

8. *Glossochlamys transmutans,* Ett. and Gard. (British Museum).

8 *a*, 8 *b*, 8 *c*. Enlargements, showing position of sori.

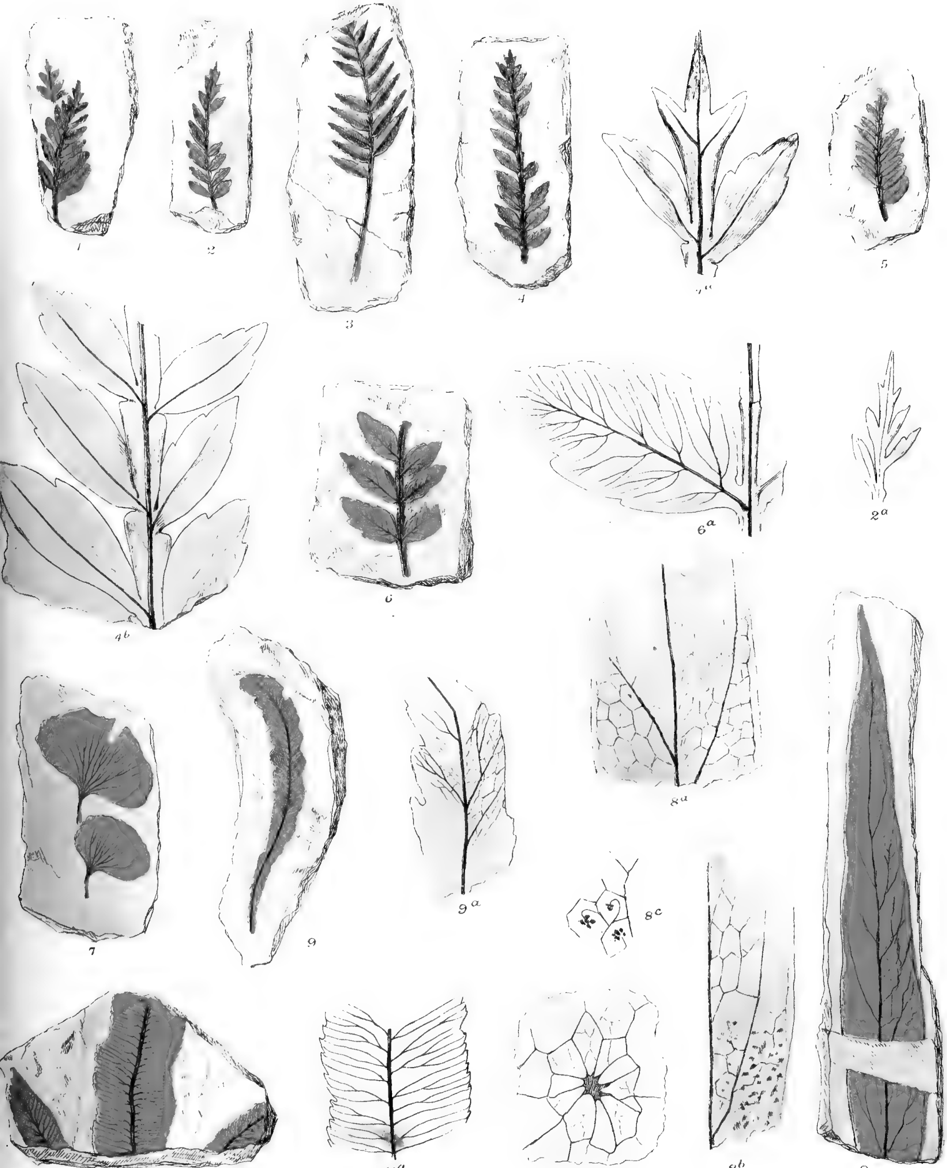
9. Fern fragment, indeterminable (British Museum).

10. *Podoloma polypodioides,* Ett. and Gard. Enlargement of veins beneath sorus.

11. *Pteris eocænica,* Ett. and Gard. Fragment showing the relative proportion of terminal and lateral pinnæ (Jermyn Street Museum).

11 *a*. Enlargement.

[1] The specimens marked "Gardner Collection" in this work are now in the British Museum.



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EOCENE FERNS

PLATE XIII.

From the Middle Bagshot, Bournemouth.

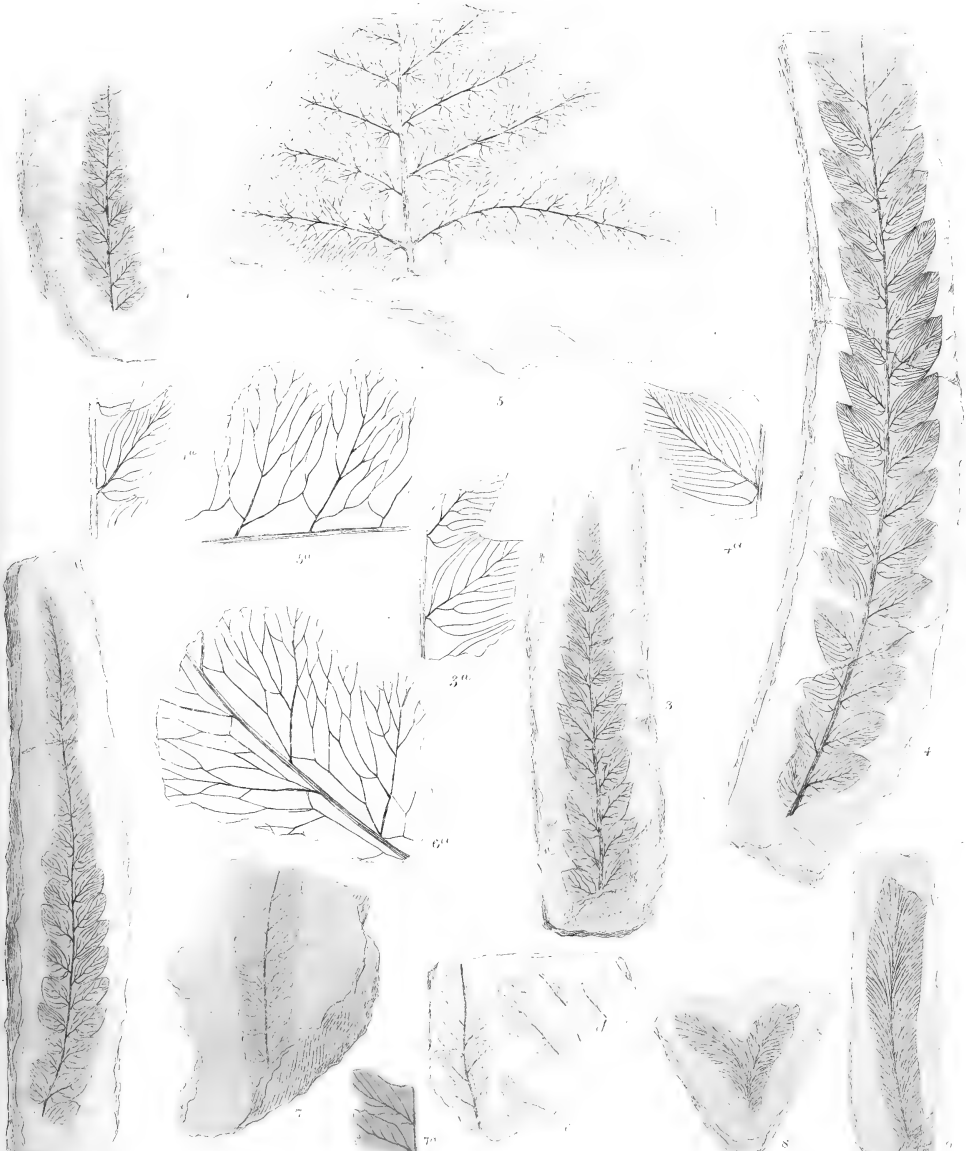
Figs. 1, 2, 3. *Osmunda lignitum* (Giebel, sp.). Terminations of pinnæ (British Museum).
4. Full size frond, showing base, part only figured.
1 *a*, 3 *a*, 4 *a*. Enlargements.
8. *Lygodium Kaulfussi*, Heer. Dwarfed, barren frond (British Museum).
9. Simple frond, which when perfect tapered to a narrow base.

From the Ardtun Beds, Mull.

5. *Onoclea hebraidica* (Forbes, sp.). Part of frond near apex (Jermyn Street Museum).
5 *a*. Enlargement.
6. Fragment (Hunterian Museum, Glasgow University).
6 *a*. Enlargement.

From the Antrim Beds, Lough Neagh.

7. *Goniopteris Bunburii*, Heer (Geological Survey Collection, Dublin).
7 *a*. Enlargement.



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MONOGRAPH

ON THE

BRITISH FOSSIL

ECHINODERMATA

FROM

THE CRETACEOUS FORMATIONS.

BY

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

VICE-PRESIDENT OF THE PALÆONTOGRAPHICAL SOCIETY; CORRESPONDING MEMBER OF THE ROYAL SOCIETY OF SCIENCES OF LIÈGE; THE SOCIETY OF NATURAL SCIENCES OF NEUCHÂTEL; VICE-PRESIDENT OF THE COTTESWOLD NATURALISTS' FIELD CLUB; CONSULTING SURGEON TO THE CHELTENHAM HOSPITAL; AND MEDICAL OFFICER OF HEALTH TO THE URBAN SANITARY DISTRICTS OF CHELTENHAM, CHARLTON KINGS, AND LECKHAMPTON.

VOLUME FIRST.

PART TENTH.

CONCLUSION.

PAGES i—xviii, 325—371; PLATES LXXVI—LXXX.
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THE CRETACEOUS ECHINOIDEA.

DIRECTIONS TO THE BINDER.

The Monograph on the Cretaceous Echinoidea will be found in the Volumes of the Palæontographical Society for the years 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, and 1882.

Cancel the Title-pages affixed to the separate parts, and *substitute* the general Title-page provided in the Volume for the year 1882.

ORDER OF BINDING AND DATES OF PUBLICATION.

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325—371	LXXVI—LXXX	1882	June, 1882

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VOLUME I.—THE ECHINOIDEA.

LONDON:

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1864—1882.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

CONTENTS.

PREFACE.

With this Preface the history of the British Fossil Cretaceous Echinoidea is brought to a close, and it only remains for the Author to record his warmest acknowledgments to the many kind friends, enumerated in the retrospect, who have generously assisted him in his long and laborious task. The duty imposed upon him by the Council of the Palæontographical Society, occasioned by the untimely death of his distinguished colleague, Prof. Edw. Forbes, F.R.S., has been much lightened by their ready, willing, and friendly aid at all times.

When the Plates for this Monograph had been nearly completed his accomplished artist, Mr. Charles Bone, who had assisted him during so many years, likewise passed away; so that in writing this preface the Author is solemnly reminded of the mutability of all human undertakings, and desires to express his deep regret that one who had aided him for nearly thirty years by steady, continuous, and most accurate work, had not been spared to see the conclusion of his labours. The Author, therefore, embraces the present opportunity of recording his high appreciation of Mr. Bone's artistic drawings, which for beauty and accuracy in lithographic art have not been surpassed, whilst all essential details relating to the anatomical structure of the Echinoidea have been faithfully rendered throughout.

The Author in an especial manner desires to return his warmest acknowledgment and very best thanks to his old friend the Rev. Professor Wiltshire, F.G.S., the indefatigable Secretary of the Palæontographical Society, for his unwearied attention to every part of his work as it passed in successive years through the press. The admirable summary of the British Cretaceous Echinoidea and copious index which he has kindly contributed to complete this volume, have added much to its value and general usefulness; and he must further add that the liberal supply of fine specimens from his rich collection of Chalk Echinoderms, in order to furnish the artist with the best possible specimens for the plates, has been of very great assistance in carrying out the work, and for which he now expresses his deep obligations, and records his lasting gratitude for all his most kind, generous, and friendly aid from first to last.

4, St. Margaret's Terrace, Cheltenham;
25th April, 1882.

A RETROSPECT.

Before bringing this Monograph to a termination I desire to state to my Readers (many of whom have joined our Society since the work was commenced), the circumstances under which I became the historian of the British Cretaceous Echinodermata, and the difficulties I experienced and had to overcome during the progress of its composition, as they help to explain the apparent delay that has occurred and the length of time which has elapsed between the issue of the first and last part of the Monograph.

When the History of the British Fossil Echinodermata was first proposed to the Council of the Palæontographical Society in 1851, by the late Professor Edward Forbes, it was arranged that the description of the Cretaceous species was to be undertaken by him, and that of the Jurassic species by myself. Long, however, before the Jurassic portion was complete my highly esteemed and learned colleague died (in November, 1854), very soon after he had attained the object of his life's ambition, the Chair of Natural History in the University of Edinburgh. Before leaving London, Professor Forbes had gathered from various sources a large collection of materials for the Cretaceous Monograph; these he took with him to Edinburgh, intending to commence the work as soon as he had settled down into the routine duties of his new chair; but his sudden death unfortunately deprived science of the rich store of facts and notes on the specimens he had collected from various cabinets for this work. Under these painful circumstances the Council of the Palæontographical Society urged me to undertake the description of the Cretaceous forms as soon as I had finished the Jurassic species; and this I consented to do in the belief that the materials collected by Professor Forbes would be available for the work. On making inquiry, however, I found to my dismay that after the death of my friend the fossils had been packed up with other property and sent into the cellars of the University, and could not be touched until some legal matters were arranged. A long delay now took place; and at last, when a search was made, the cases containing the Cretaceous specimens of Echinides could not be found. In this dilemma, and not then having a good collection of Chalk Urchins myself (all my energies up to that time having been given to complete my Jurassic collection), I applied to the authorities of the British Museum, to the Director of the Museum of Practical Geology (the late Sir Roderick Murchison); and to the Earl of Ducie, the Rev. Thos. Wiltshire, the late Dr. Bowerbank, the late Professor Tennant, the late Dr. S. Woodward, Mr. W. Cunnington, Major Cockburn, Mr. Caleb Evans, Mr. Robert Etheridge, and Mr. Weist. Messrs. E. T. Newton and Sharman, Assistant Naturalists of the Jermyn Street Museum, most kindly at all times aided me in making selections of specimens for figuring in the plates.

On the Continent I have had much friendly aid from MM. Gustave Cotteau, of Auxerre, Perceval de Loriol, of Geneva, Herr Struckmann, of Hanover, Professor De Koninck, of Liège, and the late MM. Seemann and Triger, of Paris.

In addition to the valuable aid of the above kind friends, to whom individually and collectively I tender my warmest thanks, I have made many tours of inspection to all the best private collections in England containing Chalk Echinoderms, and have visited and worked the quarries in the different Cretaceous formations, in order to identify the distribution of the species with the beds from whence they were said to have been collected. All these proceedings have occupied much time, and were undertaken at a period when I was fully occupied in the laborious practice of my profession, so that I found much difficulty in bringing out the parts consecutively in the annual volumes of the Palæontographical Society.

The many duties and incessant occupation connected with my present position as Medical Officer of Health having deprived me of the leisure necessary to continue my sketch of the History of Echinology, I ventured to ask my much esteemed friend, M. Perceval de Loriol (author of the 'Echinologie Helvetique'), to undertake this portion of the work. Monsieur de Loriol, with his usual kindness, consented to do so, I have, therefore, now the pleasure of introducing his masterly sketch (for the translation of which I alone am responsible) of the progress made in Echinology during the last twenty years. For this most valuable addition to my work I beg to return my highly accomplished friend my very warmest thanks.

"ON THE HISTORY OF ECHINOLOGY SINCE 1862, BY PERCEVAL DE LORIOL.

The fourth part of the vast Monograph, undertaken by Dr. Wright, relating to the description of the Jurassic Echinides, was published in 1861. Dr. Wright had enriched that part with a Table, giving a list of the works concerning the Echinides, that had come to his knowledge up to that date. It will not be without interest and utility, therefore, to terminate the Monograph on the Cretaceous Echinides, to which Dr. Wright is now adding the last pages, with a rapid review of the progress which has been accomplished during the last twenty years in the domain of Echinology, and to take a glance at the magnificent discoveries for which we are indebted to the late Expeditions, which had for their object the investigations of the depths of the sea.

Dr. Wright's numerous professional occupations not permitting him to enter upon this branch of the subject, he has asked me to take it upon myself, and it is with very great pleasure that I embrace the occasion of co-operating, in however feeble a degree, in a great and beautiful work, brought so happily to a conclusion by my learned friend.

Commencing with an enumeration of the many works written on the Fossil Echinides, I think we shall proceed with more method if they be grouped by countries and by regions, taking into consideration, not the nationality of the authors, but the Echinitic fauna upon which they have made their observations.[1]

The study of the Fossil Echinides of Great Britain appears during late years to be concentrated in the general Monograph by Dr. Wright, and I find myself able to cite only one paper, that by Mr. Keeping (1), 'On the Genus *Pelanechinus*, a new Section established for the *Hemipedina corallina*, Wright,' the coronal plates of which appear to have been in some measure imbricated, resembling those in *Asthenosoma*.

France has contributed a great number of works on Echinology, of which most are due to the indefatigable zeal and untiring industry of M. Gustave Cotteau, of Auxerre; and it is important to mention above all a work of the first order, the 'Echinides de la Paléontologie Française' (2), the publication of which is still being actively carried on.

The 'Échinides Crétacés,' commenced by d'Orbigny and continued by M. Cotteau, is now completed. Two volumes of the 'Échinides Jurassiques' have already appeared. They comprise the *Echinides irréguliers*, the family of the Cidaridæ, and those of the Saleniadæ; those of the Diadematidæ will soon follow. Three other very important works of M. Cotteau, commenced many years ago, have been completed; the description of the Echinides of the Department of the Sarthe (3), in which he has made known the Urchins, so numerous and varied, which the Jurassic and Cretaceous strata of this Department contain, and the illustrations of which required sixty-five plates; the second part of the 'Echinides of the Yonne' (4), comprising the description and figures of ninety-nine species from the Terrains Crétacés; and lastly the first series of new or little known Echinides, which have successively appeared in the 'Revue et Magasin de Zoologie' (5), and in which are found valuable observations upon known species, as well as the description of numerous new species, the most part derived from France, but also from other countries. Independently of these works, as a whole, M. Cotteau has published many local Monographs, which have made great steps towards an exact know-

[1] To avoid the incumbrance of notes I shall add an appendix to this essay, in which I shall give the titles of the works to be identified by corresponding figures in the text. I have not cited all the works in which Fossil Echinides are mentioned, but only those which appear to me more specially important either as general works on the subject, or those in which some discovery is recorded. To this end I have made as conscientious an investigation of all the works as was in my power; but possibly some publications may have escaped my notice. If such should be the case I make an honorable amende in advance for the omission which I shall be the first to regret.

ledge of the Echinitic Fauna of France. These contributions are in the form of notes, or lists of species, with observations made to clear up critical questions, with sometimes more complete studies on which the species are found entirely described and figured. M. Cotteau has thus made known successively the Nummulitic Echinides of Biarritz (6); the Cretaceous Urchins of Martigues (7); the Echinides of the Pyrenees (8); those of the Aube (9); and those of the Oxfordian of the Ardèche (10); new species from the Environs of Bordeaux (11); the Echinides of the Cretaceous Colony of the "Garonnien" of the Department of Aude (12), among which was found the first Cretaceous *Schizaster* known; those of the Miocene deposits of Corsica (13); those of the Jurassic strata of Normandy (14); and lastly, a supplementary note (15) completes the characteristics of the curious new genus *Tetracidaris,* from the Neocomian of Central France, which possesses two series of pairs of pores in each poriferous zone, and four series of inter-amubulacral plates. In addition to these beautiful monographic studies of M. Cotteau, there are other works upon the Echinides of France, which still remain to be enumerated. Thus, Saemann and Dollfuss, in 1861, characterised with care some species from Trouville (16). Dumortier, in his remarkable work upon the 'Depôts Jurassiques du Bassin du Rhône,' has described many Echinides from the Lias (17). M. Tournouer (18), has given a revision of the Echinides of the Calcaire à Astéries (Tongrian) of the South-west of France, with figures of new species and critical remarks on the same. Caffin (19) has occupied himself with the Echinides of the Environs of Evreux. M. Bucaille (20) has given a Catalogue Raissonné of those of the Seine Inférieure, with descriptions of new species. Professor Hébert (21) has endeavoured accurately to diagnose the characters of certain Hemiasters, and he has (22) described two new *Hemipneustes* from the Chalk of the Pyrenees. M. Sauvage (23) has made known new species from the Upper Jurassic of the Boulonnais. M. Arnaud (24) has endeavoured to facilitate the determination of the numerous Cretaceous species of the genus *Cyphosoma,* to which he has added some new forms. Desmoulins (25), to whom Echinology was already indebted for numerous works, has made some interesting observations upon six species of *Echinolampas,* upon the spines of *Echinocidaris,* and upon a Miocene *Spatangus* from Saucats. Finally, I have published (26) a description of some Echinides from Berrias and Aizy (27), and have been occupied with those from the Portlandian of the Yonne (28), also with those from the Upper Jurassic of the Boulonnais (29), and of the Haute Marne (30). A general work, by Dujardin and Hupè, upon the Echinoderms (31) has likewise to be mentioned.

In Switzerland the Echinologic studies, to which Agassiz and Desor had already given such vigorous impulsion, have been continued. Etallon (32), who had already studied the Echinides from different formations bordering on the frontiers of France (33 and 34) and of Switzerland, aided in the enlargement of a posthumous work of Thurmann's, 'Le Lethæa Bruntrutana' (35), in which numerous species of Echinides are found described and figured. M. Ooster (36) a few years afterwards published his

'Synopsis of Fossil Echinoderms of the Swiss Alps,' in which numerous species from the Nummulitic formation are found figured. He has given also indications of certain Alpine species in his 'Protozoa Helvetica' (37). I have described also some Echinides from the Neocomian of Mont Salève (39), from the Valangian of Arzier (40), and the Urgonian of Landeron (41). I have also undertaken, under the title of 'Echinologie Helvetique' (42), the publication of the Fossil Urchins of Switzerland. In the First Part comprehending the Jurassic Echinides I had the happiness of having for my collaborator M. Desor. I afterwards finished alone the Second and Third Parts, which treat of the Cretaceous and Tertiary Echinides. Four hundred and thirty-eight species are the contingent of the Echinitic fauna furnished up to the present time by the Secondary and Tertiary formations of Switzerland.

Thanks to M. Cotteau, the Fossil Echinides of Belgium, hitherto known in a very summary manner, have been submitted to a new and very necessary revision. He has published, in succession, a 'Note on the Cretaceous Echinides of Hainaut' (43), with some species figured; the 'Description of the Echinides of the Calcaire Grossier' of Mons, Senonian (44); and the 'Description of the Tertiary Echinides of Belgium' (45), an important Monograph, in which thirty-one species are found figured and described, and of which thirteen species only were previously known, and the most of these very imperfectly.

It is likewise to M. Cotteau that we owe the knowledge of three interesting species from the Upper Chalk of Sweden (46).

Among the works which have appeared on the Echinides of Germany it behoves me to cite, in the first place, the volume on the 'History of Fossils of Germany,' which Professor Quenstedt has devoted to the Echinides (47). The Atlas of twenty-eight plates contains no less than 1700 figures, with numerous magnified views; whilst the text treats of not only the Echinides of Germany, but also many others which are not found there. This work, the result of very considerable labour, comprehends a great number of useful indications and previous observations; but it is to be regretted that Professor Quenstedt persists in his refusal to accept the nomenclature adopted in the mean time by all authors and corresponding to the actual state of our knowledge. The want of method and the improper denominations occasion much confusion, so that the practical utility of the work is much diminished. "Die Echiniden" has, nevertheless, a real value, and has advanced science principally in making known several details of the structure of many species which had not been previously observed, and in many cases it will be consulted with advantage. The Chalk of the North of Germany has furnished to M. Schlüter (48) many new species which he has described and figured. Subsequently he indicated some others, but only gave short diagnoses of them (49). Besides, many of the Cretaceous species from the same region have been well figured and described by Schlœnbach (50); and M. Dames has given a description of the Jurassic species collected in the North-west of Germany. The Echinides of the Upper Cretaceous strata of the Valley of the Elbe have been described and figured by Prof.

Geinitz (52); and M. Schafhäutl has given figures of the Tertiary species from Kressenberg, but in general they have not been determined in a correct manner. It is important moreover to cite the new 'Handbuch der Palæontologie' by Prof. Zittel (54), and especially the well-written chapter treating of Echinoderms.

For the Empire of Austria I have equally many Echinologic works to mention. M. Cotteau (55) has made known the Echinides of Stramberg, derived from the strata about which so much controversy has taken place. M. Laube has decribed those from the Bathonian stage at Balin (56), and those from the Upper Tertiaries of Austro-Hungary; and he has discovered in the Eocene of the Mattsee (58) a new genus, the *Oolaster* bordering on *Ananchytes*. The Miocene strata of Ottnang have furnished to Herr R. Höerness (59) some species; and from those of the environs of Felmenes some others have been noted by Herr Loczy (60), amongst others a new and interesting *Echinocardium.*

The Urchins from the Eocene deposits of Hungary and Transylvania have been studied by Herr Pavay (61), who had undertaken a general Monograph on the Echinides of Hungary (62), of which his premature death only permitted him to give a first part to the world.

The Cretaceous strata, but especially the Tertiary beds, of Istria and of Friuli (64) have furnished many Echinides to M. Taramelli. His summary descriptions have been completed by M. Bittner (65), who has also enriched the Tertiary fauna of Istro-Dalmatia with new and interesting species.

The Tertiary strata of a region bordering upon Lombardy have been for a long time celebrated for their richness in Echinides, but a monographic study has not yet been made of them. Herr Schauroth (66), in his Catalogue of the Museum of Coburg, has made known in a very imperfect manner some new species. Herr Laube (67) has much augmented the number of forms, and grouping the whole of the known species, has endeavoured to establish a parallelism amongst the beds in which they are found. Herr Dames (68), following up these observations in a very extended memoir, has revised certain of Herr Laube's species, added new ones to the list, and established two new interesting groups:—the genus *Ilarionia,* which approaches *Pygorhynchus,* but possesses a pentagonal periostome; afterwards the curious genus *Oviclypeus,* which approaches very near to *Conoclypeus,* and like it, was provided with a masticatory apparatus. It behoves us still to cite a fossil species of the genus *Palæopneustes* recently discovered in the Seas of the Antilles. The Tertiary beds of the Vicentin seem to be almost inexhaustible, for Herr Bittner (65), following up the precited memoir with another, has been able to add many more species, among which he has discovered several new forms that were unknown to his predecessors.

The Miocene Mollusca of Italy have yielded to M. Manzoni (69, 70) many interesting Echinides; and in the Middle Miocene he has collected a large and curious species of *Spatangidæ* (71, 72). M. Gemellaro (73) has described some species from the Upper

Sequanian of Sicily; and the Abbé Stoppani (74) has described some species from the Lower Lias of Lombardy.

Regarding the Echinides of Spain I have only a few remarks to make. There are two works by M. Cotteau, one very short, relative to some new Echinides collected in Spain by M. de Verneuil (75), and the other being a contribution to a memoir of M. Barrois upon the Cretaceous strata of the Province of Oviedo, giving a description of some new Echinides from the Urgonian (76).

The Echinitic fauna from the Miocene beds of the Island of Malta, which is very rich in fossil Urchins in a fine state of preservation, had been previously studied and reported upon by Dr. Wright (77). These fossils were subsequently the subject of a second memoir, in which are additional notes, and the description and figures of some new species. In the Island of Melos a very interesting little Echinitic fauna has been found, apparently of Pliocene age, and in which Herr Dames has discovered a *Cidaris*, very different from those which now live in the Mediterranean (78).

Before terminating my remarks relating to Europe I have still to mention a little work which I have made on the Tertiary and Cretaceous Echinides brought from the Crimea, by M. Ernest Favre (79).

Crossing now the Mediterranean to pass into Africa we arrive in Algeria, which appears to be the promised land to the Echinologist, for in almost all the geological formations of this region the Echinides abound in a surprising manner. M. Coquand (80), in his 'Palæontology of the Province of Constantine,' first made known a great number of species. Afterwards came the large and beautiful publication of MM. Cotteau, Péron, and Gauthier (81), which, commencing with the Jurassic strata, undertakes to describe all the Fossil Echinides of Algiers; this work has now reached the Senonian stage of the Cretaceous deposits. Among the numerous species which these rocks have yielded, the number of those appertaining to the genus *Hemiaster* is truly extraordinary. In a recent work by M. Coquand (82), a great number of additional species of the same genus are described, but unfortunately not figured, hence it is impossible to give an exact account of the value of their characters.

I am of opinion that a general revision of the species would result in diminishing the number, for I cannot but suspect that sufficient allowance has not been made for sexual differences, which are important, and which have been studied in *Hemiaster cavernosus* living in the Seas of Kerguelen, by Sir Wyville Thomson ('Challenger, Atlantic,' vol. ii, p. 229), and by Dr. Theoph. Studer ("Ueber Geschlechts Dimorphismus bei Echinodermen," 'Zool. Anzeiger,' Nos. 67 and 68, 1880). The beds in the North of Africa are certainly far from being exhausted, and the Tertiary strata yet unexplored doubtless contain many Echinides which by-and-by will become known. Mr. Etheridge has described a new Scutelloid genus obtained from the Miocene of Morocco (83), the genus *Rotuloidea*. The Tertiary deposits of Egypt contain numerous species of Echinides, of which some only have been described, and for the most part very imperfectly; they have been studied more completely of late years. Prof. Fraas has given an account of many Nummulitic species (84), and has discovered the large Clypeaster of the Pyramids (*Clypeaster Ægyptiacus*, Wright), from a Miocene rock. I have since published a 'Monograph of the Nummulitic Echinides of Egypt' (85), in which forty-four species are figured and described, and in another Monograph (86) the Eocene Echinides of Egypt and of Lybia, brought by Professor Zittel from his voyage of discovery with Dr. Rohlfs, the new species are added by me to that interesting Echinitic fauna. I may remark *en passant* that I have given in these monographs figures of the masticating apparatus of *Conoclypeus conoideus* which Dr. Zittel had already discovered. This genus ought, therefore, to be removed from the family of the Cassidulidæ, in which it has hitherto been classed.

Our knowledge of the fossil Echinides of Asia is not yet very extensive. Since the 'Monograph on the Nummulitic Beds of India,' by MM. d'Archiac and J. Haime, the only extended memoir which has been published on the subject, to my knowledge at least, is that of M. Stolitzka (87), on the 'Echinoderms of the Cretaceous Formations of India,' in which thirty-eight species are figured and described. Some isolated documents may still be noticed. Prof. Duncan has enumerated eleven Cretaceous species collected in the South-east of Arabia, and at Bagh on the Nerbudda (88). He has likewise given indications of the Cretaceous Echinides of Sinai (89). M. Cotteau, in a notice on the Echinides collected in Syria by M. L. Lartet, has described some new species. Prof. Fraas (91), in his recent travels in Lebanon, has satisfactorily proved that the spines so long known under the name of *Cidaris glandifera*, and believed to be identical with those from the Sequanian stage are, on the contrary, distinct, and are found in Cenomanian beds. M. Fuchs, lastly, has made known some Echinides from the Miocene beds of Persia (92).

In the Island of Borneo Nummulitic beds are found containing Echinides, of which M. Fritsch has described some, establishing the genus *Verbeekia*, still very imperfectly characterised (93).

Thanks to Professor Zittel we know some Echinides from the Tertiary strata of New Zealand (94).

Many recent works, have had for their object the Echinides from the Tertiary strata of Australia; whence new species have been described by M. Laube (95), Mr. Etheridge (96), and Prof. Duncan (97), who has given a list of the species from the Tertiary strata of Australia actually known. They are to the number of twenty-four, and embrace two new genera, *Paradoxechinus*, Laube, and *Megalaster*, Duncan.

It now remains for us to cross the Pacific to California, where we shall have to remark upon some very curious Miocene and Pliocene species of Echinides, discovered by Mr. Remond (98), and figured anew by Dr. Gabb (99). Some new species are still to be indicated from the Eocene of South Carolina, by M. Conrad. Beyond this I have only been able to discover a few isolated notices upon the Secondary and Tertiary

Echinides of the United States in the works published during the last twenty years. On the other hand, assisted by the activity of my learned friend M. Cotteau, whose name I have had to mention in connection with the Echinitic faunas of almost every region, the fossil Echinides of the Antilles are now very well known. Mr. Guppy had already published nine new species from the Tertiary formations of the Island of Anguilla. M. Cotteau (102) has added as many as twenty-six Eocene and Miocene forms. He has made known the magnificent species of the genus *Asterostoma* (103), of which we had known only up to the present the single individual type, coming from the Tertiary strata of the Island of Cuba, where it is accompanied with some other species, which will be figured afterwards.

In South America the Echinitic works within my knowledge are the isolated descriptions of some new species. Philippi (104) has described some from Bolivia; Herr Steinmann (105) has just added two others; and I have described one from Ecuador (106).

To this rapid exposé of the progress of our knowledge of the fossil Echinides during the last twenty years, it will not be out of place to add a few words on the recent discoveries which have been made among living Echinides in the existing seas. It does not, however, appear necessary to enter into much detail or to do more than mention the published works. The magnificent and excellent work of Alexander Agassiz (107), 'Revision of the Echini,' published between 1872 and 1874, faithfully resumes all the works anterior to it, and, so to speak, fixes our ideas upon the species of Echinides known up to this time in our seas. It will always serve as a *point de depart* for all future works. The number of distinct species which are there found established and described amounts to 206. Since then the number has been considerably augmented, but always and almost solely by the recent Expeditions undertaken for the exploration of the bed of the sea, aided by dredges and appropriate machinery placed at the command of the explorers. Most of the new types which have been discovered belong to the most extraordinary forms; and some of these represent genera found hitherto only in a fossil state, connecting in a very remarkable manner the existing fauna with that of former times. Already in the Dredging Expedition of the "Porcupine," Wyville Thomson had observed in the living state and made known in a complete manner the *Asthenosoma* (109), those regular Urchins so curious with a flexible test composed of imbricated plates, reminding us of certain Palæozoic genera and belonging to a family, the ECHINOTHURIDÆ, represented up to the present time by some fragments found in the Upper Chalk and a single example of a recent species from an uncertain province. We know actually that it was one of two species all living in depths from 10 to 2,750 fathoms, but principally in the greatest depths. The appearance of the first species of *Pourtalesia*, dredged by François de Pourtales in the latitude of the Antilles, had astonished all the Echinologists. This extraordinary genus, bordering on the *Holaster* and almost on the *Infulaster*, approached more particularly the Urchins of the

White Chalk. We have lately discovered that there are several species, most of them bizarres forms; and the Expedition of the "Challenger" has made known many new genera, which are connected with it, so that now this species, known at first by a single example, has become the *point de depart*, a few years after its discovery, of a family which appears to be truly limited to great depths. These two examples will suffice perhaps to make us appreciate the development of our knowledge of the Echinides of the actual seas during the last eight years.

I do not intend to enlarge here upon the new species and the new genera which have been successively brought to light by the dredging expeditions of the "Porcupine," of the "Hasler" (110), of the "Josephine," of the "Blake" (111), of the "Challenger" (112). This last, which perhaps may be considered the most fruitful, has brought to our knowledge no less than forty-four new species and sixteen new genera. We are able to estimate roundly at 300 the number of the species which we know in our actual seas, and it is not only the discovery of new types which we owe to these expeditions, so rich in results of all kinds, but numerous and valuable indications and information on the geographical distribution of species, and on their vast bathymetrical limits, which are of the greatest utility in explaining certain facts relative to the distribution of fossil species, a subject upon which, perhaps, we may have experienced embarrassment. Now that we know that the *Spatangus Rashi* is found from the Hebrides to the Cape of Good Hope, that the *Brissopsis lyrifera* and the *Schizaster fragilis* are met with both in the seas of Norway and in the south of the Indian Ocean, and that certain species of *Cidaris* descend from the shore to 2000 fathoms, and that a *Phormosoma* descends from 200 to 2700 fathoms, many facts relating to fossil Echinides will perhaps be able to find an interpretation.

This is not the place to recapitulate the progress of the state of our knowledge upon the Morphology, the Anatomy, and the Embryogeny of the Echinides; moreover, I am not competent to undertake the work.

I desire only to mention a remarkable work by M. Lovén (113), 'Ètudes sur les Échinides,' accompanied by fifty-three excellent plates which contain very curious and most interesting researches on the structure of the solid skeleton of Urchins, and on the different points in their organisation. This useful work ought to be studied by all those who wish to make the Echinides the object of serious research.

My task is now brought to a termination. I hope that those who, in the next twenty years, undertake a similar work will be able to register as many new facts, as many new discoveries, and as much progress of all kinds in the study of this very interesting group of animals, of which I have endeavoured to give a *résumé* in the following summary Table, which is probably less complete than I wished it to be.

APPENDIX CONTAINING A LIST OF THE WORKS REFERRED TO IN THE TEXT. SEE PAGE v.

1. WALTER KEEPING, 1878. On Pelanechinus (Quart. Journ. Geol. Soc., vol. xxxiv).
2. COTTEAU. Paléontologie française (Échinides, T. 9, Terrain crétacé; T. 9 et 10, Terrain jurassique).
3. Échinides du Département de la Sarthe, 1855—69.
4. COTTEAU, 1857, 1878. Études sur les Échinides (Fossiles du Dép. de l'Yonne, T. 2, Terrain crétacé).
5. COTTEAU, 1858—80. Échinides nouveaux ou peu connus, 1e Série (Extrait de Revue et Magasin de Zoologie).
6. COTTEAU, 1863. Note sur les Échinides nummulitiques de Biarritz (Bull. Soc. Géol. de France, 2e Série, T. 21).
7. COTTEAU, 1865. Notes sur les Oursins crétacés des Martigues (Bull. Soc. Géol. de France, 2e Série, T. 21).
8. COTTEAU, 1863. Échinides fossiles des Pyrénées (Extrait du Congrès Scientifique de France, 28e Session, T. 3).
9. COTTEAU, 1865. Catalogue raisonné des Échinides fossiles du Dép. de l'Aube (Extrait du Congrès Scientifique de France, 31e Session).
10. COTTEAU, 1871, in DUMORTIER. Sur quelques gisements de l'Oxfordien inférieur de l'Ardèche, Description du Échinides.
11. COTTEAU, 1869. Descr. de quelques Échinides Tertiaires des environs de Bordeaux (Actes de la Soc. Linnéenne de Bordeaux, T. 27).
12. COTTEAU, 1877. Descr. des Échinides de la Colonie du Garumnien de la Haute Garonne (Annales des Sciences Géologiques, T. 9).
13. COTTEAU, 1877. Description des Échinides Tertiaires de la Corse, in Descr. de la Faune des Terrains Tertiaires Moyens de la Corse, par A. Locard.
14. COTTEAU, 1877. Catalogue des Échinides jurassiques de Normandie (avec 2 planches), Mémoires de la Soc. géologique de Normandie.
15. COTTEAU, 1873. Sur le genre Tetracidaris (Bull. Soc. Géol. de France, 3e Série, T. 1).
16. SÆMANN et DOLLFUSS, 1861. Études critiques sur les Echinodermes fossiles du Coral-rag de Trouville (Bull. Soc. Géol. de France, 2e Série, T. 19).
17. DUMORTIER, 1864–1872. Études paléontologiques sur les dépots jurassiques de bassin du Rhône.
18. TOURNOUER, 1870. Recensement des Echinodermes du Calcaire à Astéries du S.-O. de la France (Actes de la Soc. Linnéenne de Bordeaux, T. 27).
19. CAFFIN, 1867. Échinides des environs d'Evreux (Bulletin de la Société des Amis des Sciences Naturelles de Rouen).
20. BUCAILLE, 1872. Échinides fossiles du Dép. de la Seine inférieure.

21. Hébert, 1865. Étude d'un groupe d'Hemiaster (Bull. Soc. Géolog. de France, 2e Série, T. 22).

22. Hébert, 1875. Descr. de deux Hemipneustes de la Craie sup. des Pyrénées (Bull. Soc. Géol. de France, 3e Série, T. 3).

23. Sauvage, 1872. Note sur quelques Echinodermes des étages supérieurs format. Jurass. de Boulogne-sur-Mer (Bulletin. Soc. géol. de France, 3e Série, T. 1).

24. Arnaud, 1877. Étude sur le genre Cyphosoma dans la Craie du Sud-Ouest (Actes de la Société Linnéenne de Bordeaux, T. 31).

25. Desmoulins. Études sur les Échinides.

26. P. de Loriol, in Pictet, 1867. Faune Terebr. diphyoides de Berrias; Mélanges Pal., 2 série.

27. P. de Loriol, in Pictet, 1868. Étude provisoire des Fossiles de la Porte de France, d'Aizy, et de Lemenc; Mélanges Pal., iv.

28. P. de Loriol et G. Cotteau, 1868. Monographie de l'étage Portlandien de l'Yonne (Bulletin Soc. Sc. Hist. et Nat. de l'Yonne, 2e série, T. 1.

29. P. de Loriol et Ed. Pellatt, 1866. Monogr. de l'étage Portlandien de Boulogne-sur-Mer (Mém. Soc. de Physique et d'Hist. Nat. de Genève, T. 19), et Monogr. des Étages supérieurs de la formation Jurassique de Boulogne-sur-Mer (Mém. Soc. Phys. et Hist. Nat. de Genève, T. 23 et 24).

30. P. de Loriol, E. Royer, et H. Tombeck, 1872. Monogr. pal. et géol. des étages sup. de la formation Jurassique de la Haute Marne (Mémoires de la Soc. Linnéenne de Normandie, vol. xvi).

31. Dujardin et Hupé, 1862. Histoire Naturelle des Zoophytes Échinodermes.

32. Etallon, 1860. Rayonnés du jurassique supérieur de Montbéliard.

33. Etallon, 1864. Paléontologie du Jura Graylois (Mém. Soc. d'Emulation du Doubs, 3e série, vol. viii).

34. Etallon, 1860. Études Paléontologiques sur le Corallien du Haut Jura.

35. Thurmann et Etallon, 1862. Lethæa Bruntutana (Mémoires de la Societé Helv. des Sc. Naturelles).

36. Ooster, 1865. Synopsis des Echinodermes fossiles des Alpes Suisses.

37. Ooster, 1869–72. Protozoa Helvetica.

38. P. de Loriol, 1863. Descr. des animaux invert. foss. du nécomien du Salève.

39. P. de Loriol, 1866. Descr. des foss. coralliens, Valangiens, et Urgoniens du Salève, in A. Favre, Recherches géologiques sur la Savoie, &c.

40. P. de Loriol, 1868. Monogr. des conches de l'étage Valangien d'Arzier (Matériaux par la Paléontolog. Suisse, publiés par F. J. Pictet).

41. P. de Loriol, 1869, in P. de Loriol et V. Gilliéron. Monogr. de l'étage Urgonien du Landeron (Mém. de la Soc. Helv. des Sc. naturelles).

42*a*. E. Desor et P. de Loriol, 1868 and 1872. Echinologie Helvétique, 1ere partie, Echinides jurassiques.

42*b*. P. DE LORIOL, 1873. Echinologie Helvétique, 2e partie, Echinides crétacés (Matériaux pour la Paléontologie Suisse, publiés par F. J. Pictet).

42*c*. P. DE LORIOL, 1875–76. Echinologie Helvétique, 3e partie. Echinides tertiaires (Mémoires de la Soc. paléont. Suisse, vol. ii et iii).

43. G. COTTEAU, 1875. Note sur les Échinides crétacés du Hainaut (Bull. Soc. géol. de France, 3e Série, T. II).

44. G. COTTEAU, 1878. Descr. des Échinides du Calcaire grossier de Mons. (Mémoires de l'Acad. de Belgique, T. 42).

45. G. COTTEAU, 1880. Descr. des Échinides tertiaires de la Belgique (Mémoires de l'Académie de Bruxelles, T. 43).

46. G. COTTEAU, 1870. Descr. de quelques espéces d'Échinides de Suède (Bibl. de l'école des Hautes Études, Sc. naturelles. T. 2).

47. QUENSTEDT, 1875. Die Echiniden.

48. CL. SCHLÜTER, 1869. Fossile Echinodermen des nördlichen Deutschlands (Verh. der nat. Ver. der Preuss. Rheinlandes, vol. xxvi).

49. CL. SCHLÜTER, 1870. Diagnosen neuer fossilen Echinodermen (Verh. der nat. Verh. Preuss. Rheinlands, vol. xxvii).

50. SCHLÖENBACH, 1869. Beitrag zur Alters Bestimmnung der Grunsandes v. Rothenfelde (Leonh. und Geinitz, Neues Journal für Miner., &c., 1869).

51. DAMES, 1872. Die Echiniden der nordwest. deutschen Jura Bildungen (Zeitsch. der Deutschen. Geol. Gesell., vol, xxiv).

52. GEINITZ. Das Elbthalgebirge in Sachsen (Palæontographica).

53. SCHAFHÄUTL, 1863. Süd-Bayerns Lethæa geognostica, Kressenberg.

54. ZITTEL, 1879. Handbuch der Paläontologie, Vol. I, 3e Livr.

55. COTTEAU, in ZITTEL, 1870. Fauna der aelteren Cephalopoden führenden Tithon Bildungen.

56. LAUBE, 1867. Die Echinodermen des braunen Jura von Balin (Denkschr. der K. K. Akad. der Wissenschaft., Wien, vol. xxvii).

57. LAUBE, 1871. Die Echinoiden der Oesterreich-Ungarischen oberen Tertiär Ablagerungen (Abhandlungen der K. K. geolog. Reichsanstalt, vol. v).

58. LAUBE, 1869. Ueber *Oolaster*, neues Echin. Gesch. von der Eocenen Schichten in Mattsee in Oesterreich (Leonhard und Geinitz, Neues Jahrb. für Mineralogie, 1869, f. 454).

59. R. HÖRNESS, 1875. Die Fauna des Schliers in Ottnang (Jahrbuch der K. K. geol. Reichtanstalt, vol. xxv).

60. LOCZY, 1877. Echinoiden aus den neog. Ablag. des weissen Körösthaler (Terme szetrajzi Tuzetck, 1st Heft).

61. Dr. AL. DE PAVAY, 1873. Geologie Klausenburgs und seiner Umgebung (Mitth. aus den Jahrbuch. der Konigl. Ung. Geolog. Anstalt, vol. i).

62. Dr. Al. de Pavay, 1874. Die fossilen Seeigel des Ofner Mergels (Mitth. aus den Jahrbuch. der Kön. Ung. geol. Anstalt, vol. ii).

63. Taramelli, 1874. Nota sopre alcuni Echinidi del Istria (Atti del Reale Istituto Venete, Série iv, Tome 3).

64. Taramelli, 1868. Note sopra alcuni Echinidi cretacei e terziarii del Friuli (Atti del Reale Ist. Veneto, Série 3, vol. xiv).

65. Bittner, 1880. Beiträge zur Kenntniss Alttiärer Echiniden faunen der Sudalpen (Beiträge zur Paläontologie von Oesterreich. Ungarn., vol. i).

66. Schauroth, 1865. Verzeichniss der Versteinerungen in Herzogl. Natur. Cabinet zur Coburg.

67. Laube, 1868. Ein Beitrag zur Kenntniss der Echinodermen des Vicentinischen Tertiär-Gebietes (Denkschriften der Wiener Akademie der Wiss., vol. xxix).

68. Dames, 1877. Die Echiniden der Vicentinischen und Veronesischen Tertiaerablagerungen (Palæontographica, vol. xxv).

69. Manzoni, 1873. Il Monte Titano.

70. Manzoni et Mazzetti, 1878. Echinodermi nuovi delle Molassa miocenica di Montese (Atti della Soc. Toscana di Sc. Nat.).

71. Manzoni, 1878. Gli Echinodermi fossili dello Schlier delle colline di Bologna (Denkschriften der Wiener Akademie der Wiss., vol. xxxix).

72. Manzoni, 1880. Echinodermi fossili della Molassa Serpentinosa (Denkschriften der Wiener Akademie der Wiss., vol. xlii).

73. Gemellaro, 1871. Studi paleont. sulla Fauna del Calc. a Ter. janitor del nord di Sicilia, iii.

74. Stoppani, 1863. Paléontologie Lombarde, 3e série, Infra-lias de Lombardie.

75. Cotteau, 1860. Note sur quelques Échinides recueillis en Espagne par M. de Verneuil (Bulletin Soc. Géol. de France, 2e série, Tome 17).

76. Cotteau, 1879. Notice sur les Échinides urgoniens recueillis par M. Barrois dans la Province d'Oviedo (Annales des Sc. géologiques, x).

77. Dr. T. Wright, 1864. On the Fossil Echinidæ of Malta (Quarterly Journal of the Geol. Soc. of London, vol. xx).

78. Dames, 1877. Échiniden fauna von der Insel Melos. (Sitzungs-Berichte des Gesell. Naturforscher zu Berlin, 1877).

79. P. de Loriol, 1877. In the Étude stratigraphique de la Partie S. O. de la Crimée, par Ernest Favre.

80. Coquand, 1862. Géologie et Paléontologie de la Province de Constantine.

81. Cotteau. Péron et Gauthier, 1873–1881 (Echinides fossiles de l'Algérie, 7 fascicules).

82. Coquand, 1880. Etudes supplémentaires sur la Paléontologie Algérienne.

83. Etheridge, 1872. Description of a new genus of fossil Scutelloid Echinoderm from Saffe, Morocco (Quart. Journ. Geol. Soc. of London, vol. xxviii).

84. FRAAS, 1867. Aus dem Orient. (Württemb. Naturn. Jahreshefte, 1867).

85. P. DE LORIOL, 1880. Monographie des Echinides nummulitiques de l'Egypte (Mém. de la Soc. de Phys. et d'hist. nat. de Genève, T. 27).

86. P. DE LORIOL, 1881. Beschreibung der aus seiner Reise mit der Rohlfscher Expedition; von Herrn Prof. Zittel mitgebrachten Echiniden (Palæontographica).

87. STOLITZKA, 1873. Monograph of the Echinodermata of the Cretaceous Deposits in South India (Memoirs of the Geological Survey of India).

88. DUNCAN, 1865. Descr. of the Echinodermata from the Strata on the S. E. Coast of Arabia, and Bagh on the Nerbudda (Quart. Journ. Geol. Soc. London, vol. xxi.

89. DUNCAN, 1867. Descr. of some Echinoderms from the Cretaceous Rocks of Sinai (Quart. Journ. Geol. Soc. London, vol. xxiii).

90. COTTEAU, 1869. Notice sur les Echinides recueillis par M. Lartet en Syrie (Bull. Soc. géol. de France, 2e série, T. 26).

91. FRAAS, 1878. Aus dem Orient, ii (Geolog. Beob. am Libanon).

92. TH. FUCHS, 1880. Ueber einige Tertiäre Echiniden aus Persia (Sitzungsber. der Wiener Akademie der Wiss., vol. lxxxi).

93. V. FRITSCH, 1877. Die Echiniden der nummulitenbildungen von Borneo (Palæontographica).

94. ZITTEL, 1869. Fossile Mollusken und Echinodermen aus Neu-Zeeland (Novara-Expedition, vol. i).

95. LAUBE, 1869. Ueber einige fossile Echiniden von den Murray Cliffs in Sud Australien (Sitzungsberichte der Wiener Akad. der Wiss., vol. lix).

96*a*. ETHERIDGE, 1875. On Australian Tertiary Echinoderms (Quart. Journ. Geol. Soc., vol. xxxi).

96*b*. ETHERIDGE, 1875. Descr. of a New Species of the genera Hemipatagus from the Tertiary Rocks of Victoria, Australia (Quart. Journ. Geol. Soc. of London, vol. xxxi).

97. DUNCAN, 1876. On the Echinodermata of the Australian Cainozoic Deposits (Quart. Journal. Geol. Soc. London, vol. xxxiii.)

98. REMOND, 1863. Proceed. California. Acad. for 1863.

99. GABB, 1869. Geol. Survey of California; Palæontology, vol. ii.

100. CONRAD, 1865. Catalogue of the Eocene Echinodermata, &c., of the United States (Proceed. Acad. Nat. Sc., Philadelphia, 2nd series, vol. ix).

101. GUPPY, 1866. West-Indian Echinoderms (Quart. Journ. Geol. Soc., London, vol. xxi).

102. COTTEAU, 1875. Description des Echinides Tertiaires des Antilles (Mém. de l'Academie de Suède, vol. xiii).

103. COTTEAU, 1871. Notice sur le genre *Asterostoma* (Mém. Soc. Géolog. de France, 2e Série, T. 9).

104. PHILIPPI, 1860. Reise in die Wüste Atacama.

105. Steinmann, 1881. Die Kenntniss der Jura und Kreideformation in Caracoles, Bolivia.

106. P. de Loriol, 1876. Note sur quelques esp. nouvelles appartenant à la Classe de Echinodermes (Mém. Soc. de Phys. et d'Hist. nat. de Genève, T. 24).

107. Alexander Agassiz, 1872–74. Revision of the Echini (Illustrated Catalogue of the Museum of Compar. Zoology at Harvard College, No. 7).

108. Wyville Thomson, 1873. The Depths of the Sea.

109. Wyville Thomson, 1874. On the Echinoidea of the "Porcupine" Deep Sea Dredging Expedition (Philos. Trans. of the Royal Soc. of London, vol. clxiv).

110. Alexander Agassiz, 1874. Zoological Results of the Hasler Expedition; Echini (Illustrated Catalogue of the Museum of Compar. Zoology at Harvard College, No. 8).

111. Alexander Agassiz, 1878. Report on the Results of Dredging . . . . by the U. S. Coast Survey Steamer "Blake;" Echini (Bull. Mas. of Compar. Zool. at Harvard College, vol. v, No. 9).

Alexander Agassiz, 1880. Idem., idem. (Bull. Mas. of Compar. Zool. at Harvard College, vol. viii, No. 2).

112. Wyville Thomson, 1877. The Voyage of the "Challenger;" the Atlantic.

Alexander Agassiz, 1879. Preliminary Report on the "Challenger;" Echini (Proceed. Amer. Acad. of Arts and Sciences, vol. xiv).

113. Lovèn, 1874. Études sur les Échinoidées (Kongl. Svenska Vetenskapt..Akademiens Handlingar, vol. xi)."

CARDIASTER PILLULA, *Lamarck*. Pl. LXXI, figs. 1—3.

ANANCHYTES PILLULA,	*Lamarck*. Animaux Sans Verteb., tom. iii, p. 27, No. 11, 1816.
SPATANGUS PRUNELLA,	*Mantell*. Geology of Sussex, pl. xvii, figs. 22, 23, p. 193, 1822.
ANANCHYTES PILLULA,	*Deslongchamps*. Encycloped. Method., tom. ii, p. 64, 1824.
NUCLEOLITES CORAVIUM,	*Cutullo*. Saggio de Zool., p. 226, pl. 2, fig. *e*, 1827.
SPATANGUS PILLULA,	*Desmoulins*. Études sur les Échinides, p. 406, No. 50, 1837.
ANANCHYTES ANALIS,	*Roemer*. Norddeutsch Kreide, pl. 6, fig. 18, p. 35, 1840.
HOLASTER PILLULA,	*Agassiz and Desor*. Catal. raisonné, An. Sc. Nat., tom. viii, p. 29, 1847.
ANANCHYTES (HOLASTER) PILULA,	*Forbes*. Mem. Geol. Surv., decade iv, pl. viii, 1852.
CARDIASTER PILULA,	*d'Orbigny*. Paléontol. Française Terr. Crétacés, tom. vi, p. 126, pl. 824, 1853.

Diagnosis.—Test oblong, lofty, always more or less elevated; sides tumid; anterior border round and flattened; posterior accuminated and truncated; base flatly convex with sharp angulated sides, mouth near the anterior border; vent elevated in the middle of the posterior border; upper surface highly arched, with a carina passing from the disc to the vent; apical disc narrow, elongated, and nearly central.

Dimensions.—Height, $\frac{11}{20}$ of an inch; antero-posterior diameter, $\frac{7}{10}$ of an inch; transverse diameter, $\frac{5}{10}$ of an inch.

The proportional dimensions of this Urchin vary considerably, a fact which may best be illustrated by the measurement of six specimens of different bulk, in inches and parts of an inch, as shown in the following table:

TEST.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Height	$0\frac{8}{10}$	$0\frac{5}{8}$	$0\frac{1}{2}$	$0\frac{1}{2}$	$0\frac{4}{10}$	$0\frac{11}{12}$
Antero-posterior diameter.........	1	$0\frac{8}{10}$	$0\frac{7}{10}$	$0\frac{8}{10}$	$0\frac{16}{10}$	$0\frac{11}{12}$
Lateral diameter.....................	$0\frac{8}{10}$	$0\frac{7}{10}$	$0\frac{7}{10}$	$0\frac{6}{10}$	$0\frac{6}{10}$	$0\frac{9}{12}$
Vent above margin	$0\frac{3}{10}$	$0\frac{3}{10}$	$0\frac{2}{12}$	$0\frac{2}{12}$	$0\frac{2}{12}$	$0\frac{2}{12}$

Description.—Test oblong, always more or less elevated, tumid above, inflated at the sides and flattened at the base; the anterior border depressed, with the central sulcus feebly developed and the posterior border accuminated and abruptly truncated.

The anteal and antero-lateral ambulacra are short, lanceolate and nearly vertical; the postero-lateral long, ascending obliquely forward, and conjointly forming an arch which encloses the posterior truncated border with the circular vent about half way up the total height of the test (see Table). The plates of the ambulacra are large and broad, each equal to as much or rather more than half the height of an interambulacral plate. In a rather large example of this species there are seventeen dorsal plates in each vertical row of the anteal ambulacrum, about fourteen and thirteen respectively in the rows of each lateral ambulacrum, and seven in each vertical row of each lateral inter-ambulacrum (Pl. LXXI, fig. 1 *c*). These plates all bear minute scattered primary tubercles, with myriads of interspersed granules (Pl. LXXI, fig. 1 *h*).

The upper surface is convex, and more or less arched throughout; the highest point is in the anterior third, from whence it gently declines towards the posterior border (figs. 1 *c* and 3 *a*). The apical disc is closely wedged in between the other plates of the test, and often distinguished with difficulty; it is situated about the centre of the test, rather nearer the anterior border, and is narrow and extremely elongated (fig. 1 *e*); the ovarial plates being placed in line behind each other, and four are perforated. The ocular plates are very small, and can only be discerned by the aid of a magnifying lens. The madreporiform body is very small and indistinct. In some flint casts the four ovarial holes are seen, and the pairs of pores in the poriferous zones very well shown (fig. 2); their courses are much better traced out in such moulds than in specimens with the test preserved.

From the posterior side of the apical disc to the upper margin of the vent a carina more or less acute is developed (fig. 1 *a*), this ends in a beak-shaped process which overhangs the anal aperture.

The under surface is slightly convex, and a little angular along the median line, without any concavity around the mouth, which occupies a position near the anterior extremity, about one fourth of the length of the test from the margin, which in the region of the anteal ambulacrum is slightly sinuous (fig. 1 *b*). The oral aperture is roundish or ovate, the fore lip is depressed, and the hinder lip turned and elevated, but not overlapping.

The vent of an oval form occupies an elevated position in the posterior border (figs. 1 *d* and 3 *a*). This aperture was defended by a series of small plates, eight polygonal calcareous pieces forming the outer, and ten smaller pieces the inner circle of the lid, so that the periprocte was entirely closed with the exception of a small central aperture for the passage of the rectum. I have given an accurate drawing of these anal ossicles *in sitû* for shutting up the periprocte in fig. 3 *b*.

This beautiful little Urchin likewise possesses a band of minute granules towards the side margins of the ambitus, forming there a fasciole like a *Cardiaster;* for this reason it is now removed from the genus *Ananchytes,* where it was placed, but in which no fascioles exist, into the group which possesses this granular band along the margin of the cheeks. In other respects its form and structure has many affinities with *Echinocorys* on the one side and *Holaster* on the other, between which it forms a connecting link.

Locality and Stratigraphical Position.—It is found in the upper chalk of Kent, Sussex, and other English counties.

In France it is collected from the upper chalk at Meudon, near Paris; Dens, Poigny, Yonne; Beauvais, Oise; Saintes, Charente-Inférieure.

In North Germany it has been found at Peine, at Yseburg, near Hanover.

History.—This Urchin was first described by Lamarck as *Ananchytes pillula*, and afterwards by Deslongchamps under the same name. Desmoulins removed it into the genus *Spatangus*, Roemer described and figured it as *Ananchytes analis;* Agassiz and Desor removed it into the genus *Holaster*. Forbes called it *Ananchytes* (*Holaster*) *pillula*, and described and figured it in his Memoirs of the Geological Survey, in much detail and with great accuracy; and finally D'Orbigny, having ascertained the presence of the fasciole which extends along the margin and under the posterior border, removed it into the genus *Cardiaster*, among its marginal fasciolated congeners.

Genus—ECHINOCORYS, *Breynius*, 1732.

ANANCHYTES, *Lamarck*, 1801.

Form of the test more or less oval; upper surface much elevated, helmet-shaped, convex, conoidal, or rounded; under surface flat.

Ambulacral summit central, the poriferous zones occupy the middle of the ambulacral plates; the single ambulacrum similar in structure to the antero- and postero-lateral pairs. The pores round or elongated, alike identical in structure, disposed in single pairs, set obliquely widely apart in the middle of the ambulacral plates, and forming two rows in each area, which radiate from the summit and diverge towards the circumference.

Apical disc elongated, formed of four ovarial and five ocular plates. The two pairs of ovarial plates are separated by a pair of oculars.

Under surface very flat. Mouth-opening near the anterior border transversely oval; peristome bilabiate, situated in a depression, and surrounded by a stellate arrangement of primary tubercles, which diverge from the circumference of the peristome.

Vent marginal or infra-marginal; periprocte small and oval in a vertical direction.

Surface of the plates covered with small primary tubercles; those at the base are larger and more developed, some are raised upon bosses with crenulations, and all are perforated at the summit.

The Echinocorys resemble the Holasters, but are distinguished from them in having the single ambulacrum precisely similar to the others, and by the absence of the anteal sulcus. The position of the periprocte is likewise entirely marginal or infra-marginal.

This genus was well established by Breynius, in 1732, and illustrated with good figures; it is to be regretted that Lamarck, in 1801, suppressed the name *Echinocorys*, and proposed, without any reason for it, that of *Ananchytes*, now so well known to all geologists; still, in justice to Breynius, I am under the necessity of restoring his name in order to carry out the principle which has guided me in the nomenclature I have adopted throughout this work.

Echinocorys vulgaris, *Breynius*. Pl. LXXVII, figs. 1—11.

Cap-stones,	oval form, Plot. Nat. Hist. of Oxfordshire, p. 92, tab. ii, 1677.
Echinocorys vulgaris,	*Breynius.* Schediasma de Echinis., p. 58, pl. iii, fig, 2, 1732.
— scutatus,	*Leske.* Apud Klein Dispos. Echinod., p. 175, pls. xv, A, B, 1778.
— ovatus,	*Leske.* Ibid., p. 178, pl. xliii, fig. 1, 1778.
— minor,	*Leske.* Ibid., p. 183, pl. xvi, C, D; pl. xvii, fig. *a*, *b*, 1778.
— pustulosus,	*Leske.* Ibid, p. 180, pl. xvi, figs. A, B, 1778.
Echinus scutatus,	*Gmelin.* Systema Naturæ, t. i, p. 3184, 1789.
Echinocorytes ovatus,	*Gmelin.* Ibid., p. 3185.
— pustulosus,	*Gmelin.* Ibid.
Ananchites pustulosa,	Encycl. Méthod. Mollusques et Zoophytes, t. i, p. 143, Atlas, t. ii, pl. 154, figs. 12—17, 1791.
— ovatus,	*Lamarck.* An. sans Vert., t. i, p. 348, 1801.
Echinocorys scutatus,	*Parkinson.* Organic Remains, vol. iii, p. 21, pl. ii, fig. 4, 1812.
Ananchytes ovata,	*Lamarck.* Animaux sans Vertèbres, vol. iii, p. 25, No. 1, 1816.
— striata,	*Lamarck.* Ibid., No. 2.
— gibba,	*Lamarck.* Ibid., No. 3.
— pustulosa,	*Lamarck.* Ibid., No. 4.
— semiglobus,	*Lamarck.* Ibid., No. 10.
Ananchitres ovatus,	*Defrance.* Dic. Sc. Nat., vol. ii, Suppl., p. 40, 1816.
Ananchites carinatus,	*Defrance.* Ibid., p. 41.
Echinites scutatus, major et minor,	*Schlotheim.* Petrefaktenkunde, p. 309, 1820.
Ananchytes ovata,	*Brongniart* (Cuvier). Géol. Environs de Paris, p. 390, pl. M, fig. 7, A, B, D, 1822.
— hemisphærica,	*Brongniart.* Ibid., fig. 8, A, B, C, 1822.
Echinocorys scutatus,	*Mantell.* Geology of Sussex, p. 191, 1822.
Ananchytes ovata,	*Deslongchamps.* Mollusques et Zoophytes, t. ii, p. 61, 1824.
— striata,	*Deslongchamps.* Ibid., p. 62, No. 2.
— gibba,	*Deslongchamps.* Ibid., p. 62, No. 3.

ANANCHYTES PUSTULOSA, *Deslongchamps.* Ibid., No. 4.
— SEMIGLOBUS, *Deslongchamps.* Ibid., p. 63, No. 5.
— OVATUS, *Goldfuss.* Petrefact. Germaniæ, vol. i, p. 145, pl. xliv, fig. 1, 1826.
— CONOIDEUS, *Goldfuss.* Petrefact. Germaniæ, vol. i, p. 145, pl. xliv, fig. 2, 1826.
— STRIATUS, *Goldfuss.* Ibid., fig. 3.
ECHINO-CORYS OVATUS, *Mantell.* Geol. Transact., vol. iii, p. 205, 1829.
ANANCHYTES OVATUS, *Blainville.* Zoophytes, Dict. Sc. Nat., t. lx, p. 187, 1830.
— STRIATUS, *Blainville.* Ibid.
— PUSTULOSUS, *Blainville.* Ibid.
— SEMIGLOBUS, *Blainville.* Ibid.
— GIBBUS, *Blainville.* Ibid.
— GIBBA, *Agassiz.* Monogr. Radiaires; Mém. Soc. des Sc. Nat. de Neuchâtel, vol. i, p. 183, 1835.
— HEMISPHÆRICA, *Agassiz.* Ibid.
— GIBBA, *Agassiz.* Ibid.
— PUSTULOSA, *Agassiz.* Ibid.
— STRIATA, *Grateloup.* Act. Soc. Lin. Bord., t. viii., Mém. Oursins Foss., p. 60, 1836.
— GIBBA, *Grateloup.* Ibid., p. 61.
— SEMIGLOBUS, *Grateloup.* Ibid., p. 62.
— HEMISPHÆRICA, *Grateloup.* Ibid., p. 62.
— CONOIDEA, *Grateloup.* Ibid., p. 62.
— PUSTULOSA, *Grateloup.* Ibid., p. 63.
— OVATA, *Des Moulins.* Études sur les Échin., p. 369, No. 1, 1837.
— CONOIDEA, *Des Moulins.* Ibid., p. 370, No. 2.
— STRIATA, *Des Moulins.* Ibid., No. 3.
— GIBBA, *Des Moulins.* Ibid., p. 372, No. 4.
— PUSTULOSA, *Des Moulins.* Ibid., No. 5.
— HEMISPHÆRICA, *Des Moulins.* Ibid., p. 374, No. 6.
— SEMIGLOBUS, *Des Moulins.* Ibid., No. 8.
— OVATA, *Agassiz.* Échin. de la Suisse, p. 30, pl. iv, figs. 4—6, 1839.
— STRIATA, *Agassiz.* Catal. Syst. Éctyp. Echin. Foss. Mus. Neoc., p. 2, 1840.
— CRASSISSIMA, *Agassiz.* Ibid.
— CONICA, *Agassiz.* Ibid.
— OVATA, *Dujardin.* In Lamarck, Anim. sans. Vert., 2 ed., t. iii, p. 316, 1840.
— STRIATA, *Dujardin.* Ibid., No. 2.
— GIBBA, *Dujardin.* Ibid., No. 3.
— PUSTULOSA, *Dujardin.* Ibid., No. 4.
— SEMIGLOBUS, *Dujardin.* Ibid., No. 10.
— CONOIDEA, *Dujardin.* Ibid., No. 13.
— HEMISPHÆRICA, *Dujardin.* Ibid., No. 14.
— OVATA, *Roemer.* Norddeutschen Kreidegebirges, p. 35, 1840.
— — *Geinitz.* Charakteristik. Petref. Kreidegebirges, p. 91, 1842.

ANANCHYTES PYRAMIDATUS, *Portlock.* Rep. on Londonderry, p. 355, 1843.
— OVATUS, *Morris.* Catal. of Brit. Fossils, p. 48, 1843.
— CONOIDEUS, *Morris.* Ibid.
— HEMISPHÆRICUS, *Morris.* Ibid.
— OVATA, *Sismonda.* Mém. Geo.-Zoologique, Mem. Accad. Torino, ser. ii, tom. vi, p. 353, 1844.
— OVATA, *Agassiz* et *Desor.* Catal. raison. des Échinides; Ann. Sc. Nat., 3 série, t. viii, p. 29, 1847.
— GIBBA, *Agassiz* et *Desor.* Ibid., p. 30.
— STRIATA, *Agassiz* et *Desor.* Ibid.
— GRAVESII, *Agassiz* et *Desor.* Ibid.
— SEMIGLOBUS, *Agassiz* et *Desor.* Ibid.
— CONICA, *Agassiz* et *Desor.* Ibid.
— — *Albin Gras.* Oursins Foss. de l'Isere, p. 65, 1848.
— OVATA, *d'Orbigny.* Prod. de Pal. Strat., No. 1147, t. ii, p. 268, 1850.
— GIBBA, *d'Orbigny.* Ibid., No. 1148.
— STRIATA, *d'Orbigny.* Ibid., No. 1149.
— GRAVESII, *d'Orbigny.* Ibid., No. 1150.
— SEMIGLOBUS, *d'Orbigny.* Ibid., No. 1152.
— CONICA, *d'Orbigny.* Ibid., N. 1154.
— OVATA, *Forbes.* In Dixon, Geol. of Sussex, p. 341, 1850.
— — *Sorignet.* Oursins de l'Eure, p. 71, No. 89, 1850.
— GIBBA, *Sorignet.* Ibid., No. 90.
— EUDESII, *Sorignet.* Ibid., No. 91.
— STRIATA, *Sorignet.* Ibid., No. 92.
— GRAVESII, *Sorignet.* Ibid., No. 93.
— CONICA, *Sorignet.* Ibid., No. 94.
— SEMIGLOBUS, *Sorignet.* Ibid., No. 95.
— OVATA, *Leymerie.* Mém. Soc. Geol. France, 2 ser., t. iv, p. 201, pl. xi, fig. 5, 1852.
— — *Quenstedt.* Handbuch Petrefak., p. 591, pl. i, fig. 19, 1852.
— — *Forbes.* Mem. Geol. Survey, Dec. iv, pl. vi, 1852.
— OVATA, *Bronn.* Lethæa Geognost. Kreidegebirge, p. 206, 1852.
ECHINOCORYS VULGARIS, *d'Orbigny.* Pal. Française Ter. Crétace, t. vi, p. 62, pls. 805, 806, 1853.
— PAPILLOSUS, *d'Orbigny.* Pro part., ibid., p. 69.
ANANCHYTES OVATUS, *Morris.* Catal. of British Fossils, p. 71, 1854.
ECHINOCORYS VULGARIS, *Leymerie* and *Cotteau.* Catal. des Echin. des Pyrenées, Bull. Soc. Geol. France, t. xiii, p. 331, 1856.
ANANCHYTES OVATA, *Desor.* Synops. des Echinides Foss., p, 330, 1857.
— — *Hébert.* Craie de Meudon, Bull. Soc. Géol. de France, 2 ser., t. xvi, p. 145, 1858.
— — *Coquand.* Bull. Soc. Géol. France, 2 ser., t. xvi, p. 1016, 1859.
— GRAVESII, *Coquand.* Ibid.
— GIBBA, *Coquand.* Ibid.
— STRIATA, *Coquand.* Ibid.

ANANCHYTES CONICA,	*Coquand.* Ibid.
ECHINOCORYS VULGARIS,	*Cotteau.* Ech. d'Espagne Bull. Soc. Géol. France, t. xvii, p. 373, 1860.
ANANCHYTES OVATUS,	*Strombeck.* Uber die Kreide bei Luneburg, Zeitschrift der Deutschen Geol. Gesellschaft, vol. xv, p. 134, 1863.
ECHINOCORYS VULGARIS,	*Cotteau.* Échinides Foss. des Pyrenées, p. 45, 1863.
— —	*Cotteau.* Catal. des Échin. Foss. de l'Aube, p. 41, 1865.
— —	*Tate.* Cretaceous Rocks of Ireland, Quart. Journ. Geol. Soc., vol. xxi, p. 31, 1865.
ANANCHITIS OVATA,	*Ooster.* Synop. des Êchinod. foss. des Alpes Suisses, p. 91, 1865.
— —	*Heer.* Die Urwelt der Schweiz, p. 205, vign., fig. 117, 1865.
ANANCHITES CONICA,	*Favre.* Rec. Géol. Savoie, t. iii, p. 494, 1867.
ECHINOCORYS GIBBA,	*Schlönbach.* Grünsandes von Rothenfelde, p. 821, 1869.
— VULGARIS,	*De Loriol.* Échinides Crétacés de la Suisse, p. 308, 1873.

Diagnosis.—Test large, rounded anteriorly, with a circular, ovate, or suborbicular ambitus; upper surface much elevated with turned sides; under surface flat; mouth sunk in a deep depression; vent small and infra-marginal. My late colleague, Professor Edward Forbes, admitted the following varieties.

FORMA α.—*Alta, hemispherica, ambitu ovato.*
ANANCHYTES OVATA and CONOIDEA, *Auctorum.*

FORMA β.—*Alta, elongata, superne depressa, ambitu ovato,*
ANANCHYTES STRIATA, *Auct.?* OVATA, pars.

FORMA γ.—*Alta, superne depressa, ambitu orbiculari.*
ANANCHYTES GIBBA, *Agassiz.*

FORMA δ.—*Sub-globularis.*

FORMA ε.—*Alta, conica.*
ANANCHYTES CONICA, *Agassiz,* ANANCHYTES PYRAMIDATA, *Portlock.*

Dimensions.—Height, 55 millimètres; transverse diameter, 62 millimètres; antero-posterior diameter 75 millimètres. Monsieur Cotteau has given the comparative dimensions of the three varieties which he admits of this species.

Var. GIBBA.—Height, 69 millimètres; transverse diameter, 68 millimètres; antero-posterior diameter, 86 millimètres.

Var. CONOIDEA.—Height, 77 millimètres; transverse diameter, 68 millimètres; antero-posterior diameter, 79 millimètres.

Var. CONICA (young form).—Height, 37 millimètres; transverse diameter, 33 millimètres; antero-posterior diameter, 43 millimètres.

Description.—This fine large Urchin, so very characteristic of the Upper Cretaceous formation, is rounded before and slightly contracted behind the upper surface, is much elevated, inflated, and more or less regularly convex. Sometimes elevated and conical, always slightly carinated in the posterior region. The inferior surface is flat, more or less rounded at the border, and deeply depressed around the mouth, presenting, in the median plane, an elevation which corresponds to the single interambulacral area. The ambulacral summit is nearly central. The ambulacra separated without being disjoined, are entirely similar to one another, and visible from the summit to the mouth; the poriferous zones are formed of round holes placed obliquely in pairs; the holes are perforated in the middle of the ambulacral plates (fig. 1 *f*), a form of structure which is altogether different from other congeneric groups. The pairs of pores are set closely together in the upper part of the zones, more widely apart on the sides, and remote from each other about the ambitus; near the peristome the pores again approximate, where they are surrounded by a stellate arrangement of the tubercles around the oral aperture (fig. 1 *b* and *e*).

The ambulacral plates are small and narrow in the upper part, and become large and broad in the lower and middle portions of the areas, and they are all perforated near their centres.

The tubercles developed on the upper surface of the plates of both areas are small and nearly equal in size, and those found at the base are large and prominent. In well-preserved specimens they are seen to be scrobiculated, crenulated, and perforated; they are small and irregularly placed on the upper surface (fig. 1 *a*, *f*), larger and more regularly arranged near the ambitus, and in the middle of the under surface they are much larger and more closely set together, and raised on bosses with crenulated summits (fig. 1 *g*, *h*). The intermediate granulation on the surface of the plates is quite microscopic, abundant, and homogeneous, forming regular circles around the tubercles and filling up all the intermediate spaces with minute granules (fig. 1 *f*).

The apical disc (fig. 1 *d*) is elongated; it is formed of four large perforated ovarial plates and five large oculars. Of the two anterior ovarials the right one is the largest, and supports the madreporiform body. The two anterior oculars are larger than the other three, and the orbits in all are marginal; all the discal elements are closely soldered together and covered with a fine granulation. On flint moulds (fig. 11) the position of the central portion of the apical disc is marked by a space included within an oblong groove. This groove is caused by the impressions of the walls of a solid tube-like body projecting from the inner surface of the apical disc into the cavity of the test and directed backwards. This organ appears to have been the sand canal, and was connected with the madreporiform body, as shown in fig. 11. On flint moulds the pores of the avenues are strongly projecting (fig. 10), where we notice the basal position of the poriferous zones.

The small mouth-opening is situated in a deep depression near the anterior border. At the termination of the median elevation the peristome is transversely oval, with a slightly prominent under lip, and there radiates from its circumference a stellate disposition of large tubercles (fig. 1 *b, e*), which highly ornament the oral opening. The small vent opens at the infra-marginal region near the termination of the posterior carina and behind an elevation and thickening of the test, which may be described as the anal area; the periprocte is oval in the longitudinal direction (fig. *a, b*).

Affinities and Differences.—The abundance of this species in the Upper Chalk beds causes many variations of form to be displayed which have been described and figured by collectors as distinct species; I shall mention some of the most remarkable. The upper surface is often inflated and gibbous, very regularly convex, angular, and a little contracted towards the base; this is the *Ananchytes gibba*, Lamarck, the *Ananchytes striatus* (var. *subglobosus*), Goldfuss (' Petref. Germaniæ,' pl. xliv, fig. 3). Sometimes this variety has the body more elongated, the upper surface less gibbous and marked in the posterior region, with the carina more developed, the base always angular at the circumference and slightly contracted; this is the *Echinocorys scutatus*, Leske, and *Ananchytes striata*, Lamarck. Sometimes the upper surface, whilst preserving a gibbous and convex aspect, is elevated and conoidal; this is the *Ananchytes conoideus*, Goldfuss (pl. xliv, fig. 2), the variety γ of Professor Forbes. When the ambitus is considerably contracted, and the upper surface inflated, the shell has a remarkable subspherical appearance; it then forms the *Ananchytes Gravesii*, Desor. This variety sometimes attains a large size, then the upper surface loses its gibbous aspect and becomes altogether conical, it is then the *Echinocorys pustulosus*, Leske, and the *Ananchytes conica*, Agassiz.

All these varieties, and several others which are mentioned in the works of different authors, such as *Ananchytes carinatus*, Defrance, *A. pyramidatus*, Port., *A. semiglobus*, Lamk., *A. crassissima*, Agass., *A. Eudesii*, Sorignet, &c., appear to be modifications of the same type, and merely varieties of the fine formed shell I have figured as *Echinocorys vulgaris*, Breynius.

On this subject Professor Forbes observes,[1] "To this last view I feel compelled to assent, for, however distinct the forms termed *ovata*, *gibba*, *striata*, *semiglobus*, *conica*, &c., may seem when selected and contrasted in the cabinet, every one of them is linked with the others by the most delicate shades of gradation. Neither in degree of elevation, rotundity, flatness of base or curve of back, smoothness or roughness, can I find any constant character. Scarcely two individuals out of more than a hundred examples now before me exhibit the same proportions."

The *Echinocorytes ovatus*, Leske (Pl. LXXVII, fig. 9), is a well-marked form found in the Chalk of Meudon. When compared with the *Echinocorys vulgaris* (Pl. LXXVII, fig. 1 *a, b, c*), its general outline is seen to be more ovoid, elongated, and more sensibly rostrated posteriorly; its upper surface is thicker and more inflated anteriorly; the ambitus is rounder, less angular, and the under surface more depressed around the mouth-opening; the ambulacra are larger as they approach the summit, and form a less acute angle; the

[1] 'Memoirs of the Geological Survey; British Organic Remains,' decade iv, pl. vi, p. 4, 1852.

vent is, in general, more infra-marginal, and the single inter-ambulacrum has well-marked eminences. Now, all these points of difference, so well marked in some specimens, are not constant, since they gradually disappear in some and vanish away entirely in others.

Locality and Stratigraphical Range.—The variety *Echinocorys ovatus*, Leske, is a characteristic fossil of the White Chalk, and found in abundance in the south-east of England, especially in the Counties of Kent, Surrey, Sussex, and the Isle of Wight. It occurs in both the middle and lower parts of the series. The varieties *striata,* Lamk., and *subglobularis* prevail in the Lower Chalk, so that varieties in point of form may have a certain value in stratigraphical distribution, such as is apparent in certain species of *Micraster*.

In Ireland, General Portlock found the variety *E. ovatus* was characteristic of the Lower Chalk beds, whilst in England its horizon is the Upper Chalk.

ADDENDA.

MICRASTER COR-TESTUDINARIUM, *Goldfuss*. Pl. LXXVI, fig. 1 *a—f*, and fig. 2 *a—e*.

SPATANGUS COR-TESTUDINARIUM,		*Goldfuss*. Petref. German., p. 156, pl. xlviii, fig. 5, 1826.
MICRASTER	—	*Agassiz*. Prod. Monog. des radiaires; Mém. Soc. des Sc. Nat. de Neuchâtel, t. i, p. 184, 1835.
—	—	*Roemer*. Nord-deutschen Kreidgebirges, p. 33, 1840.
—	—	*Morris*. Catal. of British Fossils, p. 54, 1843.
—	—	*Hébert*. Foss. de la Craie du Meudon Mém. Soc. Géol. de France, 2 sér., t. v, pl. xxix, fig. 18, 1855.
—	—	*Evans*. Proc. Geol. Assoc., vol. v, No. 4, pl. ii, 1877.

Diagnosis.—Test cordiform, greatest width at the junction of the anterior with the middle third of the ambitus, posterior two-thirds tapering to a very narrow posterior border. Upper surface convex, more or less elevated, anterior half obliquely declining towards the anteal sulcus, posterior half often developing a prominent central ridge extending from the disc to the periprocte; summit central; surface of the plates covered with small tubercles. Under surface convex; plates covered with large tubercles; mouth-opening at a distance from the border, near the junction of the first with the second fourth of the antero-posterior diameter of the base. Peristome transversely oval, with a thick, projecting lower lip.

Dimensions.—Height one inch and a half; length two inches and one tenth; width two inches and one tenth.

Description.—It is difficult to unravel the synonymy of this species, seeing that it has been confused by some with *Micraster brevis*, and by others with *Epiaster gibbus;* so that unless we had the specimens referred to for special examination and comparison, it would be impossible to determine the species indicated in some published lists. I have limited, therefore, my synonyms to the few examples I happen to know.

Goldfuss figured, as the type of his species, a large globular variety, but did not at the same time indicate that it was an exceptional example, and for this reason English geologists were long doubtful whether our Chalk contained the German *Micraster cor-testudinarium*, Goldf. In consequence of considerable importance having lately been attached to this species by Continental geologists in their classification of the Cretaceous formation, and good examples of the common type-forms of the Urchin having been sent from France and Belgium for comparison with English specimens, it soon became evident that we had an abundance of the form in our Cretaceous strata, and that with us, as on the Continent, the species characterised a well-marked zone in the Cretaceous formation. I am indebted to Caleb Evans, Esq., F.G.S., for a series of good specimens from different Sussex and Surrey railway-cuttings, to illustrate the stratigraphical distribution of this species; and in order that I might figure the ordinary forms of the true German types of *Mic. cor-testudinarium*, I applied to my friend, Herr C. Struckmann, of Hanover, a distinguished palæontologist, to send me good types of this Echinide to enable me to give figures of it for reference; and I beg to thank my friend for four beautiful examples, one of which I have figured in Pl. LXXVI, fig. 1 *a—f*, for comparison with the British forms obtained from sections on the Surrey and Sussex Railway, near Purley and Kenley, villages between Croydon and Caterham, and likewise from Dover.

It is a very difficult matter to describe the points in which *Micraster cor-anguinum* differs from *Micraster cor-testudinarium*, *Micraster breviporus*, and *Micraster cor-bovis*, inasmuch as these four forms blend into each other by intermediate shapes, which may be obtained from a number of specimens of each group; and yet typical examples of the four forms when placed alongside each other, seem sufficiently distinct to the eye of the observer to justify the separation of the species.

In *Micraster cor-testudinarium*, the test, in general, is flattened on the upper surface, and the ambitus from the anterior third backwards tapers much towards the posterior border, so that the shell has an elongated pyriform shape not much inflated at the sides. In some specimens with an elevated upper surface the test assumes a conoidal outline, as seen in Pl. LXXVI, fig. 1 *b*. In some a prominent ridge extends from the apical disc to the periprocte (fig. 1 *a* and fig. 2 *a*), which is absent in others; in all, the anteal sulcus is shallow and only slightly grooves the anterior border (fig. 1 *a* and fig. 2 *a*); the apical disc is likewise nearly always central and lies in a depression at the summit (fig. 1 *a*, fig. 2 *a*).

The pairs of petaloid ambulacra are of unequal length, the antero-lateral pair is one third longer than the postero-lateral; they are not flexed, and extend straight and obliquely outwards at an angle of 40° (fig. 1 *a* and fig. 2 *a*); the poriferous zones have very small holes arranged in pairs, with a double row of granules extending vertically between the two rows, and forming, in the petaloid portion of the area, a well-marked boundary to the central suture, which is very much depressed. The non-petaloid portion of the area is formed of rhomboidal plates which are articulated with the large interambulacral series (fig. 1 *d*); the single ambulacrum filling the anteal sulcus is narrow, the pores are placed closer together, and the plates are flatter, and have an imbricated appearance in many specimens (fig. 1 *a*, fig. 2 *a*). The non-petaloid portion consists of longer rhomboidal plates with the pores situated widely apart and visible down to the central sulcus (fig. 1 *d*).

The interambulacral areas are wide, and formed of large plates, eight, ten, or twelve in each column, according to the age of the Urchin. They are largest at the base and diminish in size on the sides and upper surface. The plates are covered with several (four to six) irregular rows of tubercles, nearly uniform in size, and from 20 to 30 on each (fig. 1 *d*); the surface of the plates is covered with a microscopic granulation, which forms circles around the tubercles. At the base, the tubercles are much larger, especially about the cheeks and anteal sulcus, and on the plastron they are closely clustered together; they are encircled by smooth areolæ, each surrounded by a ring of granules (fig. 1 *f*).

The subanal fasciole is very distinctly visible in all the specimens that have passed through my hands.

The apical disc is a small body set in a central depression, and composed of four perforated ovarial, and five perforated ocular plates, all closely welded together, the right antero-lateral ovarial having a small madreporiform body on its surface (fig. 2 *d*).

The posterior border is narrow and truncated obliquely downwards and inwards. The vent occupies the upper part of this region, and the oval periprocte opens beneath the termination of the central ridge on the upper surface (fig. *c*).

The base is rounded laterally, and flattened in the longitudinal direction, the mouth-opening is situated at some distance behind the sulcus, the peristome is transversely oblong, and the under lip forms a strong projecting process of the shell (fig. 1 *c* and fig. 2 *b*).

Affinities and Differences.—I have already pointed out (pp. 275, 279) the affinities which this Urchin has with *Micraster cor-anguinum* on the one side, and with *Micraster breviporus* and *Micraster cor-bovis* on the other, and have stated how difficult it is to detect any characters of specific value by which it may be described as distinct from either. I have long considered *M. cor-testudinarium* as a variety of *M. cor-anguinum.* The backward position of the mouth-opening, the flatness of the upper surface, and more cordate shape of the test, are not characters of specific value, although they may be useful in establishing the fact that varieties lived under special conditions in the Cretaceous sea, and a separation of the varieties may, therefore, be of value for stratigraphical purposes.

Stratigraphical Position.—Mr. Meÿer regards *M. cor-testudinarium* as a characteristic fossil of the Dover chalk, and *M. cor-anguinum* of the Charlton Chalk which belongs to a much higher bed in the Cretaceous series;[1] and this appears to correspond with the horizons in which these forms are found in France and North Germany.

Herr Struckmann's specimens of *Micraster cor-testudinarium*, Goldf., were all obtained from the Middle Plæner of Hanover, and very much resemble the English Urchins collected from the cuttings of the Surrey and Sussex Railway,—so much so that, were they not carefully marked, the English and German forms could not be distinguished from each other. Two of the specimens were collected from the Middle Plæner of Weddingen near Liebenburg, and the largest of these is figured in Pl. LXXVI, fig. 1 *a*, *b*. The details of the anatomy of the test are given in fig. 1 *c*, showing the backward position of the

[1] C. Evans "On Forms of the Genus Micraster," 'Proc. Geol. Assoc.,' vol. v, No. 4, p. 3, 1877.

mouth-opening and the width of base; fig. 1 *d* shows three large interambulacral plates, with numerous irregular rows of tubercles on each set in an abundant microscopic granulation, with parts of the petaloid and non-petaloid portions of the ambulacral area magnified to show the wide-set disposition of the pores in the poriferous zone in the petaloidal, and their very different condition in the nonpetaloidal parts; fig. 1 *e* shows the size and distribution of the smaller tubercles, and fig. 1 *f* the size and structure of the larger tubercles, where each tubercle is seen encircled by a smooth areola, with a circle of granules disposed around the margin thereof; fig. 2 *d*[1] exhibits the structure of the apical disc, and shows the four ovarial plates with very large holes, having the five ocular plates arranged alternately with the ovarials, and the large madreporiform body covering the central portion of the disc. A third specimen, which resembles very much the one I have figured, was collected from Othfresau near Liebenburg. The fourth specimen resembles the *breviporus* variety, and was found at Langelsheim, near Gosler, Hanover.

When we compare Herr Struckmann's specimens with the figures in Goldfuss's 'Petref. Germaniæ,' pl. xlviii, fig. 5 *a*, *b*, we see that the type specimen was shorter, broader, and more globular than the Hanoverian Urchins, and that the specimen, fig. 5 *d*, of smaller size, very much resembles the English Urchins from Purley figured in Pl. LXXVI, fig. 2 *a*, of this work. The types figured by Prof. Goldfuss were collected from the Chalk of Westphalia, and other examples are recorded from the White Chalk of Maestricht and Quedlinburg, and from the Hard or Lower Chalk of Coesfield.

In Belgium, France, and Germany two zones of Chalk have been recognised by Continental geologists, characterised respectively by *Micraster cor-anguinum* and *M. cor-testudinarium*, the former characteristic of our Charlton Chalk, and the latter of the Dover Chalk; and these, it has been shown by Mr. Meÿer, F.G.S., and Mr. Caleb Evans, F.G.S.,[2] who have paid special attention to this subject, exist in England.

In 1876 Dr. Charles Barrois published a very valuable memoir on "*le Terrain Crétacé Supérieur de l'Angleterre et de l'Irlande*," in which he described the Chalk of the South Downs and the Hampshire Basin, and most other parts of England and Ireland, and has clearly shown that it is possible to correlate the zones of life in the English Chalk with corresponding zones which he has already established in the Chalk of France. Mr. Caleb Evans contributed to the Geologists' Association in 1877, a valuable paper,[2] with figures of species, "On the Forms of the Genus *Micraster* common in the Chalk of West Kent and East Surrey," in which he pointed out the distribution of the species in these zones.

The classification which Dr. Barrois adopts is shown in the following Table, to which I have added the English equivalents of the same as identified by Mr. Caleb Evans.

[1] In the lettering of this plate the numerals 1 *d* have been twice repeated; that of the apical disc should be 2 *d*.

[2] 'Proceedings of the Geologists' Association,' vol. v, No. 4, p. 149, 1877.

Dr. Barrois' General Classification.	Mr. C. Evans' Classification in East Surrey and West Kent.
Zone à *Belemnitella.*	Gravesend Beds ?
,, *Marsupites.*	
,, *M. cor-anguinum.*	Charlton and Croydon Beds.
,, *M. cor-testudinarium.*	Riddlesdown Beds.
,, *Holaster planus.*	Kenley Beds.
,, *Terebratulina gracilis.*	Whiteleaf Beds.
,, *Inoceramus labiatus.*	Upper Marden-Park Beds.
,, *Belemnites plenus.*	Lower Marden-Park Beds.
,, *Holaster sub-globosus.*	Oxtead Beds.
Zone à *Pecten asper.*	
,, *Ammonites inflatus.*	

Micraster brevis, *Desor.* Pl. LXXV, figs. 2 *d,* 3 *a—g.*

Micraster latus, *Sismonda.* Echin. foss. de Nizza, p. 29, tab. i, fig. 13, 1843.
— brevis *Hébert.* Étud. sur les terr. Crétacés ; Mém. Soc. Géol. de France, 2e ser., tom. v, tab. xxix, fig. 19, 1854.
Spatangus ananchytoides, *Desmoul.* Tabl. Synom., p. 406, 1837.
Micraster brevis, *Desor.* Synopsis des Échinides Foss., p. 364, 1858.

Diagnosis.—Test cordiform, very short, as broad as it is long ; antero-lateral ambulacra long and wide, postero-lateral pair shorter ; poriferous zones wide, holes forming a pair placed far apart. Test elevated, sometimes conoidal ; anteal sulcus very shallow ; single ambulacrum similar in structure to the anterior pair ; posterior border narrow and very obliquely truncated.

Description.—This Urchin appears to belong to the "*Craie à hippurites*" and has many structural affinities with certain forms of *M. cor-testudinarium ;* it is, however, a much wider shell with a more elevated upper surface, and as far as external form goes very different from that species ; the summit is excentral, a little nearer the anterior border. The ambulacral areas are built of narrow elongated plates, and the pores forming a pair are placed wider apart than in any of the congeneric forms I have described.

My late friend, Monsieur Michelin, sent me several very good type shells from the "*Craie à hippurites*" from Sougraigne, near les Bains de Rennes, and Soulage, Corbières, Aude ; it is found also at Tuco, near Caseneuve, "Craie de Tercis au Périgord étage Senonien." Among the many varieties of Micrasters collected from the Chalk rocks of the British Islands, I have seen no form that I can assign to *Micraster brevis*. I have given a drawing of a good type form of this species for reference should any forms allied to it be discovered in course of time; and have furnished numerous details for special comparison. The wide ambulacra, with narrow elongated plates and wide-set pores in the zones, the character of the tubercles in the plates (fig. 3 *f* and *g*), the structure of the apical disc, with the uniform structural character of the five ambulacra, form an assemblage of points of structure which are very diagnostic of this species. My learned friend, Monsieur Cotteau, considers this form to be a variety only of *M. cor-testudinarium*; in reviewing the different varieties of this species he remarks,[1] "in the south-west of France, and in the basin of the Mediterranean, the variety which predominates is short and dilated before, and wider than it is long. It is the *M. brevis*, Desor, which we can collect by hundreds in the quarries of Villedieu and of Saint-Fraimbault, and in the Chalk of Corbières at Sougraigne and at Soulage (Aude)."

Catopygus pyriformis, *Goldfuss*. Pl. LXXVIII, fig. 2 *a*, *b*, *c*.

Nucleolites pyriformis, *Goldfuss*. Petref. Germaniæ, p. 141, pl. 43, fig. 7, 1829.
Catyopygus — *Agassiz and Desor*. Catal. raison. R. 6, An Sciences Nat., tom. 7, ser. 3, p. 158, 1847.
— tenuiporus, — Ibid., ibid., R. 7.
— pyriformis, *d'Orbigny*. Prodrome II, p. 271, Étage 22, 1850.

Diagnosis.—Test ovate, posterior border produced and tapering, upper surface depressed, posterior half most elevated and slightly carinated; ambitus inflated, posterior border narrow, truncated, vent in the middle covered by the beak-shaped termination of carina, base flat, plastron elevated, oral aperture central, surrounded by five prominent lobes with petaloidal expansions proceeding therefrom; ambulacral areas narrow, equal sized, poriferous zones with 10—12 pairs of pores set obliquely and well spaced out; periprocte oblong, transverse, test thick, external surface covered with fine, close-set granules lodged in depressed areolæ excavated out of the test like the small concavities around the top of a thimble, those on the base larger than those of the upper surface.

Dimensions.—Antero-posterior diameter $\frac{9}{10}$ of an inch; transverse diameter across the widest part of ambitus $\frac{7}{10}$ of an inch; height $\frac{5}{10}$ of an inch.

Description.—I am indebted to Mr. E. T. Newton, F.G.S., Palæontologist of the Survey, for calling my attention to this very beautiful Urchin, obtained by Mr. J. F. Walker, F.G.S., of York, and said to have been collected from the Upper Greensand of Warminster. This specimen was presented by him to the Museum of the Royal School of Mines, Jermyn Street, where it is now contained. A careful examination of

[1] 'Échinides du Départ. de la Sarthe,' p. 323, 1861.

the matrix of this Urchin has, however, raised doubts in my mind as to the accuracy of the stratum and locality. Mr. Walker it appears bought it from a dealer in Warminster, who may have had it in exchange along with some foreign specimens. *Catopygus pyriformis* is found in the Senonian of Maestricht, Ciply, and Sens, Yonne, and is a very characteristic Urchin of this stage of the Cretaceous formations.

The following description and figures of a new species of *Pseudodiadema* have been forwarded to me by my valued friend, the Rev. Professor Thos. Wiltshire, F.G.S., as a contribution to my Addenda.

Pseudodiadema fragile, *Wiltshire.* Pl. LXXX, figs. 1—11.

"Test somewhat small, thin, circular, depressed, almost flat on upper surface, slightly convex on under. Poriferous zones narrow, straight, pores unigeminal on upper surface, trigeminal on lower. Ambulacra narrow above, rather wider below, with two rows of small perforated tubercles from oral aperture to above ambitus. Interambulacral wide, two rows of small primary perforated tubercles in the middle extending the whole distance, and two rows of secondary perforated tubercles on lower side, ceasing after passing the ambitus. Miliary zone granular below, showing a few secondary tubercles above and below the ambitus. Mouth-opening large, peristome circular, lobed. Discal opening large, pentangular. Spines small, slender, straight; surface striated, striæ interrupted and diverging, and producing a roughened surface.

Dimensions.—Height less than $\frac{1}{2}$ inch, transverse diameter $1\frac{1}{2}$ inches.

Description.—The test is thin, circular, almost flat on upper surface, slightly rounded on under. In the specimen from which the drawings were made the upper and under sides, prior to their fossilisation, had been subjected to considerable pressure, and brought into closer contact than they were in the living stage. The distance between the upper and the under sides therefore cannot be accurately determined; probably the figured specimen was under half an inch in height.

The ambulacral areas are straight and narrow (about two-ninths the width of the ambulacra at the upper side, and nearly one-half at the peristome), contracting in their range upwards. Two rows of about nine perforated tubercles (one tubercle to each plate) start from the under side, and cease soon after passing the ambitus. The tubercles are small, placed in small areolæ, with slightly projecting bosses and crenulated summits, and are separated by an undulating series of granulations. The poriferous zones are narrow and straight. The pores are oval and simple, and are arranged in single file throughout the zones, save near the peristome, where they form into a few transverse lines of sets of three pores.

The interambulacral areas are four times the width of the ambulacral at the equator, and are throughout much wider than the latter. On the under side they have four rows of small perforated primary tubercles, crenulated, and slightly raised above a smooth areola, whose margin is generally surrounded by granules. The two inner rows are best developed, and extend from the peristome to the discal margin; the two exterior rows are absent from the uppermost plates. The figured specimen (figs. 6, 11) seems to have had ten tubercles in the inner rows. The miliary zone is narrow in the infra-marginal region, is wider in the middle, and expands at the upper side; it is filled with small irregularly placed granules, among which, on the upper side near the junction of plates, are a few mamillated tubercles, one on each plate.

The spines (figs. 3, 8) are extremely fine, needle-shaped, rather longer than twice the width of the plates of the ambitus; are solid, though occasionally longitudinal internal cavities exist. The surface is sculptured with fine long lines, and is marked by alternate angular contractions and expansions, so that the section lengthways is serrate, but circular in the opposite direction. A representation of a similar spine will be found in Pl. XIV, fig. 2 *c*.

Locality and Stratigraphical Position.—The very rare Urchin illustrated on Pl. LXXX, figs. 1—11 was obtained many years since by myself from the Upper Chalk at Gravesend. When the fossil was first discovered it exhibited no more than the inner surface of the plates of the upper side. Indications, however, were not wanting to show that the fracture of the piece of chalk containing the Pseudodiadema had split the test into two halves, along the plane of the ambitus, and that the second piece of chalk which bore the impression of these plates (and which fortunately had been saved) contained the under plates of the Urchin. The two halves were afterwards mounted on plaster of Paris, and carefully cleaned until the parts of the test previously concealed began to appear. In the removal of the chalk evidence was given that several extremely fine hair-like spines, with a striated and quasi-imbricated exterior, were in contact with or close to the test, and were the spines of the Urchin. Such spines are occasionally met with in the Upper Chalk, and solitary plates similar to those depicted in figs. 1, 5, are found in the same geological horizon. It is very unusual for the plates and spines to be associated together as in the present instance.

Affinities and Differences.—*Pseudodiadema fragile* has some resemblance to *Pseudodiadema ornatum* of the Lower Chalk, but can be distinguished by its smaller and widely separated tubercles, the general smooth surface of its test, and its spines with their series of short longitudinal striations, which by their divergence form a succession of fringes. The circumstance that the plates of this Urchin are generally found separated from one another has suggested the specific name of *fragile*."

At pages 1—14 I gave an account of the subdivisions of the Cretaceous beds of England as they were recognised at that period when that part of my Monograph was written, viz. in the year 1864. I append now, however, as a conclusion to my work, the following remarks by A. J. Jukes-Brown, Esq., F.G.S., on a proposed new classification of the English Chalk.

"English geologists have hitherto been accustomed to divide the Chalk into three portions, which have long been known by the name of: (1) Chalk Marl; (2) Lower Chalk, without flints; (3) Upper Chalk, with flints. But recent researches have shown that such an arrangement is not supported by either stratigraphical or palæontological evidence, and that the divisions above named do not constitute natural rock-groups. It is time, therefore, that a new nomenclature should be introduced, founded on a better system of classification.

"D'Orbigny's divisions of Cenomanian, Turonian, and Senonian have long been adopted on the Continent, and in 1875 they were applied to the English Chalk by Dr. Ch. Barrois, who found that even the zonal subdivisions of the system were substantially the same in both countries.[1] That system might be accepted in England.

The zones of the English Chalk in the Eastern and Southern Counties may be thus stated on the authority of the respective authors whose names are appended.

	Cambridgeshire. Jukes-Brown.	Norfolk. Woodward.	Kent. Price.	Dorset. Barrois.
Upper.	Upper zones concealed Zone of Micrasters	Upper Chalk	Upper Chalk	Zone à Belemnitelles. Zone à Marsupites. Zone à Micraster.
Middle.	Chalk Rock	?	Chalk with flints	Zone à *Holaster planus.*
	Zone of *Holaster planus* Zone of *Terebratulina gracilis* Zone of *Rhynchonella Cuvieri*	Medial Chalk and part of the Lower Chalk	Zone of *Terebratulina gracilis* Zone of *Cardiaster pygmæus*	Zone à *Terebratulina gracilis.* Zone à *Inoceramus labiatus.*
	Melbourn Rock	?	Belemnite Marl	Marne à *Belemnites plenus.*
Lower.	Zone of *Holaster subglobosus*	Hunstanton Chalk	Zone of *Holaster subglobosus*	Zone à *Holaster subglobosus.*
	Totternhoe Stone	? Inoceramus bed	Zone of *Ammonites varians*	
	Zone of *Rhynchonella Martini*	? Absent	Chalk Marl	
	Cambridge Greensand	Red Chalk in part	Chloritic Marl	Zone à *Pecten asper.*

"It will be seen from the above that the Lower Chalk, may be defined as including the three minor divisions hitherto called Chloritic Marl, Chalk Marl, and Grey Chalk; the Totternhoe Stone being only a local development of sandy stone between the two latter. The Lower Chalk will therefore correspond with the Cenomanian of D'Orbigny. It is characterised by an abundance of Cephalopods, Ammonites, Turrilites, Scaphites and Nautili. The most characteristic species are *Ammonites Mantelli, Am. varians, Am. Rhotomagensis, Lima globosa, Plicatula inflata, Rhynchonella Martini, Holaster subglobosus, H. lævis* and *Discoidea subucula.*

[1] Recherches sur le Terrain Crétacé Supérieur de l'Angleterre et de l'Irlande. Lille, 1876.

"The Middle Chalk may be taken to include the greater part of that formerly known as the Lower Chalk, and will answer to the French Turonian. Its fauna is very different from that of the beds below, most of the Cenomanian species having died out during the interval marked by the formation of the Melbourn Rock, while other new species were introduced, the chief of these being *Ammonites nodosoides*, *Am. peramplus*, *Inoceramus mytiloides*, *Rhynchonella Cuvieri*, *Echinoconus subrotundus*, *Cyphosoma simplex*, *Cardiaster pygmæus*, and *Holaster planus*.

"The Upper Chalk may be regarded as equivalent to the Senonian of the French. It is characterised by the abundance of *Micraster coranguinum*, *Cidaris sceptrifera*, *Terebratula carnea*, *Lima Hoperi*, and in the higher zones by *Marsupites ornatus*, *Echinoconus conicus* and *Belemnitella mucronata*."

APPENDIX I.

SUMMARY[1] OF THE BRITISH CRETACEOUS ECHINOIDEA.

Order—ECHINOIDEA, *Wright* (p. 19).

Body-shell (*test*) spheroidal, oval, cordate, or depressed, without arms, furnished with a distinct mouth (*oral opening*), whose border (*peristome*) is sometimes simple, sometimes lobed, always placed either in the centre or forwards on the under side; when the oral opening is not central its position marks the anterior region; armed with five calcareous sets of plates (*jaws*), or not armed (*edentulous*). Anal opening (*vent, periprocte, discal opening*) variously situated on the upper (*dorsal*) or under (*basal*) side in the centre (*central*) or away from the centre (*excentral*), or in intermediate positions on the marginal border (*circumference, ambitus, equator*). Body enclosed in a shell (*test*) composed usually of twenty, sometimes of more than twenty (as in the family of the Palæozoic *Perischoechinidæ*), columns of calcareous plates, forming in either case ten areas; plates either solidly connected or capable of movement. Five of the areas (*ambulacral*) narrow or wide, containing each two rows of apertures (*poriferous zones*) for the passage (in the living state) of retractile suckers (*ambulacral tubes*). The other five areas (*interambulacral*) more or less wide, destitute of sucker pores. Ambulacral pores disposed in single pairs (*unigeminal*), double (*bigeminal*), or triple oblique (*trigeminal*). Ambulacral pore-columns (*areas*) sometimes continuous from the peristome to the summit (*complete*), sometimes confined to the upper surface of the test (*interrupted*), or forming re-entering curves (*petaloid*). Surface of test studded with tubercles (*primary, secondary,* and *miliary*), possessing spines of various forms and dimensions, solid or hollow, smooth, striated, serrated. Spines articulated on the rounded upper part of a tubercle (*mamelon*) which rises from a conical process (*boss*). Base of tubercle surrounded by a round, oval, smooth, excavated space (*areola* or *scrobicule*). Summit of test marked by an apical (*genital*) disc, composed generally of five genital and five ocular plates, usually in contact and central. Cutaneous surface of shell, especially near the mouth, bearing in the living stage small, tripartite, pincer-like bodies (*pedicellariæ*), placed on a short stalk, whose

[1] Compiled by the Rev. Prof. Thos. Wiltshire, M.A., F.G.S., Hon. Sec. Pal. Soc.

lower portion encloses a calcareous nucleus. Pedicellariæ capable (in the living state) of seizing small bodies and passing them from one to the other. Movement of the animal effected by the motion of the spines and the ambulacral tubes.

The ECHINOIDEA (including the Perischoechinidæ) range from the Silurian to the existing period, and are represented in the British Cretaceous formation by ten families (CIDARIDÆ, DIADEMADÆ, SALENIADÆ, ECHINOTHURIDÆ, ECHINICONIDÆ, ECHINONIDÆ, ECHINOBRISSIDÆ, ECHINOLAMPIDÆ, SPATANGIDÆ, and ECHINOCORIDÆ), and give thirty Cretaceous genera in one hundred and thirteen species, and are divisible into one Palæozoic section, the PALECHINOIDEA, with more than twenty rows of plates, and two Mesozoic and Cainozoic sections, the ECHINOIDEA ENDOCYCLICA and the ECHINOIDEA EXOCYCLICA, wfth twenty rows of plates.

Section A.—**Echinoidea endocyclica,** *Wright* (p. 29).

Anal opening within the genital plates, always opposite the mouth. Jaws always present.

The section includes six families: CIDARIDÆ, HEMICIDARIDÆ, DIADEMADÆ, ECHINIDÆ, SALENIADÆ, and ECHINOTHURIDÆ, ranging from the Trias to the existing period. Four families (CIDARIDÆ, DIADEMADÆ, SALENIADÆ, and ECHINOTHURIDÆ) are represented in the British Cretaceous strata, and give eleven genera : CIDARIS, PSEUDODIADEMA, PEDINOPSIS, ECHINOCYPHUS, GLYPHOCYPHUS, CYPHOSOMA, PELTASTES, GONIOPHORUS, SALENIA, COTTALDIA, and ECHINOTHURIA, consisting of fifty-nine species.

FAMILY I.—CIDARIDÆ, *Wright* (p. 35).

Test thick, spheroidal, generally depressed at the upper and under surfaces. Ambulacral areas narrow, usually undulating, and destitute of primary tubercles. Interambulacral areas wide, carrying a few large primary perforated tubercles. Poriferous zones narrow ; pores generally unigeminal. Oral and anal openings large. Peristome destitute of notches. Apical disc large, composed of five large, equal-sized, angular genital plates, and five ocular plates. Jaws large. Primary spines long, massive, and more or less cylindrical. Family ranging from the Trias to the existing period, and represented in the British Cretaceous strata by one genus, CIDARIS, with seventeen species (pp. 35—79).

Genus 1.—CIDARIS, *Klein* (p. 35).

Test thick, more or less depressed. Ambulacral areas undulating. Primary tubercles few, rarely more than six in a row. Miliary zones more or less wide. Pores of the poriferous zones unigeminal and contiguous. Range of genus, from the Trias to the existing period. Seventeen British Cretaceous species (pp. 36—79).

Family II.—DIADEMADÆ, *Wright* (p. 80).

Test in general moderately thick, subpentagonal, more or less depressed. Ambulacral areas almost always straight, more or less wide, furnished with two or four rows of tubercles often as large as those of the interambulacral. Interambulacral areas equal to, or double as wide as, the ambulacral. Tubercles of the interambulacral areas crenulated or non-crenulated, either primary, of equal size, in two to eight rows, generally perforated, or with two or four rows of secondary tubercles, much smaller in size, filling up the interspaces of the area. Poriferous zones narrow and almost always straight; pores unigeminal, bigeminal, or trigeminal. Oral and anal openings usually large. Peristome strongly decagonal, generally deeply notched. Spines cylindrical, solid or tubular. Those of the fossil not longer than the diameter of the shell; surface of the solid forms covered with very fine minute longitudinal striæ; and those of the tubular with oblique annulations of fringe-like scales. Jaws large. Range of family, from the Trias to the existing period. Family represented in the British Cretaceous strata by five genera: Pseudodiadema, Pedinopsis, Echinocyphus, Glyphocyphus, Cyphosoma, and by twenty-three species (pp. 87—124, 341, 342).

Genus 2.—Pseudodiadema, *Desor* (p. 86).

Test moderately thick, generally not large. Ambulacral areas one third to one half the width of the interambulacral. Ambulacral areas furnished with two rows of primary tubercles. Interambulacral areas sometimes provided with two rows of primary tubercles, sometimes with two rows of primary and two to four short rows of smaller secondary tubercles, sometimes with four or six rows of nearly equal-sized primary tubercles at the equator. Primary tubercles of both areas perforated, having sharply-crenulated summits. Poriferous zones narrow and straight; pores of poriferous zones unigeminal throughout, or bigeminal in the upper part of the zones. Oral opening large. Peristome deeply notched. Anal opening pentangular. Spines solid, cylindrical or needle-shaped, short, and covered longitudinally with very minute microscopic lines. Range of genus, from the Lias to the Upper Cretaceous beds. Twelve British Cretaceous species (pp. 87—113, 341, 342).

Genus 3.—Pedinopsis, *Cotteau* (p. 113).

Test thin, of moderate size, inflated, sometimes subconical. Ambulacral areas rather wide, furnished with two complete and two incomplete rows of small perforated and crenulated tubercles. Interambulacral areas marked at ambitus by six to ten lines of perforated and crenulated tubercles, decreasing in number above and below until only two lines remain. Poriferous zones wide and straight; the pores bigeminal throughout, and forming at the upper surface and ambitus two distinct rows, becoming blended together at the inframarginal region and remaining conspicuous at the base. Oral opening subcircular and lobed. Apical disc small. Spines unknown. The genus is only met with in the Cretaceous strata. One British Cretaceous species (pp. 114—116).

Genus 4.—Echinocyphus, *Cotteau* (p. 116).

Test thin, small, circular, more or less inflated on the upper surface, concave at the base. Ambulacral areas rather wide, furnished with one, rarely two, rows of primary tubercles. Interambulacral areas with two rows of tubercles. Tubercles of both areas of nearly the same size, alternate, crenulated, but not perforated. Interambulacral plates of base sculptured, with more or less strongly marked sutural depressions, and exhibiting on their surface a border of radiating miliary granules. Poriferous zones nearly straight, narrow; pores unigeminal. Oral opening moderately large, subcircular, provided with slight lobes. Anal opening of same size. Apical disc unknown. Spines unknown. The genus is only met with in the Cretaceous strata. Two British Cretaceous species (pp. 116—119).

Genus 5.—Glyphocyphus, *Haime* (p. 120).

Test thin, small, circular, more or less inflated above, concave below. Ambulacral areas somewhat narrow, generally with two rows of alternate tubercles, sometimes with only one row. Interambulacral areas with two rows of alternate tubercles. Tubercles of both areas of nearly the same size, crenulated and perforated. Ambulacral and interambulacral plates marked by sutural depressions; surface around the tubercles covered with fine, close-set, homogeneous granules. Poriferous zones straight, narrow; pores unigeminal. Oral opening small, subcircular, divided into lobes by feeble incisions. Anal opening not large, subpentagonal. Apical disc small, solidly united to the test, forming an elongated oval ring. Spines unknown. The genus confined to the Cretaceous strata. One British Cretaceous species (pp. 121—124).

Genus 6.—Cyphosoma, *Agassiz* (p. 128).

Test thick, moderate in size, circular or subpentagonal. Sides slightly inflated, depressed, convex above, flattened below. Ambulacral areas furnished with two rows of prominent crenulated and imperforate primary tubercles. Interambulacral narrow above, wide below, with two perfect and sometimes two imperfect rows of prominent crenulated and imperforate primary tubercles; the two perfect rows close together at the peristome and wide apart at the anal opening. Primary tubercles of the same size in both areas. Poriferous zones well developed, straight on upper side, undulating at the ambitus and base; poriferous plates unequal and irregular. Pores unigeminal, more or less bigeminal on upper surface and crowded together at the peristome. Oral opening large, subcircular, incised and lobed. Anal opening large, pentagonal, the angles extending into the middle portion of the interambulacra. Elements of anal disc feebly united. Spines long, solid, of moderate thickness, cylindrical, aciculate, spatuliform or spoon-shaped. The genus confined to the Cretaceous strata. Seven British Cretaceous species (pp. 129—144.

Family III.—SALENIADÆ, *Wright*, (p. 144).

Test thin, small, spheroidal, hemispherical or depressed. Ambulacral areas wide or narrow, straight or flexuous, furnished with two rows of secondary tubercles alternating with each other on the margins of the area. Interambulacral areas wide, having two rows of primary, crenulated tubercles perforate or imperforate. Poriferous zones narrow. Pores unigeminal, except near the peristome where they fall into oblique rows of three. Oral opening sometimes small, sometimes large, more or less decagonal, deeply or feebly indented. Anal opening sometimes small. Apical disc large or small, pentagonal or undulated, much developed, carrying a suranal plate in the middle of the disc, consisting of one to eight separate elements. Periprocte excentric. Spines long, slender, straight, curved, angular or flattened, ovoid or subglandiform. Family ranging from the Jurassic to the existing period, and represented in the British Cretaceous strata by four genera: Peltastes, Goniophorus, Salenia, Cottaldia, in eighteen species (pp. 149—189).

Genus 7.—Peltastes, *Agassiz* (p. 149).

Test thin, small, circular, more or less inflated above, almost flat below. Ambulacral areas narrow, straight, or slightly flexuous, furnished with two rows of small, close-set, alternating secondary imperforate tubercles. Interambulacra large, provided with two rows of large crenulated, imperforate tubercles. Poriferous zones narrow. Pores unigeminal, crowded near the peristome. Oral opening moderate in size. Peristome slightly incised, unequally lobed. Apical disc generally large and solid, projecting above the surface, marked by impressions and striæ, shield shaped, composed of large plates more or less undulated at the border. The right antero-lateral ovarial provided with an oblong fissure always directed from right to left and corresponding to the oviductal pore and representing the madreporiform body. Periprocte excentric, elliptical, its minor axis in a line with and near to one of the ambulacral areas. Spines slender, striated. Range of genus, from the Lower Cretaceous to the existing period. Seven British Cretaceous species (pp. 150—162).

Genus 8.—GONIOPHORUS, *Agassiz* (p. 165).

Test thin, circular, elevated above, flat below. Ambulacral areas narrow, slightly undulating, with two rows of secondary alternate imperforate tubercles. Interambulacral areas wide, marked by two rows of primary, alternate, crenulated tubercles. Poriferous zones narrow. Pores simple unigeminal. Oral opening small. Peristome decagonal, slightly incised, and equally lobed. Apical disc large, regularly pentagonal, smooth without incised impressions, ornamented with prominent carinæ independent of the form of the ovarial plates. Periprocte excentric, rhomboidal, elliptical, with its minor axis in a line with but distant from one of the ambulacral areas. Disc composed of five ovarial and five ocular plates, and one suranal. Genus confined to Cretaceous strata. One British species (pp. 166—169).

Genus 9.—SALENIA, *Gray* (p. 169).

Test thin, small, circular, elevated, sides inflated, more or less convex above, flat beneath. Ambulacral areas narrow, gently flexuous, with two or four rows of equal-sized secondary imperforate tubercles. Interambulacral areas wide, with two rows of primary, crenulate, imperforate tubercles. Poriferous zones narrow, pores unigeminal, crowded near the peristome. Oral opening large. Peristome feebly incised, unequally lobed. Apical disc large, shield shaped with deeply undulated border. The ovarial and suranal plates large and pentagonal, the oculars wide and cordate with punctured or incised sutures. Surface of plates smooth, granulated, or striated. Periprocte subcircular, excentric, and variable in position in the different species, but on the right side of a line passing through the axis of the body. Spines long and slender, aciculate or spatulate, straight or bent. Range of genus, from the Lower Cretaceous strata to the existing period. Nine British Cretaceous species (170—186).

Genus 10.—COTTALDIA, *Desor* (p. 186).

Test extremely thin, small, circular, inflated, more or less depressed. Ambulacral areas moderately narrow, furnished with numerous small mamillated, imperforate, uncrenulate tubercles, one row to each plate. Ambulacral areas moderately wide, with numerous small equal-sized, imperforate, uncrenulate tubercles, one row to each plate. Poriferous zones straight. Oral opening depressed, large, circular, slightly decagonal, feebly notched. Apical disc solid, narrow, forming a prominent ring composed of five perforated, rhomboidal ovarial plates, and five cordate oculars, much granulated. Periprocte small. Spines unknown. Range of genus, from the Upper Greensand to the existing period. One British Cretaceous species (pp. 187—189).

FAMILY IV.—ECHINOTHURIDÆ, *Wyv. Thomson.*

Test thin, circular, flexible, plates more or less overlapping, those of the ambulacral areas imbricating from below upwards, those of the interambulacral from above downwards. Under and upper sides sometimes very different. Ambulacral and interambulacral areas carrying primary perforated tubercles, and scattered secondary tubercles and granules. Poriferous zones with three pairs of pores. Oral and anal openings large. Oral opening protected by scale-like plates. Jaws strong. Spines thin, hollow, with projecting processes arranged in an imperfect spiral. Range of family, from the Cretaceous to the existing period. One British Cretaceous genus (ECHINOTHURIA) and one species.

Genus 11.—ECHINOTHURIA, *Woodward* (p. 124).

Test circular; depressed, plates slightly overlapping. Ambulacral plates narrow, long, imbricating from the anal aperture towards the oral aperture. Interambulacral plates arranged in the reverse order. Ambulacral plates containing two smaller plates, each perforated by a pair of pores intercalated in a notch in the middle of the lower margin, and perforated by a third pair of pores nearer the interambulacral areas. Primary tubercles of the ambulacra perforated, few, and irregularly distributed. Alternate plates of the interambulacral areas bearing one perforated primary tubercle. Oral opening large. Spines small, slender, striated, fringed. One British Cretaceous species (pp. 125—127).

Section B.—**Echinoidea exocyclica,** *Wright* (p. 29).

Anal opening outside the genital plates, never opposite the mouth.

The section contains eight families: ECHINOCONIDÆ, COLLYRITIDÆ, ECHINONIDÆ, ECHINOBRISSIDÆ, ECHINOLAMPIDÆ, CLYPEASTERIDÆ, ECHINOCORIDÆ, SPATANGIDÆ, and ranges from the Liassic to the existing period. Six families (ECHINOCONIDÆ, ECHINONIDÆ, ECHINOBRISSIDÆ, ECHINOLAMPIDÆ, SPATANGIDÆ, ECHINOCORIDÆ), are represented in the British Cretaceous strata by nineteen genera: DISCOIDEA, ECHINOCONUS, HOLECTYPUS, PYRINA, CATOPYGUS, CLYPEOPYGUS, ECHINOBRISSUS, TREMATOPYGUS, CARATOMUS, PYGURUS, HEMIASTER, EPIASTER, MICRASTER, ECHINOSPATAGUS, ENALLASTER, CARDIASTER, INFULASTER, HOLASTER, ECHINOCORYS; and by fifty-four species.

Family V.—ECHINOCONIDÆ, *Wright* (p. 198).

Test thin, circular, elongated or pentangular, elevated or depressed. Ambulacral areas narrow. Interambulacral areas wide. Both areas covered with numerous small perforated and crenulated tubercles. Poriferous zones simple, narrow, straight. Pores unigeminal except near the peristome, where they are trigeminal. Oral opening on under side central, circular, or pentagonal, notched into ten nearly equal lobes armed with five jaws. Apical disc central on upper side, composed of five ovarial and five ocular plates, madriporiform body very large, extending from the right antero-lateral ovarial plate into the centre of the disc. Anal opening variable in position on upper, lower, or marginal surface. Spines small, short, subulate. Range of family, from the Lower Oolites to Upper Chalk. Three British Cretaceous genera: Discoidea, Echinoconus and Holectypus, with eleven species (pp. 198—234).

Genus 12.—Discoidea, *Klein* (p. 199).

Test thin, circular, hemispherical, elevated. Ambulacral areas straight, narrow. Interambulacral wide, covered with numerous small, perforated, crenulated tubercles. On the inner side surface of the interambulacral plates near the poriferous zones are thick, shelly processes projecting inwards and forming small septa. Poriferous zones very narrow. Oral opening small, circular. Peristome decagonal, marked by slight notches. Anal opening oval, always inferior, and placed between the peristome and border, covered with small irregular granular plates. Apical disc solid, forming a slight projection on the summit of the test, having four or five perforated and one imperforate ovarial plates. Spines short and stout. Range of genus, from the Upper Greensand to the White Chalk. Five British Cretaceous species (pp. 200—213).

Genus 13.—Echinoconus, *Breynius* (p. 213).

Test thin, round, oval or pentagonal, enlarged a little before and slightly contracted behind. Upper surface more or less elevated, rounded or conoidal, under surface flat, sometimes concave. Ambulacral areas lanceolate. Interambulacra wide. Tubercles perforated and crenulated. Poriferous zones straight, narrow. Pores unigeminal becoming trigeminal at the peristome. Oral opening central, small, circular. Peristome subdecagonal, notched. Jaws present. Apical disc solid, placed at summit, having four perforate and one imperforate ovarial plates. Ocular plates very small and interposed between the angles of the ovarials. Spines small, acicular. Range of genus, from the Upper Greensand to the Upper Chalk. Five British Cretaceous species (pp. 213—231).

Genus 14.—Holectypus, *Desor* (p. 231).

Test thin, circular or subcircular, more or less hemispherical, conical or subconical, always tumid at the sides and flat or concave at the base. Ambulacral areas narrow, straight, lanceolate, with six or eight rows of small, perforated and crenulated tubercles, of which the marginal series only extend from the base to the apex. Poriferous zones narrow, pores unigeminal throughout. Interambulacral areas wide, furnished with small perforated and crenulated tubercles. Interambulacral plates not carrying on the inner surface projecting plates. Oral opening circular, central. Peristome notched. Jaws present. Apical disc central, vertical, composed of five ovarial and five ocular plates. The right antero-lateral much the larger and supporting a prominent madriporiform body. In Oolitic species, anterior and posterior plates perforated, and single plate imperforate; in Cretaceous species all the plates perforated. Anal opening large, inframarginal rarely, marginal sometimes occupying the centre space between peristome and border. Spines short, longitudinally striated. Range of genus, from the Inferior Oolite to the Lower Chalk. One British Cretaceous species (pp. 233, 234).

Family VI.—ECHINONIDÆ, *Wright* (p. 234).

Test thin, oval, or round, depressed. Ambulacral areas small, lanceolate. Interambulacral wide. Plates of both areas furnished with small, equal-sized imperforate and noncrenulate tubercles. Oral opening subcentral, irregularly pentagonal. Jaws absent. Apical disc nearly central, four ovarial plates perforated, one imperforate. Anal opening oblong, pyriform, basal or marginal closed by plates. Range of family, from the Cretaceous rocks to the existing period. One British Cretaceous genus: Pyrina, and three species (pp. 235—239).

Genus 15.—Pyrina, *Desmoulins* (p. 235).

Test thin, oval or round, depressed or globular; under surface inflated and often depressed around the mouth opening. Ambulacral areas moderately narrow, lanceolate. Interambulacral areas wide. Both areas covered with small equal-sized and imperforate tubercles. Poriferous zones straight and narrow, pores in regular pairs. Oral opening oval, oblique, subcentral. Peristome destitute of lobes. Apical disc small, subcentral, with four perforated genital plates. Anal opening oval and marginal, generally nearer the upper than the under surface. Spines unknown. Three British Cretaceous species (pp. 236—239).

Family VII.—ECHINOBRISSIDÆ, *Wright* (p. 240).

Test thin, circular, oblong, subpentagonal or clypeiform, covered with microscopic perforate or imperforate tubercles surrounded by excavated areolæ. Ambulacral areas narrow. Poriferous zones more or less petaloid, pores set at different distances apart, and united by connecting sutures. Interambulacral areas wide. Oral opening small, nearly central, pentagonal. Peristome generally lobed. Jaws absent. Apical disc small with four perforate and one imperforate genital plates; ocular plates very small. Madriporiform body extending into the centre of the disc. Anal opening in a furrow in upper margin or under surface of the single interambulacrum. Range of the family, from the Oolitic to the existing period. Five British Cretaceous genera: Catopygus, Clypeopygus, Echinobrissus, Trematopygus, Caratomus, and eight species (pp. 241—256).

Genus 16.—Catopygus, *Agassiz* (p. 240).

Test thin, oval or elongated, convex above, flat below, sides inflated, anal half much higher than oral half. Ambulacral areas narrow, petaloid above, forming a straight band on under side. Poriferous zones composed of an inner series of round pores, and an external series of elongated pores arranged in conjugate pairs; tubercles very small, numerous and scattered. Oral opening small, subcentral, pentagonal, with five prominent lobes. Apical disc small at the summit, prominent, with four perforated ovarial plates, and five microscopic ocular, the madriporiform body projecting. Anal opening small, round or oval, situated in the posterior border, at the summit of the vertical truncation of the posterior border. Spines unknown. Range of genus, from the Lower Greensand to Upper Tertiary. Three British Cretaceous species (pp. 241—246, 340).

Genus 17.—Clypeopygus, *d'Orbigny* (p. 246).

Test thin, oblong, depressed, convex above, concave below, covered with numerous small tubercles which are larger on the under side than the upper, and are placed in areal depressions. Ambulacral areas narrow and subpetaloid on upper surface, narrow below, and suddenly contracting near the peristome. Poriferous zones unequal in width from summit to base. Interambulacral area wide. Oral opening excentral nearest the anterior border. Peristome pentangular, surrounded by five rosettes of buccal pores, and separated by five prominent lobes. Apical disc small, excentral, and composed of four perforated and one imperforate genital plates, the right antero-lateral supporting the madriporiform body, which extends into the middle of the disc and forms a prominence there. A Lower Cretaceous genus. One British Cretaceous species (pp. 247, 248).

Genus 18.—Echinobrissus, *Breynius* (p. 248).

Test small, oval or subcircular, rounded anteriorly, truncated posteriorly; base slightly concave, upper surface convex; plates covered with microscopic granulations, and perforated tubercles in depressed areas. Ambulacral areas narrowly lanceolate. Oral opening small, excentral, pentagonal, lodged in an excentral depression. Apical disc small, quadrate and compact, composed of four perforated and one imperforate genital plate; the right antero-lateral supports the madreporiform body. Anal opening oval, in a groove extending from the summit to the margin. Range, from the Inferior Oolite to the existing period. Two British Cretaceous species (pp. 249—251).

Genus 19.—Trematopygus, *d'Orbigny* (p. 252).

Test thin, ovate, contracted and rounded before, more or less enlarged behind, convex above, concave on under surface. Ambulacral areas subpetaloid above, narrow below. Oral opening irregularly pentagonal, compressed obliquely from left to right, and from above downwards. Apical disc quadrate, excentral, with four perforate ovarial plates, and one imperforate plate. Madreporiform body covering the genital elements, and forming a prominence in the centre of the disc. Oculars very small. Anal opening very large, pyriform elongated above the margin and placed in a groove. One British Cretaceous species (pp. 253, 254).

Genus 20.—Caratomus, *Agassiz* (p. 254).

Test thin, small, ovoid or circular, rounded before, often rostrated behind; sides inflated, convex above and below. Ambulacra petaloid on upper surface, straight below. Poriferous zones with simple, equal, non-conjugate pores, disposed in pairs closely approximated at the summit, apart in the middle, and approximated at the ambitus, feebly indicated at base by lines converging around the peristome. Interambulacral zones wide, covered with large tubercles. Oral opening nearly central, always obliquely elongated. Apical disc nearly central, with four perforated ovarials and five oculars, the madreporiform body extending into the middle of the disc. Anal opening inframarginal and not visible from upper surface, transversely oblong or triangular, and sometimes placed in a rostrated development of the single interambulacrum. Genus found in the Cretaceous series of rocks. One British Cretaceous species (pp. 255—256).

FAMILY VIII.—ECHINOLAMPIDÆ, *Wright* (p. 256).

Test thin, oval, oblong, elevated or subdiscoidal, studded on upper and under surface with small tubercles, often perforated on sunken areolæ. Ambulacral areas large, petaloidal. Poriferous zones wide; pores distant, united by sutures, and extending nearly to the margin. Oral opening small, subcentral. Peristome with five prominent lobes and well-developed petaloid concavities. Jaws absent. Apical disc very small, excentral, and composed of four perforated genital and one imperforate plate, with five oculars wedged into the circumference of the disc. Range of family, from Lower Oolites to the existing period. One British Cretaceous genus: PYGURUS, with one species (pp. 256—260).

Genus 21.—PYGURUS, *d'Orbigny* (p. 257).

Test large, discoidal or clypeoidal, rostrated posteriorly, furnished with small perforated tubercles on sunken areolæ. Ambulacral areas strongly petaloidal. Poriferous zones near the peristome crowded in triple oblique ranks. Oral opening pentagonal, excentral. Peristome with five lobes and bays. Apical disc small. Anal opening oval inframarginal, surrounded by a distinct area. Range of genus, from the Lower Oolites to the Upper Greensand. One British Cretaceous species (pp. 258—260).

FAMILY IX.—SPATANGIDÆ, *d'Orbigny* (p. 260).

Test thin, oval or cordiform, covered with small perforated tubercles. Fasciole generally present. Ambulacral areas united at the summit. Anterior ambulacrum lodged in a depression which extends to the anterior border. Oral aperture anterior, bilabiate. Jaws absent. Apical disc with two or four genital pores, sometimes in proximity, sometimes apart. Ocular pores five, arranged pentagonally at the apices of the ambulacra. Anal opening posterior and supramarginal, and closed by small plates. Spines hairlike. Range of family, from the Cretaceous to the existing period. Five British Cretaceous genera: HEMIASTER, EPIASTER, MICRASTER, ECHINOSPATAGUS, and ENALLASTER, in fifteen species (pp. 260—292).

Genus 22.—HEMIASTER, *Desor* (p. 261).

Test thin, elevated, cordiform, ambulacral summit excentral and posterior. Fasciole single, circumscribing the petaloid portions of the ambulacra. The pairs of ambulacra petaloidal, unequal in length, and lodged in depressions, having large poriferous zones, with elongated pores placed close together. The single ambulacrum in a long shallow anteal sulcus, with very narrow poriferous zones composed of small round pores disposed apart in oblique, widely separate simple pairs. Oral opening bilabiate, very excentral near the margin. Apical disc small, compact, with four perforated genital plates and five very small oculars. Anal opening oval, high up on the posterior border. Genus Cretaceous. Three British Cretaceous species (pp. 262—264).

Genus 23.—Epiaster, *d'Orbigny* (p. 265).

Test thin, oblong, more or less elevated, often cordiform, with small crenulated tubercles apart, furnished with interspaced granules. No fascioles. Antero- and postero-lateral pairs of ambulacra petaloidal and lodged in depressions. Anterior pair longer and more developed than posterior. Poriferous zones equal in each ambulacra, composed of elongated pores, shorter in the internal than the external rows. Single ambulacrum lodged in a well-defined furrow, composed of pores different from those of the antero- and postero-lateral pairs. Oral opening near the anterior border and strongly bilabiate, the inferior lip strong and prominent. Apical disc with four perforated genital and five ocular plates. Anal opening round or oval, situated at the posterior border. Genus confined to Cretaceous strata. Two British Cretaceous species (pp. 265—270).

Genus 24.—Micraster, *Agassiz* (p. 270).

Test thin, cordiform, more or less inflated. Tubercles perforated, crenulated, sparsely distributed on upper surface, larger and closer below. Fasciole subanal, forming a ring around the posterior extremity, embracing half of the upper and half of the lower part of the border. Ambulacral pairs petaloidal, closed at their extremities, the anterior exceeding the length of the posterior pair. Anterior ambulacrum in a wide, shallow furrow, indenting the border of the test. Poriferous zones equal in each ambulacra; pores oval, joined by transverse depressions. Oral opening transverse, near the border, bilabiate with prominent projecting lip. Apical disc small, central, solid, composed of four perforated ovarial and five perforated ocular plates. Madreporiform body small, located in the middle of the disc. Anal opening oval in the upper part of the border under a ridge-like projection of the dorsal surface. Spines small, acicular. Genus found in Cretaceous strata. Four British Cretaceous species (pp. 271—280, 335—340).

Genus 25.—Echinospatagus, *Breynius* (p. 280).

Test thin, cordiform, granulated, more or less inflated above, flattened below. Fasciole absent. Tubercles of various sizes, crenulated, most numerous at the anterior border. The pairs of ambulacra petaloidal, unequal in length, large, lodged in a depression. Poriferous zones of the anterior pair longer and wider than the posterior pair. The single ambulacrum lodged in a wide, deep anteal furrow; its poriferous zones are narrow and equal, and the holes are smaller and placed closer together than the pores in the pairs. Oral opening small, subpentagonal near anterior border. Apical disc compact, composed of four finely perforated ovarial plates, and five small oculars with madreporiform body extending into the centre of the disc. Anal opening oval, placed in the upper part of the posterior border. Spines unknown. Genus found in the Cretaceous strata. Four British Cretaceous species (pp. 281—287).

Genus 26.—Enallaster, *d'Orbigny* (p. 288).

Test thin, cordiform, tubercles small, chiefly developed on sides and base. Ambulacral summit subcentral. Ambulacral pairs subpetaloid, unequal, and depressed. Poriferous zones in the anterior pair unequal. The posterior zones much larger and wider than the anterior zones. Single ambulacrum wider than laterals, in a wide anteal furrow with narrow poriferous zones, and pores arranged obliquely. Oral opening subpentagonal near anterior border. Apical disc small, with four perforated ovarial and five perforated ocular plates. Anal opening oval, at summit of truncated posterior border. Genus found in the Lower-Cretaceous strata. Two British Cretaceous species (pp. 288—292).

Family X.—ECHINOCORIDÆ, *Wright* (p. 292).

Test thick or thin, oval, cordate or conoidal, furnished with irregular small perforated tubercles. Sometimes a marginal fasciole. Ambulacral areas equal, narrowly lanceolate, converging to the vertex. Poriferous zones narrow; pores disposed in pairs at a distance apart. Oral opening transversely oblong, often bilabiate near the anterior border. Apical disc small or large, narrow and elongated, having four perforated and one unperforated ovarial plate with five perforated oculars. Anal opening round, marginal, or supra-marginal. Spines small. Range of family from the Lower Cretaceous to the existing period. Four genera: Cardiaster, Infulaster, Holaster, Echinocorys, with sixteen species (pp. 293—334).

Genus 27.—Cardiaster, *Forbes* (p. 293).

Test thin, cordiform, upper surface convex, anteal furrow well-marked with angulated borders. Tubercles perforated, raised upon crenulated bosses and surrounded by areolæ. A fasciole passing beneath the anal opening and continued on the sides. Oral opening near the margin. Apical disc elongated, composed of four perforated genital and five perforated ocular plates. Genus found in the Cretaceous strata. Seven British Cretaceous species (pp. 293—304, 325—327).

Genus 28.—INFULASTER, *Hagenow* (p. 305).

Test thin, narrow, oblong, ovato-cordate. Anterior half very much elevated, rising into a prominent vertex. Anteal furrow narrow, deep, directed obliquely downwards and backwards with angular borders. Plates covered with very small granules, and with a few primary tubercles near vertex, and at sides and centre of under surface. Sur-anal fasciole present. Oral opening transverse near furrow. Anal opening oval, high up on truncated border. Genus found in the Cretaceous strata. Two British Cretaceous species (pp. 305—308).

Genus 29.—HOLASTER, *Agassiz* (p. 309).

Test thin, oval, cordiform, convex above, flat below, covered with granulations and a few tubercles irregularly arranged. Pairs of antero- and postero-lateral ambulacral areas lanceolate, widely apart above, joined below. Poriferous zones with elongated pores in single pairs. Single anterior ambulacrum lodged in a shallow central furrow with minute pores. Ambulacral summit central or subcentral. No fasciole. Oral aperture transversely oval and perfectly bilabiate, near anterior border in a slight depression. Apical disc elongated with four perforated ovarial plates and five perforated oculars. Genital plates disposed in pairs, the anterior being separated from the posterior by a pair of ocular plates. Anal opening oval, low down near base. Range of genus, from Middle Cretaceous to Middle Tertiary. Six British Cretaceous species (pp. 310—324).

Genus 30.—ECHINOCORYS, *Breynius* (p. 327).

Test thin, more or less oval, elevated, helmet shaped, convex or conoidal above, flat below. Ambulacral areas identical, radiating from summit. Pores round, in single pairs, set obliquely apart in the middle of the ambulacral plates and forming two rows in each area. Oral opening transversely oval, bilabiate near border. Apical disc elongated, formed of four ovarial and five ocular plates. The two pairs of ovarial plates separated by a pair of oculars. Anal opening small, oval in vertical direction, marginal or infra-marginal. Genus found in Upper Cretaceous strata. One British Cretaceous species (pp. 328—334).

APPENDIX II.

RANGE IN GEOLOGICAL TIME OF THE BRITISH CRETACEOUS ECHINOIDEA.

	Upper Chalk.	Medial Chalk.	Chalk Marl.	Chloritic Marl.	Upper Greensand.	Blackdown Beds.	Red Chalk.	Gault.	Lower Greensand.	Farringdon Sponge Gravels.
ECHINOIDEA ENDOCYCLICA.										
Family I. CIDARIDÆ, *Wright.*										
Genus 1. Cidaris	×	...	×	...	×	...	×	×	...	×
„ II. DIADEMADÆ, *Wright.*										
Genus 2. Pseudodiadema, *Desor.*	×	...	×	×	×	...	×	×	×	×
„ 3. Pedinopsis, *Cotteau*	...	...	...	×						
„ 4. Echinocyphus, *Cotteau*	...	...	×	...	×					
„ 5. Glyphocyphus, *Haime*	...	...	×							
„ 6. Cyphosoma, *Agassiz*	×	...	×							
„ III. SALENIADÆ, *Wright.*										
Genus 7. Peltastes, *Agassiz*	...	...	×	...	×	...	×	...	×	×
„ 8. Goniophorus, *Agassiz*	...	...	...	...	×					
„ 9. Salenia, *Gray*	×	×	×	...	×					
„ 10. Cottaldia, *Desor*	...	...	...	...	×					
„ IV. ECHINOTHURIDÆ, *Wyv. Thomson.*										
Genus 11. Echinothuria, *Woodward*	×									
ECHINOIDEA EXOCYCLICA.										
„ V. ECHINOCONIDÆ, *Wright.*										
Genus 12. Discoidea, *Klein*	×	×	×	...	×	...	×			
„ 13. Echinoconus, *Breynius*	×	×	×	×	×					
„ 14. Holectypus, *Desor*	...	...	...	×						
„ VI. ECHINONIDÆ, *Wright.*										
Genus 15. Pyrina, *Desmoulins*	...	...	×	×	×					
„ VII. ECHINOBRISSIDÆ, *Wright.*										
Genus 16. Catopygus, *Agassiz*	...	...	×	×	×	...	...	...	×	
„ 17. Clypeopygus, *A. d'Orbigny*	...	...	...	...	...	...	...	...	×	
„ 18. Echinobrissus, *Breynius*	...	...	...	×	×	×				
„ 19. Trematopygus, *A. d'Orbigny*	...	...	...	...	...	...	...	...	...	×
„ 20. Caratomus, *Agassiz*	...	...	...	...	×					
„ VIII. ECHINOLAMPIDÆ, *Wright.*										
Genus 21. Pygurus, *d'Orbigny*	...	...	...	...	×					
„ IX. SPATANGIDÆ, *d'Orbigny.*										
Genus 22. Hemiaster, *Desor.*	...	...	×	...	...	...	...	×		
„ 23. Epiaster, *d'Orbigny*	×	...	...	...	×					
„ 24. Micraster, *Agassiz*	×	×								
„ 25. Echinospatagus, *Breynius*	...	...	...	...	×	×	...	...	×	
„ 26. Enallaster, *d'Orbigny*	...	...	...	...	...	×	...	...	×	
„ X. ECHINOCORIDÆ, *Wright.*										
Genus 27. Cardiaster, *Forbes*	×	×	...	...	×	×	...	...	×	
„ 28. Infulaster, *von Hagenow*	×	×								
„ 29. Holaster, *Agassiz*	×	...	×	×	×	...	×			
„ 30. Echinocorys, *Breynius*	×									

INDEX

TO THE

FAMILIES, GENERA, AND SPECIES OF THE BRITISH CRETACEOUS ECHINOIDEA.

The synonyms are printed in Italics.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

PLATE LXXVI.

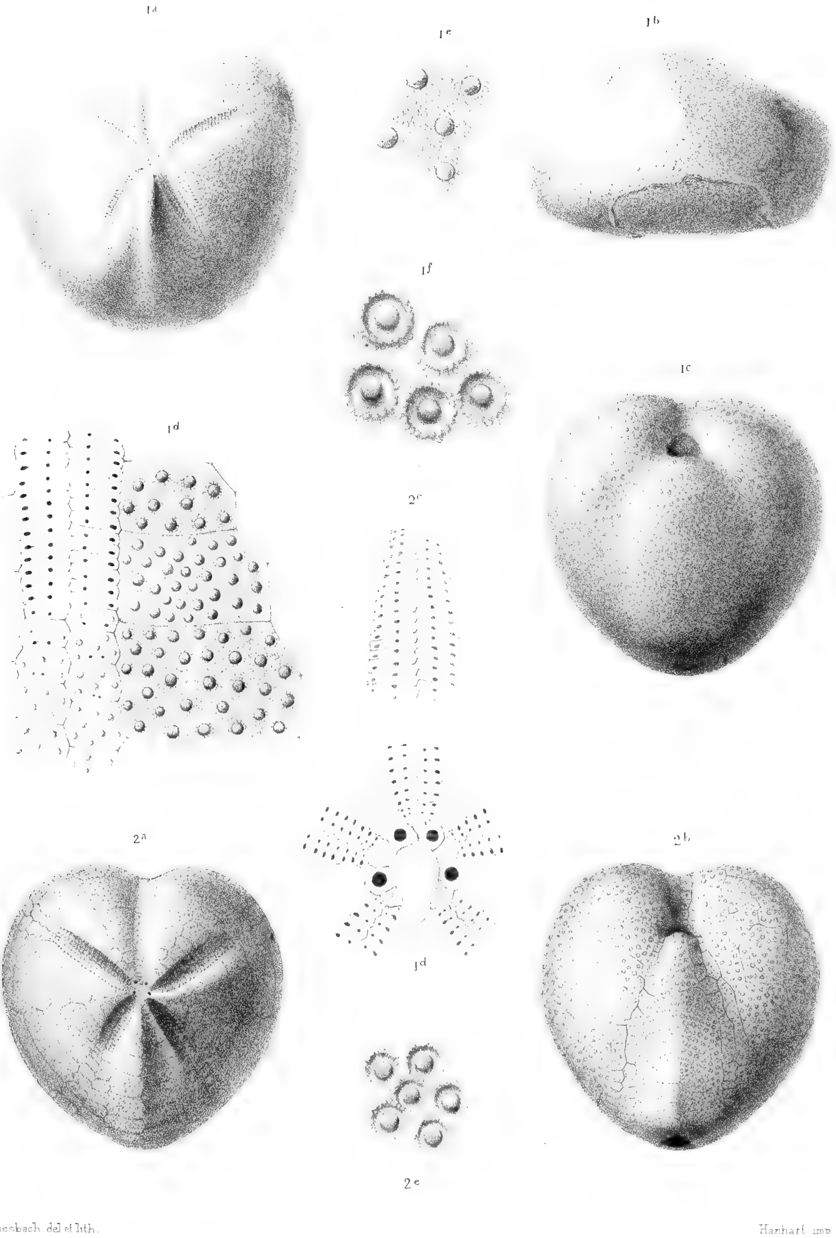
The German type-form from Weddingen, near Hanover.

Fig. 1 *a.*	MICRASTER COR-TESTUDINARIUM, *Goldfuss.*	Upper surface, natural size. My collection. (P. 335).
1 *b.*	— — —	Lateral view, do.
1 *c.*	— — —	Under surface, do.
1 *d.*	— — —	Ambulacral area, poriferous zones, and interambulacral plates, magnified.
1 *e.*	— — —	Primary tubercles in granulated surface, magnified.
1 *f.*	— — —	Primary tubercles, under side, magnified.

English specimen type-form from Purley, Surrey.

2 *a.*	MICRASTER COR-TESTUDINARIUM, *Goldfuss.*	Upper surface, natural size. My collection.
2 *b.*	— — —	Under surface, do.
2 *c.*	— — —	Petaloidal ambulacra and poriferous zones, magnified.
2 *d.*[1]	— — —	Apical disc, showing the circle of ovarial and ocular plates, with the summits of the ambulacra magnified.
2 *e.*	— — —	Primary tubercles on upper surface, with granules on plates, magnified.

[1] Written 1d in error on the Plate.



G. L. Griesbach del et lith.

Hanhart imp

PLATE LXXVII.

Fig. 1 *a*. Echinocorys vulgaris, *Breynius*. Posterior border, showing marginal vent. The type-form. My collection. (P. 328).

1 *b*. — — — Under surface, showing mouth and vent. The type-form.

1 *c*. — — — Lateral view, showing ambulacra and interambulacra with poriferous zones. The type-form.

1 *d*. — — — Apical disc, showing ovarial and ocular plates *in sitû*.

1 *e*. — — — Peristome, showing ambulacra and large tubercles radiating therefrom.

1 *f*. — — — Ambulacral and interambulacral plates, near the summit (upper figure), and ambulacral and interambulacral plates, from the sides of test (under figure).

1 *g*. — — — Tubercles and granules of the upper surface.

1 *h*. — — — Tubercles and granules from the lower surface.

2. — pyramidatus, *Portlock*. Type-specimen outline. School of Mines Museum.

3. — — — Unsymmetrical form of this variety.

4. — ovatus, *auctorum*. Elongated and depressed form. My collection.

5. — gibbus, *Agassiz*. My collection.

6. — pyramidatus. Tumid unsymmetrical variety. My collection.

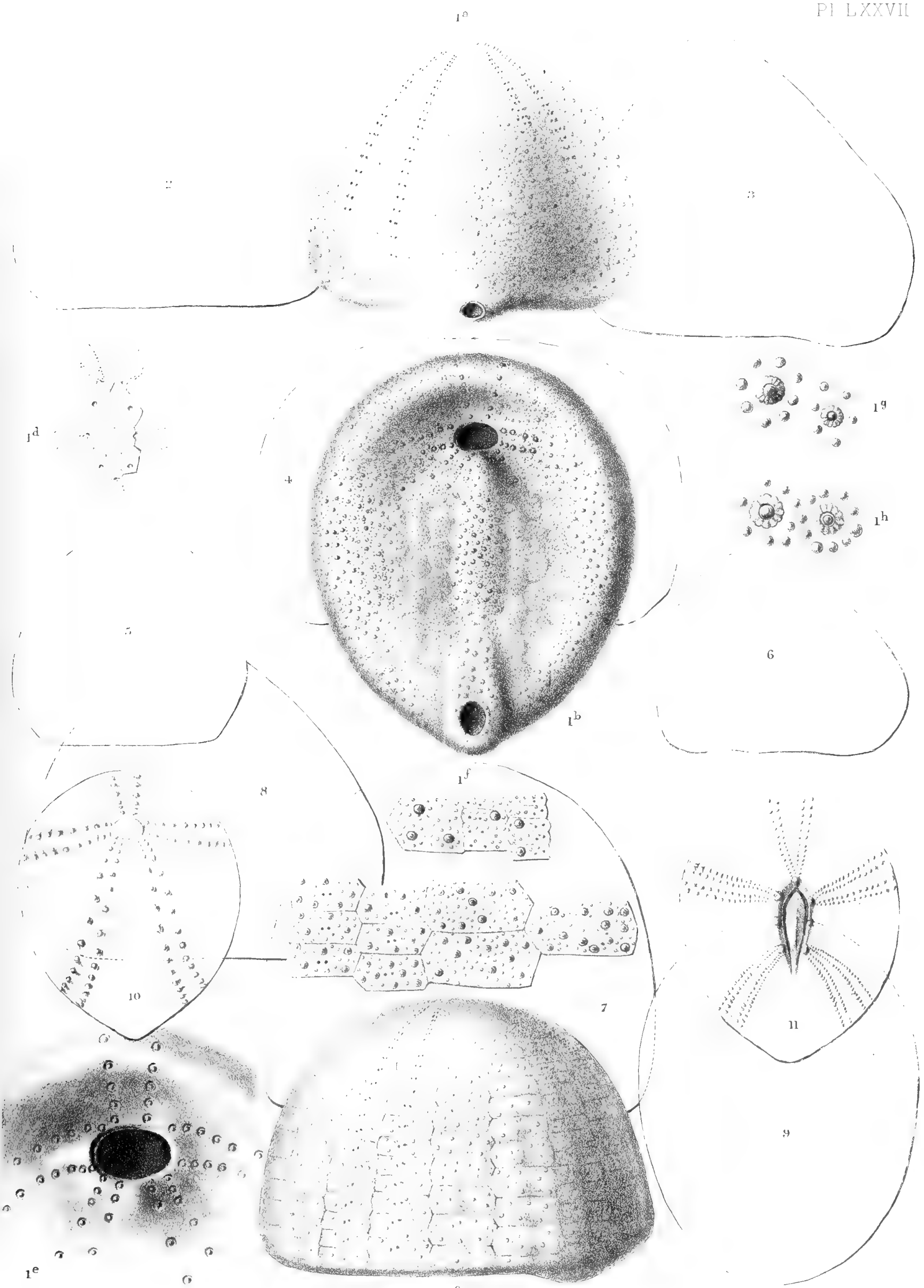
7. — striatus, *auctorum*. A very elevated example. do.

8. — pyramidatus. Tumid and unsymmetrical example. do.

9. — ovatus, *Leske*. French example, common. do.

10. — vulgaris. Flint mould, under surface, showing lines of poriferous zones. My collection.

11. — — Flint mould, upper surface, showing impressions of the apical disc, the position of the ovarial and ocular apertures, and furrow indicating the position of the base of the sand canal.



A Gawan del et lith

Hanhart imp

PLATE LXXVIII.

Fig. 1 *a*. HOLASTER OBLIQUUS, *Wright*. Under surface, natural size. My collection. (P. 313.)

1 *b*. — — — Upper surface, natural size, showing the excentral position of the apical disc.

1 *c*. — — — Lateral view, showing the obliquity of the test.

1 *d*. — — — Posterior border, showing the central position of the vent.

1 *e*. — — — Anterior border, showing the anteal sulcus and tubercles and posterior border.

2 *a*. CATOPYGUS PYRIFORMIS, *Goldfuss*. Upper surface and thimble-like depressions magnified three times. Museum, School of Mines. (P. 340.)

2 *b*. — — — Posterior border, with anal area and periprocte magnified. do. do.

2 *c*. — — — Under surface, showing mouth with lobes and petaloidal oral leaves. do. do.

3 *a*. ECHINOBRISSUS LACUNOSUS, *Goldfuss*. Upper surface magnified four diameters. My collection. (P. 249, 250.)

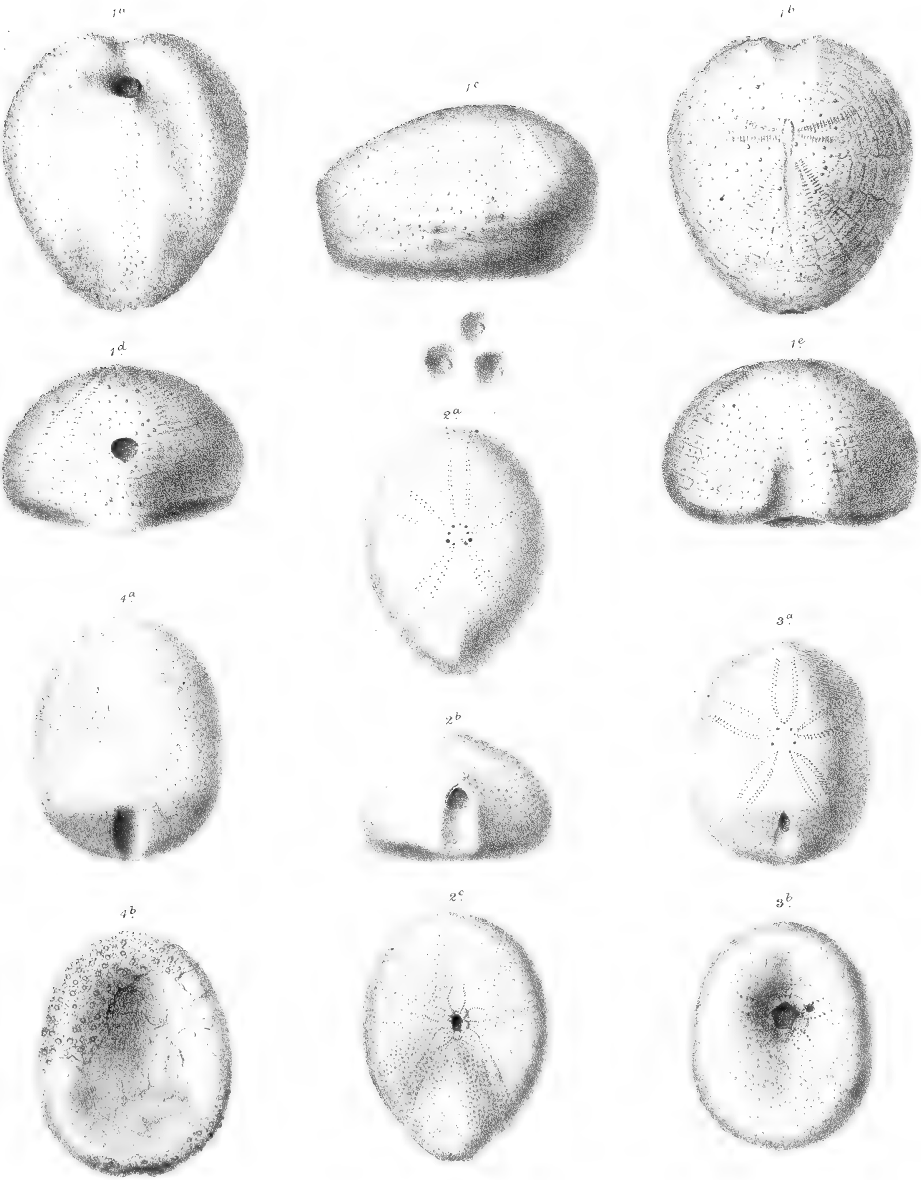
3 *b*. — — — Under surface magnified, showing petaloidal oral expansions.

The figured specimen was obtained from the "Craie Chloritée de la Sarthe."

4 *a*. ECHINOBRISSUS MORRISII, *Forbes*. Upper surface, highly magnified. My collection. (P. 250.)

4 *b*. — — — Under surface, highly magnified.

The figured specimen was collected from the Chloritic Marl, Chardstock.



A. Gawan del et lith.

West, Newman & Co. imp.

PLATE LXXIX.

Fig. 1 *a b*. HOLASTER LÆVIS, *var.* PLANUS, *Mantell.* Flint, with moulds of this species, showing its gregarious character and stratigraphical position in the Chalk with flints, Lewes. Natural size. Collection of the Rev. Prof. T. Wiltshire, F.G.S. (P. 317.)

2 *a*. — SUBGLOBOSUS, *Leske.* Posterior border, natural size, showing a small variety of test from the Red Chalk of Speeton, inflated at the ambitus, and truncated posteriorly. Natural size. Collection of the Rev. Prof. T. Wiltshire. (P. 319.)

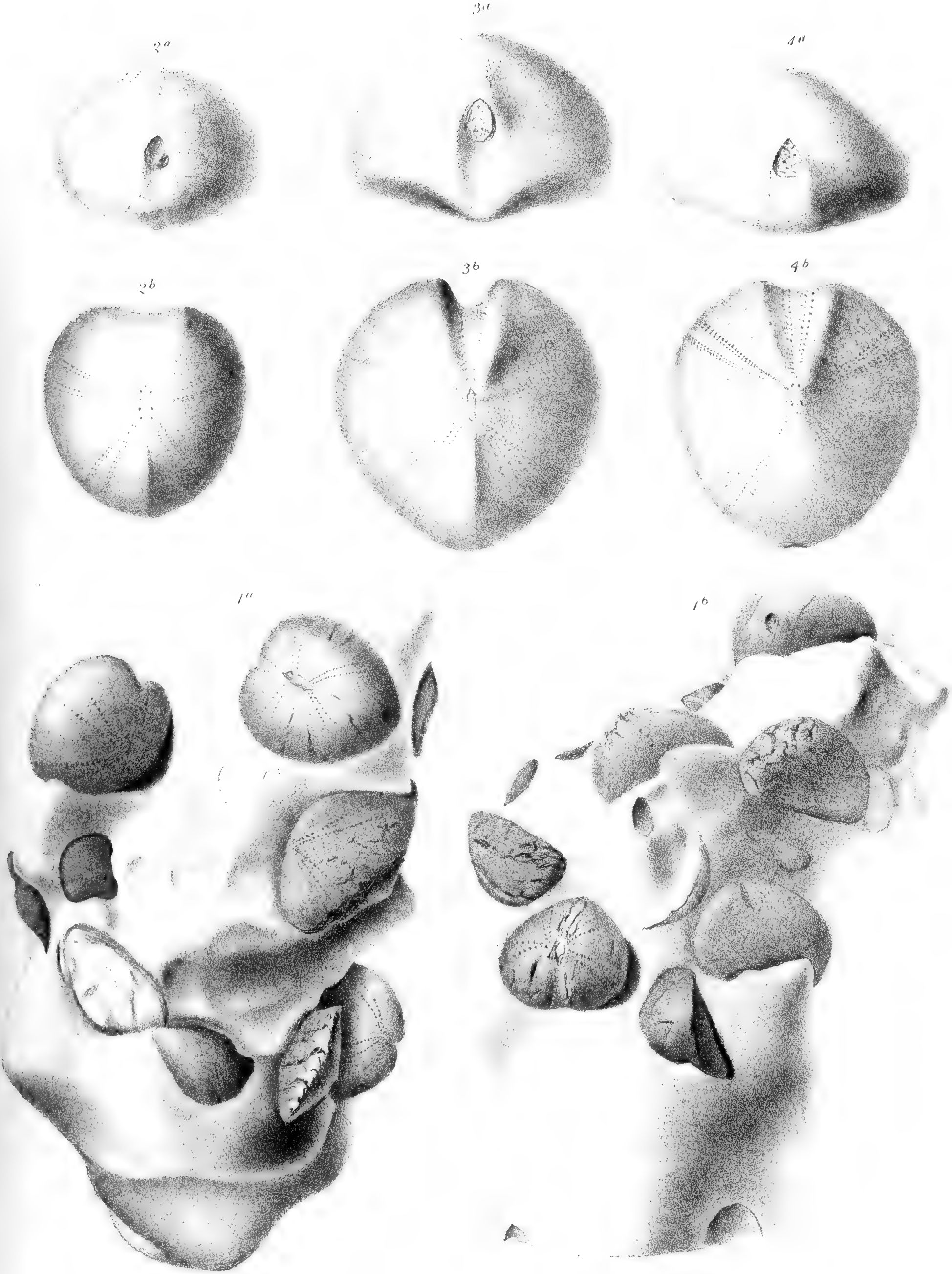
2 *b*. — — — Upper surface.

3 *a*. CARDIASTER FOSSORIUS, *Benett.* Posterior surface, natural size, showing the narrow posterior border; anal area and high position of the vent, an extremely sharp angular variety. Cherty cast, from Lyme Regis. Collection of the Rev. Prof. T. Wiltshire. (P. 297.)

3 *b*. — — — Upper surface of the same test, natural size, showing the deep anteal sulcus with angulated borders and central position of apical disc.

4 *a*. HOLASTER OBLIQUUS, *Wright.* Posterior border. Natural size. Red Chalk of Hunstanton. Collection of the Rev. Prof. T. Wiltshire. (P. 313.)

a b. — — — Upper surface, showing test covered with small tubercles.



A Gawan lith.

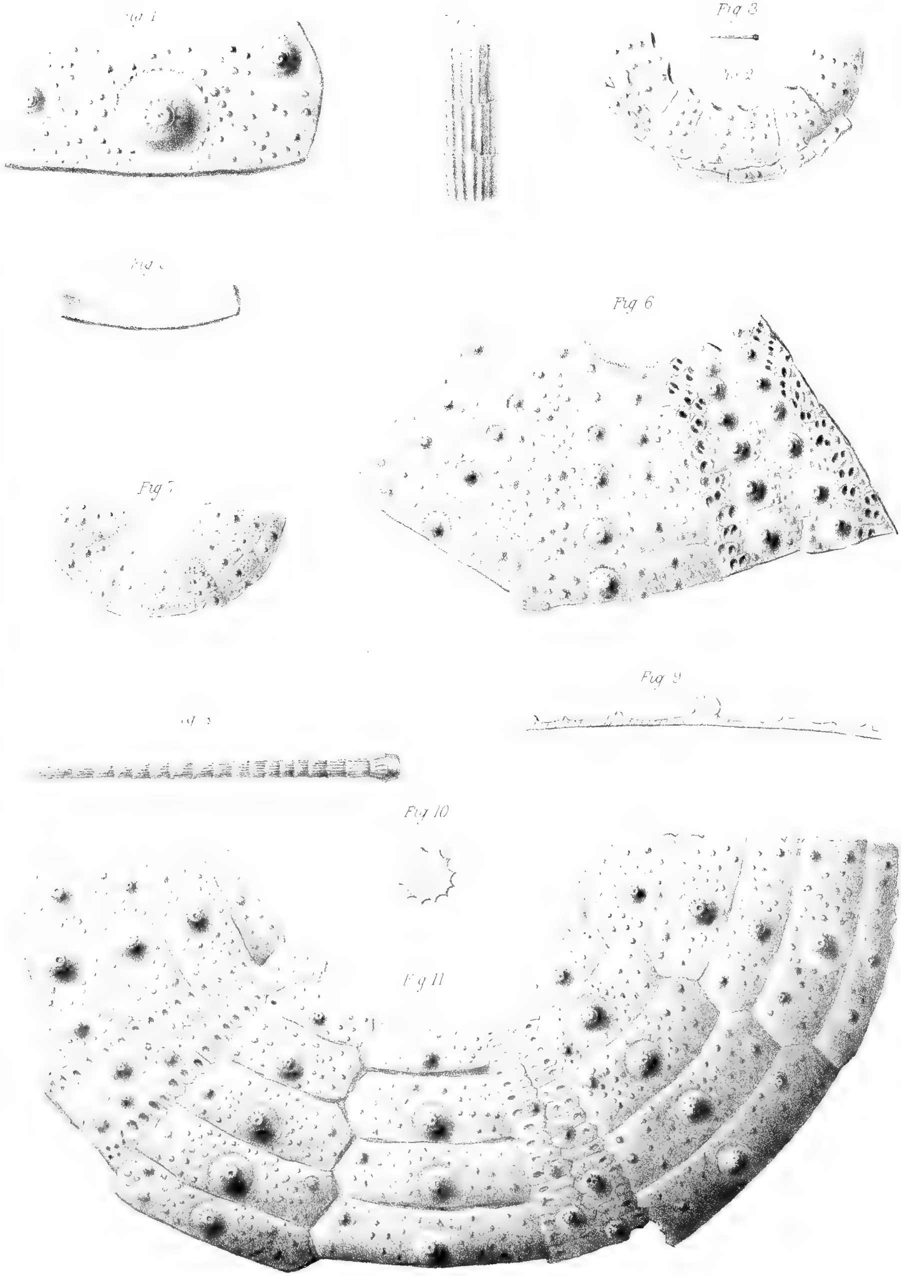
Hanhart imp

PLATE LXXX.

Fig. 1.	Pseudodiadema fragile, *Wiltshire*.	Exterior surface of an interambulacral plate, magnified eight diameters.
2.	— — —	Under surface of test, somewhat crushed and broken, natural size.
3.	— — —	Spine, natural size.
4.	— — —	Portion of surface of spine, magnified sixteen diameters.
5.	— — —	Interior surface of a plate, magnified four diameters.
6.	— — —	Under surface plates of ambulacral and interambulacral areas, magnified four diameters.
7.	— — —	Upper surface of test, natural size.
8.	— — —	Spine, magnified eight diameters.
9.	— — —	Section of interambulacral plate (Fig. 1), passing through the primary tubercle.
10.	— — —	Transverse section of spine (Fig. 3), magnified twenty diameters.

The specimens figured are from the collection of the Rev. Prof. Thos. Wiltshire, F.G.S.

PLATE LXX.



T. Wiltshire del A Gowan lith

Hannart imp.

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A MONOGRAPH

OF THE

BRITISH FOSSIL BRACHIOPODA.

BY

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WITH TITLE-PAGE TO VOL. IV AND DIRECTIONS TO THE BINDER.

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BRITISH FOSSIL BRACHIOPODA.

DIRECTIONS TO THE BINDER.

The Monographs on the Fossil Brachiopoda of the Tertiary, Cretaceous, Jurassic, Triassic, Permian, and Carboniferous Supplements will be found in the publications of the Palæontographical Society issued for the years 1873, 1876, 1878, 1880, 1881, and 1882.

Cancel the title-pages of the separate parts in the volumes for the years 1873, 1876, 1878, 1880, 1881, and 1882, and *substitute* the general title-page now provided, and follow the order of binding given in the accompanying table of pages, plates, and dates.

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A MONOGRAPH

OF THE

BRITISH FOSSIL BRACHIOPODA.

BY

THOMAS DAVIDSON, LL.D., F.R.S., F.L.S., F.G.S.,

VICE-PRESIDENT OF THE PALÆONTOGRAPHICAL SOCIETY; MEMBER OF THE GEOLOGICAL SOCIETIES OF FRANCE, BELGIUM EDINBURGH, GLASGOW, AND OF CORNWALL; FOREIGN MEMBER OF THE PROVINCIAL INSTITUTE OF FRANCE; OF THE LINNEAN SOCIETY OF NORMANDY; CORRESPONDING MEMBER OF THE IMPERIAL ACADEMY OF SCIENCES OF ST. PETERSBURG; OF THE IMPERIAL MINERALOGICAL SOCIETY OF ST. PETERSBURG; OF THE IMPERIAL SOCIETY OF NATURALISTS OF MOSCOW; OF THE ROYAL ACADEMIES OF BELGIUM AND BAVARIA; OF THE ROYAL SOCIETY OF HOLLAND, HAARLEM; OF THE ROYAL SOCIETY OF LIÈGE; OF THE ACADEMY OF ST. LOUIS; OF THE AMERICAN PHILOSOPHICAL SOCIETY, PHILADELPHIA; OF THE INSTITUTE OF ALBANY, UNITED STATES; OF THE ZOOLOGICAL SOCIETY OF VIENNA; OF THE PALÆONTOGRAPHICAL SOCIETIES OF BELGIUM AND OF SWITZERLAND; OF THE MALACOLOGICAL SOCIETY OF BELGIUM; HON. MEMBER OF THE GEOLOGISTS' ASSOCIATION, LONDON; OF THE DUDLEY AND MIDLAND GEOLOGICAL AND SCIENTIFIC SOCIETY; OF THE NATURAL HISTORY SOCIETY OF GLASGOW; AND OF THE YORKSHIRE PHILOSOPHICAL SOCIETY, ETC. ETC.

VOL. IV.

TERTIARY, CRETACEOUS, JURASSIC, PERMIAN, AND CARBONIFEROUS SUPPLEMENTS;

AND

DEVONIAN AND SILURIAN BRACHIOPODA THAT OCCUR IN THE TRIASSIC PEBBLE BED OF BUDLEIGH SALTERTON IN DEVONSHIRE.

LONDON:

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J. E. ADLARD, BARTHOLOMEW CLOSE.

INDEX TO VOLUME IV,

PREPARED BY

THE REV. PROFESSOR T. WILTSHIRE, M.A., F.G.S., &c., Hon. Sec. Pal. Soc.

*_** *The Synonyms are printed in Italics.*

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VOL. V.

PART I.

DEVONIAN AND SILURIAN SUPPLEMENTS.

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SUPPLEMENT

TO THE

BRITISH DEVONIAN BRACHIOPODA.

The first part of my Devonian Monograph was published in August, 1864; the second in June, 1865.

On account of the comparatively limited area occupied by the fossiliferous Devonian Formation in Great Britain, the few collections, and the difficulty of procuring well-preserved specimens of a large proportion of the species, that Monograph caused me more trouble than those relating to the other divisions of the Palæozoic period.

Every specimen that could be procured was carefully examined, and the whole illustrated in twenty quarto plates; but it was to be expected that further collecting and research by local geologists would, with time, bring to light new facts in connection with those species already discovered, and that a small number of additional forms, not recorded in my work, would be the result of further investigation. This expectation has been realised, as will be seen in the sequel; and I have also been able to correct several, at the time unavoidable, mistakes, revise to some extent the old Monograph, and add to the number of our British Devonian species. Much will remain to be achieved by further favorable conditions. Upon the Continent and in America the Devonian rocks and fossils have been carefully studied by competent geologists and palæontologists, and this has also assisted us in correlating our divisions with those established upon the Continent, and in arriving at a more correct identification of some of our own species by comparing them with foreign types.

At page 157 of his 'Anniversary Address,' as President of the Geological Society,[1] Mr. Etheridge, referring to the Devonian Brachiopoda, says, "With the exception of the Fishes of the Old Red Sandstone (125 species), this is the largest group in the British Devonian rocks. We should expect this when we know that no less than 61 genera and over 1100 foreign species have passed through the hands of European, American, and British zoologists and palæontologists, and all have been described; of these 1100 species only 116 are British; and of the 61 known genera we possess 26."

[1] 'Quarterly Journal of the Geological Society,' vol. xxxvii, 1881.

In his 'Thesaurus Devonico-carbonarius,' published in 1878, Dr. Bigsby enumerated some 1240 so-termed species and named varieties of Brachiopoda from the Devonian formation, distributed into 57 genera; but, on looking over the list, I find a large number of synonyms, which, if taken into account, would diminish the number very considerably; there are also some few species not recorded.

We are certainly not in a position to state accurately how many really good species occur even in our British Devonian rocks, notwithstanding all the care that has been devoted to their study. In my Devonian Monograph and present Supplement I shall have described and figured some 108 so-termed species and varieties; but, as seven or more are still uncertain, or are varieties of some of the others, I estimate the number of good species under 100, distributed into 30 genera.[1]

Time and continued research will enable future palæontologists to arrive at something more definite than we are at present in a position to offer. When, three years ago, I began assembling material and observations for a Devonian Supplement, I felt almost in despair of being able to add much to what I had previously published. Several friends, however, soon came forward to assist me in their usual generous manner. To Mr. G. F. Whidborne, F.G.S., of Torquay, I am especially indebted, for he spared no trouble in visiting and revisiting the quarries in the vicinity of Torquay, and in procuring from his friends all that could be obtained. Mr. Whidborne I found to be a careful and accurate observer, and he also, in the most generous manner possible, placed his specimens unreservedly into the hands of myself and the Rev. Norman Glass, intimating at the same time that we might make any use of them we might deem necessary for the advancement of science.

Nothing had then been done in developing the loops and spirals of our British Devonian spiral-bearing species. Notwithstanding the generally unsatisfactory and intractable nature of the matrix surrounding and filling the shells, necessitating much hard labour, the destruction of very many specimens, and much time and patience, Mr. Glass determined to make a special study of these internal structures, and the results obtained bring him the greatest credit.[2]

I received also much valuable help from Mr. W. Pengelly, F.R.S., who, with his usual liberality, kindly obtained for me the loan of a number of specimens out of the Museum of the Torquay Society of Natural History. The other veteran geologist of the locality, Mr. J. E. Lee, F.G.S., contributed likewise whatever his collection could offer. To Mr. A. Champernowne, F.G.S., of Dartington Hall, Totnes, to Mr. W. Vicary, F.G.S., of Exeter, Mr. Townshend M. Hall, F.G.S., and others, I am likewise deeply indebted for much valuable help. I also wish to acknowledge the assistance I have

[1] See also a paper by Mr. W. Pengelly, "On the Distribution of the Brachiopoda in Devonshire and Cornwall," 'Trans. of the Devonshire Association for the Advancement of Science, Literature, and Art,' 1876.

[2] Mr. Glass will give a full account of his operations in the Silurian Supplement.

received from Dr. Kayser, of Berlin, Prof. F. Roemer, Herr Zugmayer, Prof. Zittel, Professors L. de Koninck and Dewalque, F. Sandberger, and others. Helped in so able and zealous a manner I could not fail to fill up the pages and plates of this Supplement with much new and instructive information.

The geology of the Devonian Systems in Great Britain has been the subject of many able investigations; and the Devonian question, as it has been sometimes termed, has given rise to considerable divergence of opinion, as observed by Mr. Townshend Hall in his able article, "A Sketch of the Geology of Devonshire," in White's 'History, Gazetteer, and Directory of the County,' p. 60, 1878:—"The late Mr. Jukes, Director of the Irish Branch of the Geological Survey," with an "intimate knowledge of the Carboniferous strata of the West of Ireland . . . . . . entered into an argument to prove that the Devonian rocks do not form an independent system of themselves, but are in truth equivalents of the Carboniferous strata of Ireland. These views have been vigorously opposed, chiefly on palæontological evidence, by Mr. Etheridge, in a very elaborate paper on the "Physical Structure of the West Somerset and North Devon,"[1] also by Mr. Townshend M. Hall, Mr. Champernowne, and others.

Mr. T. Hall observing that the Devonian beds may be divided into two principal areas, those of North and those of South Devon, classifies them as *Lower*, *Middle*, and *Upper*.

Mr. Hall proposes to divide the North-Devon series into the following sequence of beds in ascending order:

Lower Devonian	Foreland Sandstone. Linton Beds.
Middle Devonian	Martinhoe and Hangman Beds. Ilfracombe Shales and Limestones. Morthoe Shales.
Upper Devonian	Pickwell Down Sandstone. Cuculæa or Marwood Zone. Pilton Beds.[2]

[1] 'Quarterly Journal Geol. Soc.,' vol. xxiii, p. 568.

[2] See also a valuable paper by Mr. T. Hall in the 'Proceedings of the Geol. Soc.' for June, 1867, "On the Relative Distribution of Fossils throughout the North-Devon Series;" refer likewise to a paper by Mr. A. Champernowne, "On the Divisions of the Old Red Sandstone of North and South Devon," 'Geol. Mag.,' vol. v, May, 1878. We are informed by Mr. Pengelly that Pilton is now a suburb of Barnstaple; Marwood and Sloly are about three miles north by west, and two and a half miles north by east, respectively, from that town. Baggy Point is the northern horn of Barnstaple and Croyde Bays, the latter being a branch of the former.

Brushwood is a village about one mile and a half south of Dulverton, and three and a half north-west of Bampton.

South Petherwyn is a village about two miles south-westerly from Launceston; in Cornwall, the fossils are chiefly found in the quarries of Landlake, in the parish of South Petherwyn.

As the great divisions of systems introduced by geologists into the regular sequence of formations have been proposed more for convenience of reference than as indicating the existence of completely independent periods, we should accept these divisions or systems in a general sense. The more we advance in our knowledge we find that in nature such sharp lines do not exist, and that passage-beds will turn up between two consecutive systems supposed to be entirely distinct. This indisputable fact has been very often demonstrated, and in particular in the case of the Upper-Devonian and Lower-Carboniferous formations. It would, therefore, be incorrect to assert, as Jukes has endeavoured to do, that the Devonian rocks are the equivalents of the Carboniferous Slates of Ireland. Palæontologically the Silurian, Devonian, Carboniferous, and Permian formations are, in the main, characterised by distinct faunas, although a certain number of species do in reality pass from one contiguous formation into the other. As far as the Brachiopoda are concerned, it may be asserted, in the state of our present information, that but few species are common to the Silurian and Devonian, but that a larger number have been found to be common to the Devonian, Carboniferous, and Permian.

There are, however, some difficult geological questions still to be solved with respect to the subdivisions of the Devonian formation, but which cannot be entered upon in the present Supplement.

I have little or nothing new to add with respect to the species that occur in the Upper and Lower Devonian formations. These, as a rule, are not found in a very good state of preservation, as they occur chiefly in the condition of casts or flattened impressions, often much out of shape.

At Saltern Railway Cutting (behind Saltern Cove, within four or five miles of Torquay) Mr. J. G. Greenfell and Mr. G. F. Whidborne came upon a light brownish-red shale in which several species of Brachiopoda occurred in considerable numbers, accompanied by *Pleurodictyum problematicum* and *Petraia*, sp. The fossils occur in the condition of

Woolborough quarry is adjacent to the road from Newton Abbot to Totnes, in South Devon, a short mile from the former.

The limestone quarries grouped under the general name of Ogwell are in the immediate neighbourhood of Chircombe Bridge on the River Lemon, about two miles west of Newton Abbot. Looe Harbour in Cornwall is from thirteen to fourteen miles almost due west from Plymouth.

Mr. N. H. Valpy, in his 'Notes on the Geology of Ilfracombe and its Neighbourhood,' 2nd edition, gives a list of the Brachiopoda which he finds in the Ilfracombe series, from the Trentishoe and Hangman Grits to the Morte Shales inclusive, viz.:

Athyris concentrica.	*Orthis striatula.*	*Spirifera speciosa.*
— *lacryma ?*	*Rensselæria stringiceps.*	— *cristata ?*
Atrypa desquamata.	*Rhynchonella cuboides.*	*Stringocephalus Burtini.*
— *reticularis.*	— *pugnus.*	*Strophomena crenistria.*
— *aspera.*	— *pleurodon.*	— *umbraculum.*
Cyrtina heteroclita.	*Spirifera curvata.*	— *rhomboidalis.*
Merista plebeia.	— *Verneuilii.*	
Orthis interstrialis ?	— *nuda.*	

impressions and casts, much distorted and compressed, so that it is not possible in most cases to arrive at a satisfactory identification. I thought I could, however, recognise amongst them *Spirifera lævicosta, Rhynchonella Pengelliana, Leptæna Looiensis, Orthis hipparionyx,* a small circular species of the same genus, somewhat similar in shape to *O. arcuata,* and *Chonetes Hardrensis.*

It is from the Middle Devonian, however, and especially from the neighbourhood of Torquay, that most of the new forms I am about to describe were derived; and I am indebted to Mr. G. F. Whidborne for the following details in connection with the important localities of Hope's Nose,[1] Lummaton, and other places.

"Immediately west of the extreme point of Hope's Nose is a quarry which gives the following section :

"1. About twelve feet of solid, pale grey, thick-bedded limestones, almost entirely composed of indistinct Sponge-like growths (Stromatopora, &c.), and containing numerous Corals and joints of Encrinites. The bedding is fairly regular, but very indistinct; and similar limestone forms the floor of the quarry.

"2. Eight or ten thin bands of darker limestone with fragments of Encrinites, but without Sponges. These are evenly bedded in general, but some of the top beds thin out suddenly, and the upper surface is for some distance coincident with a fault which dips inwards from the quarry.

"3. An extremely irregular lenticular bed of solid limestone, rendered paler than those below by numerous capillary veins of calcareous spar.

"In these lower beds the fossils are almost entirely Sponges, Corals, and Encrinites, with no Mollusca. The line of their junction with the bed above is so sharp and tortuous as, from a general view, to give the appearance of a water-worn surface, which impression, however, a close examination does not confirm.

"4. Numerous thin and very lenticular beds of dull yellow sandy shales and dark limestone bands, containing *Chonetes Hardrensis* and *C. minuta, Productus subaculeatus,* with spines half an inch in length, *Orthis striatula, Kayseria lens, Atrypa desquamata, Rhynchonella cuboides, Streptorhynchus umbraculum,* and two or three kinds of *Spirifera,* also Trilobites, Cyathophyllum, Fenestella, &c. These become harder and more evenly bedded along the east face of the cliff.

"5. About 100 yards to the south of the quarry this last division is capped by much yellower, softer, and more sandy shales, containing *Bifida lepida* in great abundance, and most of the Brachiopods and other fossils quoted from the locality, with Orthoceras, Trilobites, Gasteropods, Fenestella, &c.

"The list of the Brachiopods from the Hope's Nose locality will be found further on

"These upper beds appear to have a dip different from that of those below, but this is really only cleavage, which is very finely shown, and is inclined at an angle of about

[1] Hope's Nose is the northern horn of Torbay. Meadfoot Bay is adjacent to Torquay, and lies between it and Hope's Nose; here the fossils occur in gritty slates.

30° to the true dip. This latter may be traced by the lines of fossils across the slates, and is seen to be conformable to the beds below.

"These beds continue westward as far as the Raised Beach; and immediately beyond that the strata are so much contorted that some are completely overturned. In the Cove just beyond this point Mr. Lee has found Lower-Devonian fossils.

"*Lummaton* or Happaway is about half a mile north of Marychurch (a town two and a half miles north of Torquay), and has three large contiguous quarries facing east. They are in a mass of dense, subcrystalline, bluish-grey limestone, with occasional joints, and with hardly any signs of bedding. Fossils occur rarely scattered through them, but are very difficult to extract entire. Occasionally, however, there are local accumulations of Corals and sponge-like growths, and at one spot on the top of the third quarry is a small exposure of the rock, where the smaller fossils occur in great numbers, and may in many cases be easily detached from the matrix.[1]

"It is most probable that from this spot most of the so-called Barton fossils were obtained.

"At the base of the quarry, almost perpendicularly below this, similar fossils occur in numbers, and this would lead to the supposition that the dip is here a great one."

About a quarter of a mile to the eastward is the large disused quarry of Barton, which faces north, and Mr. Whidborne has not found or heard (locally) of any fossils being obtained from this place, though it is probable that when it was worked occasional fossils might have been obtained from it as from the general mass of the Lummaton rock. Mr. Whidborne's impression, however, and this is supported by Mr. Lee, is that the name "Barton" has been generally used for fossils obtained from any one of the three quarries, but mostly from the one spot at Lummaton.[2]

Brachiopoda from Middle Devonian of Lummaton, near Torquay.	*Brachiopoda from Middle Devonian, Hope's Nose, near Torquay.*
Waldheimia juvenis, *Sow.*, sp.	Terebratula or Waldheimia, sp.?
— Whidbornei, *Dav.*	
— ? Newtoniensis, *Dav.*	
Centronella virgo, *Phillips*, sp.	
Stringocephalus Burtini, *Def.*	
Meganteris ? Vicaryi, *Dav.*	Rensselæria ? striatissima, *Dav.*
Athyris concentrica, *Von Buch.*	Athyris concentrica, *Von Buch.*
— Newtonienis, *Dav.*	— rugata, *Dav.*
— Glassii, *Dav.*	— ? phalæna, *Phillips*, sp.
— ? Bartoniensis, *Dav.*	Bifida lepida, *Goldf*, sp.
— rugata, *Dav.*	

[1] For an account of *Cyprosina Whidbornei*, lately discovered here, see *Geol. Mag.*, August, 1881.

[2] Mr. Pengelly says that Barton is a village three miles northward from Torquay Harbour. The fossils assigned to this locality are found in the Barton and Lummaton hills, and two adjacent masses of Limestone.

Brachiopoda from Middle Devonian of Lummaton, near Torquay.	*Brachiopoda from Middle Devonian, Hope's Nose, near Torquay.*
Merista plebeia, *Sow.*, sp.	Merista plebeia, *Sow.*, sp.
Retzia longirostris, *Kayser.*	Kayseria lens, *Phillips*, sp.
Glassia Whidbornei, *Dav.*	
Atrypa reticularis, *Linné.*	Atrypa reticularis, *Linné.*
— desquamata, *Sow.*	— desquamata, *Sow.*
— aspera, *Schlott.*	— aspera, *Schloth.*
— ? trigonella, *Dav.*	
Bifida ? Huntii, *Dav.*	
Spirifera nuda, *Sow.*	
— curvata, *Schlott.*	Spirifera curvata, *Schloth.*
— speciosa, *Schlott.*	— undifera, *F. Roemer.*
— undifera, *F. Roemer.*	— lævicosta, *Val.*=ostiolata, *Schl.*
— Urei, *Flem.*	— speciosa, *Schloth.*
— insculpta, *Phil.*	— sub-cuspidata, *Schnur.*
— simplex, *Phillips.*	— lineata, *Martin.*
— Verneuilii, *Murch. ?*	
Cyrtia ? Whidbornei, *Dav.*	
Cyrtina heteroclita, *Defrance.*	Cyrtina heteroclita, *Def.*
— — var. multiplicata, *Dav.*	— Demarlii, *Bouch.*
— Demarlii, *Bouch.*	— n. s. ?
— amblygona, *Phil.*	
Pentamerus brevirostris, *Phil.*	Pentamerus brevirostris, *Phil.*
— biplicatus, *Schnur.*	
Rhynchonella pugnus, *Martin.*	Rhynchonella bifera, *Phil.*
— anisodonta, *Phil.*	— parallelepida, *Bronn.*
— cuboides, *Sow.*	— angularis, *Phil.*
— triloba, *Sow.*	— cuboides, *Sow.*
— parallelepida, *Bronn.*	— protracta, *Sow.*
— implexa, *Sow.*	
— angularis, *Phil.*	
— reniformis, *Sow.*	
— acuminata, *Martin.*	
— Ogwelliensis, *Dav.*	
— protracta, *Sow.*	
— Leei, *Dav.*	
— Phillipsii, *Dav.*	
Camarophoria ? Lummatonensis, *Dav.*	
— ? rhomboidea, *Phil.*, sp.	Camarophoria ? rhomboidea, *Phil.*, sp.
Strophomena rhomboidalis, var. analoga, *Phil.*	
— — var. nodulosa, *Phil.*	
Streptorhynchus umbraculum, *Schl.*	Streptorhynchus umbraculum, *Schl.*
Skenidium areola, sp., *Quenstedt.*	
Orthis Eifliensis, *Vern.*	Orthis Eifliensis, *Vern.*
— striatula, *Schloth.*	— striatula, *Schl.*

Brachiopoda, from Middle Devonian of Lummaton, near Torquay.	*Brachiopoda, from Middle Devonian, Hope's Nose, near Torquay.*
Leptæna ? nobilis, *M'Coy.*	Orthis arcuata, *Phil.*
— ? interstrialis, *Phil.*	
Productus subaculeatus, *Murch.*	Productus subaculeatus, *Murch.*
Strophalosia productoides, *Murch.*	
Chonetes Hardrensis, *Phil.*	Chonetes Hardrensis, *Phil.*
— ? (Leptæna ?) Phillipsii, *Dav.*	— minuta, *Goldf.*
— convoluta, *Phillips*, sp.	

This list will show how specifically numerous are the Middle-Devonian Brachiopoda in the neighbourhood of Torquay, since Lummaton and Hope's Nose alone have furnished us with about seventy species and named varieties, besides two or three more not sufficiently complete to be specifically determined, and there are also some other places in the neighbourhood of Torquay that have afforded a few species that have not been hitherto found at Lummaton and Hope's Nose.

"The following is a list of some of the localities in the neighbourhood of Torquay from which Brachiopoda have been obtained.

Upper Devonian.

"Cardiola retrostriata beds . { Saltern Cove.
Lower Dunscombe (near Chudleigh).

Middle Devonian.

"Rhynchonella cuboides beds {
Hope's Nose { *a.* Beds with *Orthis arcuata* and *Bifida lepida*.
b. Beds with *Kayseria lens*.
London Bridge (to the West of Daddy Hole Plain).
Oarstone and Thatcher (islands of Torbay).

"Stringocephalus Burtini beds { Lummaton, Barton.
Torquay Cricket-ground.
Woolborough.

"Calceola sandalina beds . { Daddy Hole Cove (west of Meadfoot).
Chircombe Bridge (near Newton).

Lower Devonian.

"Pleurodictyum problematicum beds . . . . { Goodrington Sands (south of Paignton).
Saltern Railway Cutting (south of Goodrington Sands).
Meadfoot Bay.
Kingsteinton (half-mile north-east of Newton).
The "New Cut" (on Lincombe Hill, Torquay).

"Thus it seems that there is a great mass of limestone interposed between two series of shales, bounded on the top by the *Rhynchonella cuboides* beds, and below by those containing *Calceola sandalina*. The upper of these two lines of junction is very clearly marked, and may be observed in several shore and road-side sections, as at London Bridge, Hope's Nose, Anstis Cove, Bishopstowe, and Marychurch, all places in the immediate neighbourhood. It is, however, only in the two former that the beds have been identified by fossils. The shales above the limestone may also be distinguished in the precipitous face of the rock called the Oarstone in Torbay.

"In these upper shales there are at least four distinguishable horizons, namely, those of Saltern and Lower Dunscombe, and the two at Hope's Nose. The limestone itself is generally very massive, its bedding planes being few and slightly marked, and sometimes indistinguishable. In parts it is crowded with Corals and Stromatopora, and, indeed, in some places, as at the Flat Rock (between Hope's Nose and the Oarstone), it appears to be little more than a gigantic Sponge-growth; while occasionally local accumulations of Shells occur, as at Lummaton, the Oarstone, and the Torquay Cricket-ground.

"At the base of the limestone, *Calceola sandalina* (*in sitú*) has been found by Mr. Champernowne at Daddy Hole Cove; and below this are extensive series of red or dark greenish-brown shaley and gritty beds, with occasional beds of fossils in the condition of casts (Pleurodictyum, Cupressocrinus, and Lower-Devonian Brachiopoda).

"The whole group, however, appears in this neighbourhood to be in a state of extreme intricacy. This is due to several causes. There is a great curvature, and even overturning of the beds, partly caused by the presence of igneous rocks, and partly by the sliding of the rock-masses on each other. The nature of the sediment sometimes changes rapidly in the same bed. Sometimes there seems an entire absence of stratification (due, perhaps, to some of the limestones being organic growths rather than sedimentary deposits); sometimes the red colouring matter from the Trias above has been worked down and has marked the beds below; and, lastly, characteristic fossils are of unfrequent occurrence compared with the larger exposures of rock, and when found are often difficult to extract and badly preserved. Nevertheless, the evident 'pairing off' of several of the fossiliferous horizons with those of Belgium and Germany points to the discovery of a clear sequence in these rocks that will establish their individuality with the Devonian system in Brittany."

In his 'Thesaurus Devonicus,' Dr. Bigsby gives a series of Tables of the Devonian horizons recognised in different parts of Europe and America, and these materially assist in the correlation of our British Devonian horizons with those in other parts of the world. He refers to a valuable memoir by Dr. E. Kayser, published in the 'Zeitschrift d. deutschen geol. Gessel. Jahrg., 1851,' p. 375, in which the Devonian horizons of the Eifel are classed in the following manner:

[1] 'Transactions of the Devonshire Association,' 1877.

Coblentzian . . . Ahrian Schist (Dumont) . Vicht Schist . . .	Sandy Schists . .	*Lower Devonian.*
Cultrijugatus-rock . . Calceola-schist . . Stringocephalus-schist .	Marl	*Middle Devonian.*
Cuboides-limestone . Goniatites-schist . .	Marly Limestone .	*Upper Devonian.*

I have recognised that the following Eifel Brachiopods occur also in our Devonian rocks:

? Waldheimia Whidbornei.
Stringocephalus Burtini.
Rhynch. parallelepida.
— *cuboides.*
— *pugnus.*
— *acuminata.*
— *triloba.*
— *protracta.*
— *subreniformis.*
Camarophoria rhomboidea.
Pentamerus biplicatus.
— *brevirostris.*
Atrypa reticularis.
— *desquamata.*
— *aspera.*
— *latilinguis.*
Athyris concentrica.
Kayseria lens.
Uncites gryphus.
Retzia longirostris.
Bifida lepida.
Spirifera primava.
— *lævicosta.*
— *speciosa.*
Spirifera subcuspidata.
— *undifera.*
— *curvata.*
— *simplex.*
— *glabra.*
— *lineata.*
— *Urei.*
— *Verneuilii.*
Cyrtina heteroclita.
Orthis striatula.
— *tetragona.*
— *Eifliensis.*
Skenidium areola.
Streptorhynchus umbraculum.
Strophomena rhomboidalis.
— *subarachnoidea.*
— *interstrialis.*
Davidsonia Verneuilii.
Chonetes minuta.
— *sarcinulata* vel *Hardrensis.*
Strophalosia productoides.
Productus subaculeatus.
And in all probability several more.

It may also be useful to here reproduce the list of the Belgian equivalents from a table published by Mr. Grosselet in the 'Annales des Mines,' 6th series, vol. xii, p. 595:

Upper Devonian	Psammites de Condros	Calcaires d'Etrœungt.
		Psammites.
	Schistes de Famenne	Schistes de Famenne proprement dits.
		Schistes à *Cardium palmatum*.
		Calcaire (de Trelon).
		Couches à *Terebratula cuboides*.
Middle Devonian	Calcaire de Givet . . .	(divided into nine layers).
	Schistes à Calceoles	Schistes à *Spirifera speciosa*.
		Calcaire d'Ohum et de Glageon.
		Schistes à *Spirifera cultrijugata*.
Lower Devonian	Poudingue de Buinot.	
	Grauwacké à *Leptæna Murchisoni*	Schistes.
		Grès d'Aror.
	Conchos de Gedinne	Schistes bigarres à *Grammysia*.
	Conglomerats et Schistes	Poudingue.

During several years, in conjunction with Mr. Bouchard, I studied and collected the Devonian Brachiopoda from the Upper-Devonian beds of Ferques, near Boulogne. The study was subsequently continued by Mr. E. Rigaux, who published two valuable papers upon the subject.[1] Out of some forty species known to occur in the locality about fifteen have been found in our Devonian rocks, viz.:

Athyris concentrica.
Spirifera Verneuilii.
— *Urei.*
— *undifera.*
Cyrtina heteroclita.
— *Demarlii.*
Atrypa reticularis.
— *aspera.*
Rhyn. Lummatonensis.
Pentamerus brevirostris.
Orthis striatula.
— *Eifliensis.*
Streptorhynchus umbraculum.
Strophalosia productoides.
Productus subaculeatus.

Nearly all occur likewise in the Middle-Devonian beds at Lummaton or Hope's Nose. For many valuable references to the subject-matter of this Monograph, see also the "List of Works on the Geology and Palæontology of Devonshire and Cornwall," by Mr. W. Whitaker, in the 'Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art,' 1870—1872, also the 'Journal of the Royal Institution of Cornwall,' No. xvi, 1875. The volumes of the 'Geological Record' contain many useful additions to those above named.

[1] 'Description de quelques Brachiopodes du terrain Devonien de Ferques,' Boulogne, 5th Nov., 1872; and 'Geol. Mag.,' vol. v, Oct. 1878.

DESCRIPTIONS OF SPECIES.

Genus—Waldheimia, *King*, 1850.

1. Waldheimia (vel Macandrevia) Whidbornei, *Dav.* Dev. Mon., Pl. I, figs. 1—8; and Dev. Sup., Pl. I, figs. 3, 4.

Terebratula sacculus var.? *Dav.* Dev. Mon., p. 6, Pl. I, figs. 1—8 (not *A. sacculus* Martin), 1864.

Shell longitudinally oval, rather broader anteriorly, more attenuated posteriorly, slightly rounded in front. Valves evenly convex, without fold or sinus. Ventral valve the deepest; beak incurved and truncated by a small circular foramen; beak-ridges moderately defined, deltidium small. Surface smooth, finely punctated. In the interior of the dorsal valve the loop is nearly three lines in length, and rather more than half the length of the dorsal valve. Beyond their attachment to the hinge-plate the lamellæ widen into two small crural processes. They then take a gentle outward curve, and afterwards approach each other again by a slight curve before forming the reflected part of the loop. Dimensions variable—

Length 9, width 6, depth 5 lines.

Obs.—When describing this species at page 6 of the 'Devonian Monograph,' I felt very uncertain with respect to my identification; being totally unacquainted with its internal arrangements I could arrive at no definite conclusions. Some time in 1880 Mr. G. F. Whidborne, an acute and careful observer, expressed to me his suspicion that the shell under description would prove itself to be specifically distinct from Martin's *Tereb. sacculus*. Specimens of both were consequently placed into the hands of the Rev. Norman Glass for internal examination, and he soon was able to show that their loops differed materially. In *Ter. sacculus* it is similar to that of *Terebratula*, while in *Wald. Whidbornei* it is long and reflected as in *Waldheimia*. In external shape the species under description bears much resemblance to similar-sized examples of *Wald. cranium*, and its loop is much the same as that of the recent species.

Prof. King, in 1859, proposed a genus *Macandrevia* for *W. cranium* and similar shells, and that genus is maintained by Mr. Douvillé in his memoir, "Sur quelques genres de Brachiopodes," &c. ('Bull. Soc. Géol. de France,' 3rd series, vol. vii, 1879);

but I have always felt uncertain whether we should be justified in adopting that sub-genus.

Waldheimia Whidbornei seems to differ from *Wald. juvenis*, not only on account of the great difference in its exterior shape, but also in the form and position of the crura. It differs also from *T. elongata* by its straight front and by its much longer loop. *Wald. Whidbornei* is very much rarer than *W. juvenis* in the Middle Devonian at Lummaton, near Torquay.

2. Waldheimia (vel Macandrevia) juvenis, *Sow.* Dav., Dev. Mon., Pl. I, figs. 10—15; and Dev. Sup., Pl. I, figs. 1, 2.

When describing the external characters of this species at page 8 of my 'Devonian Monograph,' I was unacquainted with its internal arrangements. Since then the Rev. Norman Glass has, with much success, developed the loop in a number of specimens. The primary stems are attached to the hinge-plate. The crura are of an unusually elongated shape. These crura bend over from the inner edges of the primary branches of the loop on the dorsal side. The loop or primary branches extend to three fifths of the length of the dorsal valve, the reflected part of the loop being in about the centre of the valve. The principal stems of the loop, which are very broad and nearly straight, and parallel to each other, bend in only very slightly at their termination.

Wald. juvenis is not very uncommon in the Middle-Devonian limestone of Lummaton, near Torquay.

3. Waldheimia ? sp. ? Dav., Dev. Sup., Pl. I, fig. 5.

From the black, Middle-Devonian limestone or shales at Hope's Nose, near Torquay, Mr. G. F. Whidborne procured a rather large Terebratula-shaped shell, somewhat out of shape, compressed, and not sufficiently complete for safe specific identification. In shape it is marginally elongated, oval, with moderately convex valves; beak produced very slightly, incurved, and truncated by a circular foramen, which is separated from the hinge-plate by a rather large deltidium. Surface smooth.

Length 16, breadth 9 lines.

It differs from *Ter. caiqua*, de Vern., by its produced beak, foramen, and deltidium. It is probably a new species, but I have not thought it desirable to give it a name with only one incomplete specimen at my disposal.

Genus—Terebratula, *Llhwyd,* 1699.

4. Terebratula ? Newtoniensis, *Dav.* Dev. Mon., Pl. I, figs. 16, 17; and Dev. Sup., Pl. I, fig. 6.

One or two perfect specimens of this fine species have been found at Lummaton, near Torquay, since the publication of my 'Dev. Monogr.' I now give a figure of a perfect specimen in the possession of the Museum of the Natural History Society of Torquay. Unfortunately, no duplicates were available for the Rev. Norman Glass's interior investigation, and until its internal characters have been determined it will be impossible to determine the genus to which it belongs.

Genus—Centronella, *Billings,* 1861.

("Devonian Fossils of Canada West," 'Canadian Journal,' May, 1861.)

5. Centronella virgo, *Phillips,* sp. Dav., Dev. Sup., Pl. I, figs. 7, 8, 9.

Terebratula virgo, *Phillips.* Figures and Descriptions of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 91, pl. xxxv, fig. 167, 1841.

— sacculus, *Dav.* Dev. Mon., p. 6 (not *A. sacculus* of Martin), 1864.

Shell marginally ovate-lanceolate or longitudinally oval, longer than wide, contracted anteriorly, straight or slightly indented in front, marginally rounded, broadest posteriorly; beak acuminated, lanceolate, and prominent, slightly incurved; foramen oval, and widely separated from the hinge-line by a well-defined deltidium; beak-ridges sharply marked; valves moderately convex without fold or sinus, ventral one somewhat the deepest; both valves deepest at their posterior half and near the umbo; shell-surface beautifully reticulated, or regularly marked with equidistant punctations and canals in centrifugally curving lines; marked also anteriorly and near the margin by small, undeveloped, rounded ribs.

Length 7, breadth 5, depth 4 lines.

In the interior of the dorsal valve two delicate ribbon-shaped lamellæ, after originating from each extremity of the hinge-plate, extend to about two thirds of the length of the valve. Close to their attachment they widen into two short crura, with angular extremities facing each other. The branches of the loop diverge to about half their length when they rapidly increase in width and converge until they join, forming thus in the lower half of the loop a broad, inclined, transverse band with a pointed extremity in front. There is a slight longitudinal depression on the dorsal or convex side of this broad band where the two lamellæ join, and corresponding with this depression there is, on the other side of the band, a thin projecting ridge or plate, which sometimes extends backwards for some distance towards the ventral valve (but having no connection with it) and upwards between the two branches of the loop as they diverge from the hinge-plate.

Obs.—In 1841 Phillips briefly described the exterior characters of this species, and gave it the name *Terebratula virgo*. Knowing nothing of its interior characters, and never having seen a specimen of the shell, at p. 6 of my 'Devonian Monograph' I erroneously supposed it might be a synonym of *T. sacculus*, from which it is, however, generically and specifically distinct.

Some time in 1880 Mr. Whidborne drew my attention to this species, sending me several specimens, and intimating that he believed it to be specifically distinct from *T. sacculus*. He also forwarded to Mr. Glass a number of specimens, which Mr. Glass lost no time in operating upon. Many, indeed, have been his endeavours, conducted with great skill and patience, to work out its internal characters. The matrix filling the shell being a semiopaque sparry limestone, it was exceedingly difficult to work the specimens so as to clearly expose the loop, especially by means of transparency; nevertheless, after sacrificing dozens of specimens, he succeeded in exposing the loop in several examples as I have described and figured it.

Mr. Glass says, that, whilst he has only sent me a few preparations showing the loop as I have figured it, he has found exactly the same shape of loop in all those specimens he has operated on, which were in a condition to show the interior, and that such specimens have been very many. The majority of specimens used up, he says, were destroyed by his continued attempts to show the exact extent and shape of the projecting plate. He thinks that in many of the specimens the plate referred to has, as I have figured it, only a slight projection into the ventral valve, but that in some cases it evidently extends for some distance in this direction, as well as upwards between the two lamellæ composing the loop. Though Mr. Glass has not been able, from the Lummaton specimens, to determine the exact shape of this plate, it has been described, as we shall see further on, by Prof. Winchell.

Mr. Glass thinks that it is perfectly certain, from the many specimens upon which he has operated, that there is no reflected ribbon-band in *Centronella* similar to that which exists in *Waldheimia* and other loop-bearing species of Terebratulidæ. Professor Friele, Mr. C. Moore, and myself have found that in some loop-bearing Brachiopoda, such as *Waldheimia cranium*, the young specimens have the primary branches of the loop united in the middle to a narrow ridge or plate, but in these cases the reflected portion becomes developed with age. It is plain, however, from the full-grown specimens developed by Mr. Glass, that this does not take place in *Centronella virgo*.

At p. 62 of the 'Canadian Journal' for 1861 Prof. Billings described and figured his *Centronella* as "having the general form of *Terebratula*. Dorsal valve with loop consisting of two delicate ribbon-like lamellæ, which extend to about half the length of the shell. These lamellæ first curve gently outwards, then approach to each other gradually, until at their lower extremities they meet at an acute angle; then, becoming united, they are reflected backwards towards the beak in what appears to be a thin vertical plate. Near their origin each bears upon the ventral side a triangular crural process."

The type of *Centronella* given by Billings is *C. glans-fagea*. A preparation of the loop in this species was made by Dr. Rominger in September, 1862, and figured by Prof. Hall at p. 47 of the 'Sixteenth Annual Report of the Regents of the University of the State of New York,' 1863. Dr. Rominger's preparation clearly showed that Billings' description of the loop of *C. glans-fagea* was to some extent erroneous. Mr. Glass says that in his first attempts to get at the loop of *Centronella virgo* he obtained results similar to those figured by Prof. Billings, but afterwards found that his results were incorrect through his having rubbed away a large part of the transverse band formed by the front of the loop. By the rubbing away of this part the ridge or plate projecting behind it showed as if it were, as described by Prof. Billings, a reflected plate proceeding from the end of the loop. These remarks, however, do not apply to the profile figure given by Billings, which does not resemble anything which Mr. Glass has seen whilst making his preparations. Dr. Rominger's figure of *C. glans-fagea*, as given by Hall, agrees with Prof. Billings' figure as to the crura, and almost entirely agrees with Mr. Glass's preparations of *C. virgo*, as also with the preparations by Prof. Winchell of *C. Julia*, with the exception, in the latter case, that Dr. Rominger figures the ridge or plate on the ventral side of the loop as I have represented it and not as represented by Winchell, and that the crura are not shown in Winchell's figures. The following is the careful description of *Centronella Julia* as published by Prof. Winchell:—"A delicate ribbon-like loop originates from the stout blunt crura on each side of the socket-valve, having its flat sides at first vertical. The two branches of the loop proceed at first in lines parallel or a little convergent, and then gradually diverge, widening as they proceed, and assuming an inclined position, until, approaching the front of the valve by a regular curvature, the lower edge has become anterior, giving the band an angle of 30° with the plane of the shell. Approaching the median line the band rapidly widens, the front margin is drawn forward in a long acumination, while the inner margin is regularly concave, except that near the median line it turns abruptly forward so as to meet that line at an acute angle. The loop thus forms an urceolate figure on its inner margin, and on the outer a somewhat oval one, truncated behind and attenuately acuminate before. In the median line, where the two branches meet, both are suddenly deflected downwards, forming a double vertical plate, not quite reaching the ventral valve, the upper edge of which, when viewed from the side, is flatly roof-shaped, while the lower edge describes two convexities, the greater anterior, leaving a notch between them. The surface of the loop and median plate is covered with minute obliquely conical pustules, in some places seeming to become spinulous."

The preparations of *C. virgo* made by Mr. Glass agree with the above description of *C. Julia*, except in the following particulars :—First, Mr. Glass's preparations show the crura as described by Billings and Rominger, but which Winchell's figures and descriptions do not show ; and secondly, Mr. Glass found only a single ridge or plate, and not a double vertical plate as described by Prof. Winchell. The details also of the extension of this plate upwards and towards the ventral valve Mr. Glass was not able to ascertain, nor was he able to find the "obliquely conical pustules" referred to by Prof. Winchell as occurring on the surface of the loop and median plate.

In the 'Sixteenth Annual Report of the Regents of the University of the State of New York,' 1863, Professor Hall describes *Centronella* and *Cryptonella* at great length. His description of *Cryptonella* is based upon the description of *Centronella Julia* by Winchell; but in the footnote containing the figures of Dr. Rominger's *C. glans-fagea*, Prof. Hall withdraws the name of *Cryptonella* in favour of the older name *Centronella*, on the ground that Dr. Rominger's preparation of Billings' type shows that his description is erroneous, and that the loop of *C. glans-fagea* and *C. Julia* are identical. In conclusion, it should be observed that, according to Mr. Glass's preparations, the general outline of the loop of *Centronella* is better given in the figures of Winchell and Hall than in that of Dr. Rominger, and that Billings' figures are evidently founded on a mistake owing to imperfect preparations.

Centronella virgo is a common species in the Middle-Devonian of Lummaton, near Torquay, in Devonshire.

Since writing the above observations, and in reply to a letter I had previously sent, I have been favoured with a very kind communication from Prof. Winchell. He could not send the preparations of *Centronella Julia* from which his figures were originally drawn, but he sent to me a number of specimens of *C. Julia* unworked, with the hope expressed that they might afford the information desired. These specimens were very small, and the matrix was of an arenaceous and friable nature. Having sent the specimens to Mr. Glass, he was able by simply fracturing them in different directions to prove the truth of nearly every particular in Prof. Winchell's description. It was in this manner also that Prof. Winchell had obtained his results, as he stated in his letter to me. Ordinarily by this process no certain result can be obtained, and none could be obtained in this manner from our Devonian specimens of the same genus. But

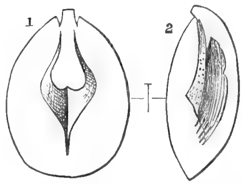


FIG. 1.—Dorsal view of *Centronella Julia*, showing the loop.
FIG. 2.—Profile view, showing one band of the loop with the vertical plate.
From drawings (enlarged four times) by Prof. Winchell. Published by Hall.

in these specimens of *C. Julia* there is sufficient contrast between the colour of the loop and the surrounding matrix to make the different parts of the loop very clear when revealed opaquely and by fracture. In most of the specimens the loop is of a rusty-brown colour, surrounded by a lighter-coloured matrix. Mr. Glass's preparations plainly show that the median plate of the loop in *C. Julia* is of the exact shape described by Winchell. In some cases, when this plate is shown by fracture, it seems to have been split laterally in half, as if it were really, as Winchell describes, a double plate, but so closely appressed as not to show its being double by a transverse fracture. Winchell says, in his note to me, "The appearance is, that the loop abuts squarely against the flat surface of the plate on each side. Homological considerations, however, would render it probable that the loop is reflected abruptly and passes into the vertical plate, or rather forms the vertical plate. This then should be double. But this is only conjecture." On either side of the front border of the median plate (*i. e.* that which is connected with the loop, and inclined towards the anterior margin) there are some faint ribs or plications, and these are indicated in Winchell's profile figure. In addition to this the whole of the median plate is finely striated longitudinally on either side, the striations having a slightly waved appearance. One of the specimens which Mr. Glass has fractured seems to show the crura near the origin of the loop. Mr. Glass could not ascertain with certainty the existence of the "obliquely conical pustules," referred to by Prof. Winchell as occurring on the surface of the loop and median plate, but he thinks there are some indications of them on the median plate, and that possibly they might be seen in larger specimens, or with a higher magnifying power than he has used. From the results thus obtained I agree with Mr. Glass that Prof. Winchell's description of the loop in *Centronella* is on the whole correct, with the exception of the crura, which are more easily shown in our Devonian specimens of *C. virgo*, and which are described both by Billings and Rominger as occurring in *C. glans-fagea*. In the preparations of *C. virgo* the loop can only be seen by transparency, and the median plate can only be shown with any certainty as I have figured it. Probably in some cases this plate was imperfectly developed, or had been partly broken away before fossilisation. In some cases, however, as I have previously stated, Mr. Glass found indications of this plate being in the shape figured by Prof. Winchell; and the preparations of *C. Julia* referred to above seem to show that this was the normal condition. I have already given Winchell's figures of *C. Julia*, in order that the above references may be more clearly understood.

Genus—STRINGOCEPHALUS, *Defrance*, 1827.

6. STRINGOCEPHALUS BURTINI, *Def.* Dav., Dev. Mon., Pl. I, figs. 18—22; and Pl. II, figs. 1—11; and Dev. Sup., Pl. III, figs. 2, 3.

At page 11 of my Devonian Monograph (1864) I fully described and illustrated this important species. Since then specimens measuring different sizes, up to three inches in length by five in breadth, have occasionally been found by Messrs. Lee, Champernowne, and Whidborne, in the Middle-Devonian Limestone of Lummaton, near Torquay. This characteristic species, therefore, marks the bed and the age of the numerous species that accompany it. *St. Burtini* has also been found by Mr. A. Champernowne at Symonds-Tree Quarry, as well as at Pit-Park and Orchard Quarries at Dartington. A young specimen, with a large open fissure and median longitudinal groove in the dorsal valve, similar to the one drawn by Professor Quenstedt, in Tab. 43, figs. 58—59, of his 'Brachiopoden,' 1871, has been met with in that locality by Mr. Champernowne.

We may also mention what has already been recorded at p. 325 of the previous volume, that the Stringocephalus-bed is in North Devon, according to Mr. Valpy, situated above the Hangman Grits, and would constitute the basement of the "Ilfracombe Group," if that group is to be severed from the Hangman beds?

Genus—RENSSELÆRIA, *Hall*, 1859.

7. ? RENSSELÆRIA ? STRIATISSIMA, *Dav.* Dev. Sup., Pl. I, figs. 20, 20*a*.

Shell marginally elongate-oval, nearly straight in front, no fold nor sinus; valves convex and covered with fine, radiating, raised striæ, with shorter and smaller ones interpolated between the larger striæ; beak moderately produced.

Length 11, width 8, depth 7 lines.

Obs.—Nothing being known of the interior character of this shell, it is not possible to assign to it its real generic position. It has been provisionally placed with *Rensselæria*. Having forwarded drawings of the shell to Dr. Kayser, he does not think it can be the *Rensselæria strigiceps*, F. Roemer, to which I thought it bore some resemblance.

One specimen only was found by Mr. Whidborne in the Middle Devonian at Hope's Nose, near Torquay.

Genus—Meganteris, *Suess*, 1856.

8. Meganteris ? Vicaryi, *Dav.* Dev. Mon., Pl. XX, fig. 15; and Dev. Sup., Pl. III, figs. 1, 1*a*, 1*b*.

Shell large, marginally nearly circular, about as wide as long; valves very gently convex and flattened. On attaining their full size they become abruptly bent marginally with an inward curve, and at right angles to the plane of their surface, thus forming a wide, flattened, or biconcave border to the shell. Beak small, much incurved; beak-ridges sharply defined, leaving a flattened space between them and the hinge-line; foramen concealed under the incurvature of the beak; deltidium sometimes visible; surface smooth. Two specimens measured—

Length 3, breadth 3, depth 1 inch.
,, 2 ,, 2, ,, 1 inch 4 lines.

Obs.—In Plate XX of my Devonian Monograph I gave a figure of an undescribed species that Mr. Vicary had obtained from the Middle Devonian at Woolborough, near Newton Abbot. I then felt, as at present, uncertain as to the genus to which this remarkable shell should be referred. Nothing is known of its interior, and it is with very considerable hesitation that I now provisionally refer it to *Meganteris*. A dark line extending from the umbo of the dorsal valve to about a third of its length shows that it was internally provided with a small septum. Since figuring the perfect example in Pl. XX of my Devonian Monograph, Mr. Vicary has obtained from the same locality a much larger but somewhat distorted example of the same species, and this has induced me to describe and name the shell after the discoverer of the only two complete specimens at present known. It is very desirable that as soon as a duplicate specimen shall have been discovered some search for its internal characters should be made. An incomplete valve of the species under description was also found by Mr. J. E. Lee, at Lummaton, near Torquay.

Genus—Merista, *Suess*, 1851.

9. Merista plebeia, *Sow.*, sp. Dav., Dev. Mon., Pl. III, figs. 2—10; and Dev. Sup., Pl. I, figs. 26 to 29.

At the time I described the exterior of this species nothing further respecting its internal character was known in addition to its being provided with spiral appendages and a shoe-lifter process. Mr. Glass was able to develop its spiral appendages in two or three examples, but could not, owing to the intractable nature of the matrix, expose its loop, rings, and attachments to the hinge-plate. I must, therefore, refer the reader for the full description of the genus *Merista* to the Silurian Supplement. The loop and its attachments were subsequently well developed by Herr Zugmayer in a closely allied species, the *Merista cassidea-prunulum*, of Quenstedt, from the Devonian rocks of the Eifel. The rings of the loop and the shoe-lifter process characterise this genus. *Merista plebeia* or *scalprum* occurs in the Middle Devonian at Lummaton, and in the dark shaley limestone at Hope's Nose, near Torquay; but, unfortunately, in the last-named locality most of the specimens are compressed and distorted. Some weathered examples show the spirals, and a section exhibited the shoe-lifter process in a very distinct manner (Dev. Sup., Pl. I, figs. 28, 29).

At p. 551 of his 'Die Brachiopoden der Eifel,' Dr. E. Kayser gives the following synonyms of *Merista plebeia*, Sow. sp. *Atrypa lacryma*, Sow. *Tereb. scalprum*, F. Roemer. *Tereb. prunulum*, Schnur.

Judging from specimens and figures, Von Buch's *Merista* (*Ter.*) *cassidea* is closely allied to *M. plebeia*, but the shell named and figured *Merista cassidea-prunulum* by Quenstedt, 'Brachiopoden,' tab. 51, fig. 69, seems very distinct from Sowerby's *T. plebeia*, although it may belong to the same genus.

Genus—KAYSERIA, *Dav.*, 1882.

10. KAYSERIA LENS, *Phillips*, sp. Dav., Dev. Mon., Pl. X, fig. 1; and Dev. Sup., Pl. II, figs. 11, 12.

ATRYPA LENS, *Dav.* Dev. Mon., p. 51, Pl. X, fig. 1.
SPIRIGERINA OVALIS, *Sandb.* Verstein. Rhein. System in Nassau, pl. xxxiii, fig. 2, 1855.
RETZIA DIVIDUA, *Quenstedt.* Atlas, Brachiop., pl. 51, figs. 21—25, 1871.
— LENS, *Kayser.* Die Brachiop. des Mittel- und Ober- Devon. der Eifel, p. 161 (Deutschen Geol. Gesel. Jahrgang, 1871).

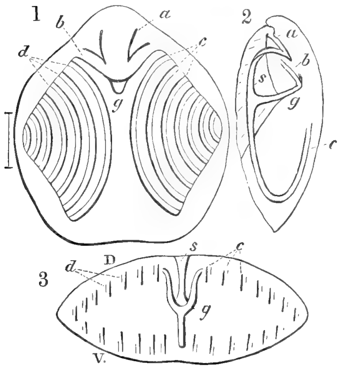
At page 21 of my 'Devonian Monograph' I described this small species under the name of *Atrypa lens*, and mentioned that Schnur had figured its spirals. His figure, I find after further examination, shows two spiral appendages with their extremities directed towards the lateral margins of the shell,[1] and he draws five convolutions in each spiral. Subsequently Quenstedt, in his 'Brachiopoden,' tab. 51, figs. 21—23, 1871, gives

[1] 'Beschreibung Eifel-vorkommenden Brachiopoden,' pl. xxiv, fig. 2, 1853.

drawings of the shell and its interior spirals with the name of *Retzia dividua*. He also shows that the extremities of the spiral coils were directed towards the lateral margins of the shell, as had been previously described by Schnur.

In the same year Emanuel Kayser, at p. 54 of his memoir 'Die Brachiopoden des Mittel- und Ober- Devon. der Eifel," names this species *Retzia lens*, but gives no figure of the spirals. Though Schnur and Quenstedt had figured the spirals of this species, yet these distinguished palæontologists were unable to trace the attachments or the loop in their German specimens.

Mr. Whidborne, having procured a number of specimens of *Kayseria lens* from Hope's Nose, forwarded them to Mr. Glass, together with some German specimens of the same species. I also procured for Mr. Glass a number of German specimens from Dr. Kayser and others. By the aid of these, especially the German specimens, Mr. Glass was enabled to determine in the most clear and satisfactory manner all the peculiar internal arrangements of this species, as they will now be described.



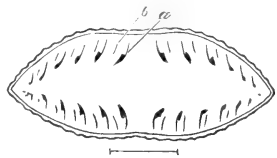
Kayseria lens, enlarged.

FIG. 1, showing spirals: *a*, attachments of primary lamellæ to hinge-plate; *g*, loop; *b* and *d*, accessory coils; *c*, principal coils.

FIG. 2. Longitudinal section: letters indicate same parts as in Fig. 1; *s*, septum.

FIG. 3. Transverse section: D, dorsal valve; V, ventral valve; *s*, septum; *g*, loop.

In the interior of the dorsal valve there is a septum, which extends to about half the distance between the beak and the anterior margin. This septum is somewhat triangular in shape, the base of the triangle being formed by the dorsal valve, and the apex being extended towards the opposite or ventral valve. This latter part of the septum, as we shall presently see, is connected with the loop. The septum after leaving the valve from which it originates soon becomes comparatively thin, but the apex of the septum is somewhat thickened at the point where it unites with the loop. The spirals are disposed in the shell in the same manner as those of *Athyris*, and each spiral consists of about fourteeen coils, that is, of seven principal coils, arising from the hook-shaped attachments to the hinge-plate, and seven accessory coils, arising from the bifurcation at the end of the loop. The primary lamellæ after leaving the hinge-plate proceed for a short distance downwards, then they suddenly bend backwards, forming a broad rounded curve facing the bottom of the dorsal valve. At about one third of their length they give off two short lamellæ, which go straight across between the spirals, and converging unite at a little more than half way between the dorsal and ventral side of the spirals. These lamellæ bend slightly outwards before coming to their point of union, thus forming when united a circular bay, through the centre of which the dorsal septum passes. The angular projection near the centre of the dorsal septum is in close apposition to that part of the loop where the two curved lamellæ unite, and, indeed, the dorsal septum and the loop seem to be united here. The two curved lamellæ which form the commencement of the loop are thin at their origin, but they increase in thickness until they unite, and then from the point of their union the loop is prolonged by a single rounded process in a straight or slightly upward direction across the remaining portion of the distance between the dorsal and ventral side of the spirals. At the end of this rounded process the loop bifurcates in an upward direction, each branch of the bifurcation passing up inside the hook-shaped attachment to the hinge-plate, and then as an accessory lamella threading its way between the main coils to the end of the spiral. This long-extended accessory lamella in each spiral is narrower than the coils which proceed directly from the hinge-plate, as may be seen by scraping the spiral, when the coils of the accessory lamellæ soon disappear whilst the other coils still remain. The fourteen coils composing each spiral are arranged in pairs, there being a greater distance between the second and third and the fourth and fifth coils than between the first and second and the third and fourth coils, and so on regularly throughout the spiral. After the above description had been put in type, Mr. Glass, receiving some more German specimens of this species from Mr. Whidborne, was able to make a perfectly clear and decisive transverse section of the coils. A figure of the section is here given, from which it will be seen that, not only are the primary lamellæ (*a*) much broader than the accessory lamellæ (*b*), but that they are also slightly curved and thickened on their inner border.



Kayseria lens. Section enlarged.

In tab. 51, fig. 25 *r*, of the Atlas of Prof. Quenstedt's work, 'Brachiopoden,' the distinguished German palæontologist figures what appear to be double spiral coils, such as are more clearly to be seen in some of Mr. Glass's preparations.

Thus it will be seen that this species, though bearing some resemblance to *Athyris* in its spiral arrangements, is in many respects unique. The prominent dorsal septum and its connection with the loop, the shape and direction of the curved lamellæ composing the commencement of the loop, and the rounded process by which these lamellæ are continued, as well as the long extension of the accessory lamellæ, distinguish this species clearly from *Athyris*, and, indeed, from all the other spiral-bearing genera with which we are acquainted. The continuation of the accessory lamellæ from their commencement at the loop to the end of the spiral is especially notable. In *Meristina* there is a simple loop; in *Whitfieldia* this loop is continued by a bifurcation; this bifurcation is still further extended in *Athyris;* whilst in the species under consideration the lamellæ arising from the end of the loop are extended throughout the whole length of the spiral. The exceptional strength of the loop in the thickness of its lamellæ, and in its connection with the dorsal septum, may be designed to bear the long extension of the accessory lamellæ.

The characters of this species being, therefore, so distinct from any previously discovered, I have decided to give it the new generic denomination of *Kayseria*, after Dr. Emanuel Kayser, of Berlin, a distinguished palæontologist, and author of the work 'Die Brachiopoden des Mittel- und Ober- Devon. der Eifel,' 1871. Most of the preparations of *Kayseria lens* from which the figures are taken are from German specimens, and in these the different parts of the loop, &c., are revealed opaquely and in very clear relief against the yellowish limestone matrix.

First placed with *Orthis* by Phillips, and then with *Spirigerina* by Sandberger, and with *Retzia* by Quenstedt and Kayser, it now, thanks to Mr. Glass, finds a resting place in *Kayseria*. It has also received several specific names besides its true one of *lens*. Schnur called it *dividua*, Steininger *Eifliensis*, Sandberger *ovalis*.

Kayseria lens is a well-marked species, easily recognised by its remarkably compressed appearance, small beak, slightly-raised and flattened radiating ribs, with interspaces of about equal breadth, and by a longitudinal groove dividing the shell into two equal parts, hence Schnur's name *dividua*. The specific name of *lens*, however, given to the species by Phillips in 1841, must be retained, that of *dividua* being one of the synonyms.

Kayseria lens is not a rare shell at Hope's Nose, near Torquay, but it is very difficult to procure specimens in a good state of preservation. In the Eifel it is found in a perfect condition. It is a small shell scarcely ever exceeding six lines in length.

Genus—Athyris, *McCoy*, 1841.

11. Athyris Glassii. Dav., Dev. Sup., Pl. I, figs. 21, 22.

Shell small; transversely oval, valves moderately convex, slightly compressed, without fold or sinus, ventral valve the deepest and most convex; beak produced, slightly incurved and truncated by a minute circular foramen, separated from the hinge-line by a small deltidium; surface of valves smooth. In the interior of the dorsal valve the spiral appendages have their extremities facing the lateral portions of the valves. About seven convolutions in each spiral.

Length 5, width 6, depth 2 lines.

Obs.—Of this small species four or five examples were procured by Mr. Whidborne from the Middle Devonian of Lummaton, near Torquay. The interior spirals were developed by the Rev. N. Glass, but from want of sufficient material he was unable to expose their attachments. The compressed shape of the shell and absence of fold and sinus distinguish it from *A. concentrica,* and it is with much pleasure that I name it after the Rev. Norman Glass, who was the first to determine its generic position.

12. Athyris concentrica, *Von Buch,* sp. Dav., Dev. Mon., Pl. III, figs. 11—15, 24; and Dev. Sup., Pl. I, figs. 23, 24; Pl. II, figs. 10, 10*a*.

The external characters of this species have been given at page 15 of my Devonian Monograph, and need not be repeated. The shell varies with age, and the var. *lamellosa* is in all probability a young condition of the full-grown *A. concentrica.* As the shell acquires age the concentric equi-distant ridges that ornament its surface become, comparatively speaking, much less marked than in young individuals, and are sometimes hardly visible in very adult individuals, such as in some of those we find at Ferques, near Boulogne-sur-Mer.

Many years ago, in 1842, Mr. Bouchard and myself found at Ferques some weathered specimens of *A. concentrica,* showing the spirals in a very beautiful and perfect condition. We also found two examples showing the hinge-plate, and close to the extremity of the umbo a small circular aperture communicating with a circular curved tube, which I have already described and illustrated in Pl. VI, fig. 66, of my Introduction to the first volume of my Monograph; but none of the Ferques specimens showed either the attachments of the principal stems of the spirals to the hinge-plate or the connecting processes or loop.

In 1871, in the Atlas to his 'Brachiopoden (Petrefactenkunde Deutschlands),' tab. 51, 1871, Quenstedt gives several figures in which he represents the accessory lamella and the loop, but not quite clearly nor completely, although he has evidently devoted much attention to the subject and very nearly got the different parts complete. Quenstedt does not, however, give any figure of the attachments to the hinge-plate.

In *A. concentrica* the convolutions of the spirals are numerous and rather close to each other; and in a specimen measuring an inch in breadth I counted fifteen coils in each spiral. The spirals are closer together on the ventral than on the dorsal side.

We are indebted to the Rev. Norman Glass for a complete knowledge of the shape of the loop and the attachments of the principal stems of the spirals to the hinge-plate. After several more or less unsuccessful attempts on specimens from Lummaton he was enabled to develop the loop and other attachments in a very complete and satisfactory manner in a specimen sent to him by Mr. Whidborne from Hope's Nose, near Torquay: of these we give two figures on Pl. I of this Supplement. These figs. 10, 10*a*, require no detailed explanation, as that will be found under the description of *Athyris* in the accompanying Silurian Supplement. In its hook-shaped attachments to the hinge-plate, and in the character of its loop, with its roof-shaped projection, curved lamella, and accessory lamellæ, this species is clearly shown to be of the true *Athyris* type.

In my 'Permian and Carboniferous Monograph' I published a full description, with figures, of the spirals and their connections in *A. pectinifera* and *A. ambigua*, and now, as recorded in these Supplements, the complete arrangement of the spirals and their connections have been worked out by Mr. Glass in *A. concentrica*, *A. plano-sulcata*, *A. ambigua*, and *A. spiriferoides*, and all have been described and figured as correctly as was possible. The descriptions and figures will show that the spirals, loops, and attachments are esentially the same in all species of a same genus, although they may differ a little in minor details.

13. Athyris rugata, *Dav.* Dav., Dev. Sup., Pl. I, figs. 25, 25*a*.

Shell small, almost circular or as broad as long. Valves convex, with a slight mesial elevation or fold near the front in the dorsal valve, and a small concave sinus in the ventral one; beak small, incurved; foramen minute. Valves covered with a small number of strong irregular concentric ridges. Interior not known.

Length 4, width 4, depth 1 line.

I know very little about this shell, having seen only two specimens of it. Mr. Whidborne is of opinion that it is a distinct species; and its few comparatively very strong concentric ridges seem to distinguish it from *A. concentrica*.

It occurs in the Middle Devonian at Hope's Nose, near Torquay.

Genus—Bifida, *Dav.*, 1882.

14. Bifida lepida, *Goldfuss*, sp., apud *d'Arch. et de Vern.* Dav., Dev. Mon., Pl. X, fig. 2; and Dev. Sup., Pl. II, fig. 13.

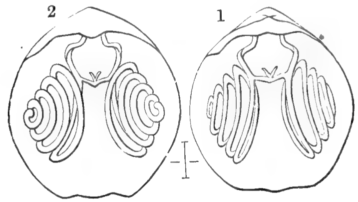
Terebratula lepida, *d'Archiac* and *de Verneuil.* Desc. of the Fossils of the Older Deposits of the Rheinish Provinces, Trans. Geol. Soc., 2nd ser., vol. vi, p. 368, pl. xxxv, fig. 3, 1840.

Atrypa — *Dav.* Mon. Brit. Dev. Brachiopoda, p. 52, pl. x, fig. 2, 1864.

Retzia — *Kayser.* Die Brach. des Mittel- und Ober-Devon. der Eifel, p. 559, 1871.

At page 52 of my 'Devonian Monograph' I described and figured the exterior characters of this little shell, under the name of *Atrypa lepida.* I was not then acquainted with its interior arrangements. In 1871 Prof. Quenstedt, in his 'Brachiopoden,' Tab. 51, fig. 29, gives a small figure of the interior from a specimen from the Devonian Limestone of Gerolstein, which he had been able partially to develop. In his figure the spiral appendages are shown in their dorsal aspect, the extremities of the spirals being directed towards the lateral margins of the shell, and each spiral being composed of three convolutions. Quenstedt, however, gives none of the attachments, either of the principal stems with each other or with the hinge-plates. In 1871, Dr. E. Kayser placed Goldfuss's species in the genus *Retzia,* but he does not seem to have been acquainted with either its attachments to the hinge-plate or its loop. In 1880 Mr. G. F. Whidborne forwarded to Mr. Glass a number of small specimens of this species which he had procured at Hope's Nose, near Torquay. Dr. E. Kayser and Prof. Dewalque, at my request, also kindly procured for Mr. Glass a number of foreign specimens from Gerolstein, in the Eifel, and some more examples from the same locality were kindly sent to Mr. Glass by Mr. Whidborne. From these specimens Mr. Glass was enabled to work out most completely the internal spiral arrangement. This result, however, was only obtained after repeated efforts and much patient application, the shells being very small, and the only possible method of revealing their interior being by means of transparency.

In the shape and position of the spirals and in the attachments to the hinge-plate this genus closely resembles *Whitfieldia,* only the spirals of *Bifida* are slightly depressed or flattened on their dorsal side. There are usually four coils in each spiral. The loop is like that in *Meristina,* with the exception that it is placed nearer to the attachments to the hinge-plate, and that at the point where the two lamellæ composing the loop join there is a short bifurcation directed upwards. In this latter respect the loop of *Bifida* resembles that of *Whitfieldia*. A comparison of the accompanying figures of *Bifida* with those of *Meristina* and *Whitfieldia*, given in the Silurian Supplement, will show the above points of resemblance and difference. The loop of this species being new I have given to it the generic name of *Bifida*, in allusion to the forked extremity of the loop.



Bifida lepida.
1. Ventral aspect. 2. Dorsal aspect. Enlarged.
Developed by Rev. N. Glass.

Mr. Whidborne informs me that *B. lepida* occurs in the Middle Devonian at Hope's Nose, near Torquay, and that it is remarkable how separate the specimens of *B. lepida* and *Kayseria lens* are from each other in that locality. In the upper beds, where he has found more than fifty specimens of *B. lepida*, he has only found one of *K. lens*. In the lower beds in the same locality, where he has found *K. lens* to be common, he has not seen a single specimen of *B. lepida*. He says that the specimens of *B. lepida* occur in one spot a few yards long, so that this species would appear to have been gregarious whilst the specimens of *K. lens* are scattered evenly along the bed in which they are found. It is very uncertain whether *B. lepida* has been found at Lummaton. The specimen in Mr. Lee's collection that had been referred to this species is in all probability a worn example of *B. Huntii*.

15. Bifida Huntii, *Dav.* Dav., Dev. Sup., Pl. I, figs. 17, 17*a*, 17*b*, 18.

Shell small, circular, about as broad as long; valves almost equally deep and moderately convex. Dorsal valve somewhat depressed and longitudinally divided by a small narrow rib. On either side are two large rounded ribs with interspaces of about equal breadth. Ventral more convex than the dorsal valve, and longitudinally divided by a narrow groove. On each of the lateral portions of the valve are two large rounded ribs with wide interspaces. Beak small, very slightly incurved. Surface crossed with transverse lines, similar to those in *B. lepida*, but more numerous and finer.

Length $3\frac{1}{2}$, breadth $3\frac{1}{2}$, depth 1 line.

Obs.—Several specimens of this small species have been found by Mr. Whidborne in the Middle Devonian at Lummaton, near Torquay. It is nearly allied to *B. lepida;* but is a larger, flatter, and broader shell. The Rev. Norman Glass has partly worked out its interior, and informs me that its spirals and connections seem arranged as in *B. lepida.*

It is with much pleasure I name this species after Mr. A. R. Hunt, late President of the Torquay Natural History Society.

Genus—Retzia, *King*, 1850.

16. Retzia longirostris, *Kayser*. Dav., Dev. Mon. (as *R. ferita*), Pl. IV, figs. 8—10; and Dev. Sup., Pl. I, figs. 30, 30*a*, 31.

Terebratula ferita of Schnur, d'Orbigny, Sandberger, Phillips, de Verneuil, Quenstedt, Hall, Davidson, and others. According to Kayser, not *Terebratula ferita*, von Buch, 'Ueber Terebrateln,' p. 76, pl. 2, fig. 37, 1834.

Retzia longirostris, *Kayser*. Die Brachiopoden des Mittel- und Ober-Devon. der Eifel, p. 558, pl. x, fig. 5, 1871.

At p. 21 of my 'Devonian Monograph' I described and figured the species under description as the *Retzia* (*Tereb.*) *ferita*, von Buch. As will be seen, all the palæontologists who subsequently to Von Buch described the shell under notice believed it to be the *Ter. ferita* of von Buch. The mistake was in 1871 pointed out by Dr. Kayser; and, on referring to Buch's original figure of *T. ferita*, I am bound to admit the correctness of Dr. Kayser's view. It is in reality quite distinct from the species which since 1843 has been termed *Retzia ferita;* and, to avoid any further misapprehensions, I have admitted Dr. Kayser's views and name of *longirostris.*

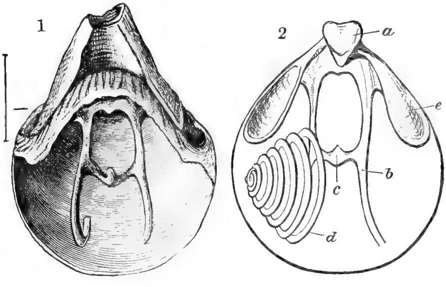
We need not here repeat the description of the exterior characters of *Retzia longirostris,* as they will be found on p. 21 of my Monograph under *Retzia ferita.* I was not, however, at that period able to give a figure of its spiral appendages. In his 'Die Brach. des Rheinischen Schichtens systems in Nassau,' pl. xxxii, fig. 13, 1855, Dr. Sandberger gives a figure of the spiral appendages of this species, but somewhat displaced; he also gives a figure of the perforated shell-structure. Prof. Hall, in the 'Sixteenth Annual Report of the University of the State of New York,' p. 56, fig. 6, represents one of the spirals. Quenstedt, in his 'Brachiopoden,' gives two or three figures showing the spirals in this species, but no one had been able to develop their connections. Thanks to Mr. Whidborne, I am now able to give a figure of the spirals of a British species of *R. longirostris,* from the Middle Devonian of Lummaton, which Mr. Glass has developed. Each spiral is formed of seven or eight convolutions. It is also said to occur at the Dock Yard, Plymouth.[1]

Genus—Uncites, *Defrance*, 1828.

17. Uncites gryphus, *Schloth.*, sp. Dav., Dev. Mon., Pl. IV, figs. 11, 12; and Dev. Sup., Pl. III, figs. 4 to 10.

Uncites gryphus, *Schloth.* Dav., Geol. Mag., New Series, vol. viii, p. 145, 1881.

For many years past I have been on the look out for specimens that would clear up the interior characters of Defrance's genus. In 1853, in the General Introduction of my work on 'British Fossil Brachiopoda,' I described and figured part of the interior of the dorsal valve of *Uncites gryphus*, showing the lateral pouch-shaped cavities opening exteriorly, as well as the attachments to the hinge-plate of the principal stems of the spiral appendages; also indications of the spiral appendages from a specimen which Prof. Beyrich, of Berlin, was so fortunate as to discover at Paffrath, and which was brought to my notice by Prof. E. Suess, of Vienna.



Uncites gryphus, Defrance.

1. Specimen in the Imperial Museum of Vienna. 2. Restored interior of the dorsal valve. *a*. Cardinal process. *b*. Principal stems of spirals. *c*. Connecting lamellæ. *e*. Pouch-shaped expansions. From Nismes, near Couven, Belgium.

In 1871 Prof. Quenstedt, in pl. 43 of the atlas of his 'Die Brachiopoden' (Petrefactenkunde Deutschlands), figures spiral coils in a specimen of *Uncites*. No one, as far as I am aware of, seems, prior to the notice I inserted in the Geological Magazine' for April, 1881, to have figured or described the mode in which the spirals

[1] By Dock Yard is meant "Devonport," which by the dwellers at Plymouth was called "Dock Yard," and by those at a distance "Plymouth Dock," until 1824. It is now a distinct municipal and parliamentary borough. On the old labels attached to specimens in the Plymouth Institution the word "Dock Yard" is written, and therefore here reproduced.

were connected. After many inquiries in different directions Prof. Zittel informed me that he believed there existed in the Imperial Museum of Vienna some specimens that might help in this investigation, and accordingly my old and valued friend Prof. E. Suess at once kindly obtained for my inspection the important specimen shown in the woodcut (fig. 1). In this are seen not only the attachments of the principal stems of the spirals to the hinge-plate, but likewise their connection by the means of a curved bridge-like process, which connects them at about half their length, small portions of the spirals themselves being visible.

We are indebted to Mr. A. Champernowne, of Dartington Hall, Totnes, not only for the discovery of the first British specimen of the genus, but also for finding a specimen showing the cardinal process, which in *Uncites gryphus* is heart-shaped and strongly developed. In Dev. Sup., Pl. III, I have given several figures of this interesting specimen. The cardinal process is comparatively large, projecting, turned up, and bilobed at its extremity, and crooks under the concave deltidial fissure of the ventral valve. Its posterior portion encroaches on the extremity of the umbo of the dorsal valve, and on either side, in the interior of the valve, are two raised channelled prolongations, to which the principal stems of the spirals, in all probability, were attached. On each side of these are the open pouch-shaped expansions. This valuable specimen was found by Mr. Champernowne in the Devonian Limestone of Orchard Quarry, Dartington, Devonshire; and was presented by him to the Albert Memorial Museum, Exeter. I am indebted to the curator, Mr. d'Urban, for the kind loan of the specimen.

Uncites gryphus is not a common fossil in Devonshire. Most of the specimens at present known were obtained by Mr. Champernowne near Dartington. Mr. Vicary has obtained well-characterised specimens, from the Chudleigh Limestone in Devonshire, which I have seen. Mr. Champernowne has procured the fossil out of Triassic conglomerate at Shaldon, opposite Teignmouth. It occurs in a black marble, from which sections can be cut. Mr. Pengelly also kindly lent me out of the Torquay Natural History Museum a similar boulder of black marble, which had been found at Petit-tor Beach just east of Babbacombe, and about three miles east of Torquay. This, having been cut and polished, exhibited a number of fine sections of *Uncites gryphus,* of which we have given a figure.

We still remain unacquainted with the shape and position of the muscular impressions, but these will in all probability be some day discovered.

Uncites gryphus varies considerably. Some specimens show the lateral open pouches, others none. I have seen from Paffrath specimens of *Uncites* measuring three inches in length and upwards. A specimen from Shaldon measured two inches and five eighths in length: and some young specimens had pouches, others none.

Genus—Spirifera, *Sow.*, 1815.

I have not much to add with respect to the species of this genus.

18. Spirifera curvata, *Schlotheim*. Dav., Dev. Mon., Pl. IV, figs. 29—32. Pl. IX, figs. 26, 27; and Dev. Sup., Pl. I, fig. 34, Pl. II, fig. 4.

This remarkable and variable species has been described at p. 39 of my 'Devonian Monograph.' Since then the Rev. Norman Glass has been able to develop its spiral appendages, of which I give a figure. I have already alluded to the difficulty of separating this species from *Sp. glabra*. Palæontologists relied on the shell-sculpture or exterior markings as a distinctive character. In general the shell of *Sp. glabra* is smooth, or nearly so. In all well-preserved examples of *Sp. curvata* the surface is marked by close equidistant concentric ridges. I have not yet detected on any specimen of *Sp. curvata* the radiating interrupted raised lines, giving rise to concentric rows of adpressed small flattened spines, similar to those that occur on the surface of well-preserved species of *Sp. lineata*, Martin.[1] It would be very difficult to procure specimens of either species showing the exterior sculpture in a perfect state of preservation. One or two weathered specimens of *Sp. lineata* from the Middle Devonian of Hope's Nose, near Torquay (Sup., Pl. II, fig. 5, 5*a*), have shown indications of short broken spiny projections, but I could not ascertain whether they were, as in the Carboniferous *Sp. lineata*, divided interiorly into two canals.

I must now refer the student to a very important paper by Prof. H. S. Williams, entitled, "The Life History of *Spirifer lævis*,"[2] in which the author endeavours to connect by their surface-markings various species of *Spirifera* that had previously been considered as specifically distinct. Early in 1881 Prof. Williams wrote and asked me to re-examine the shell-surface of *Sp. glabra*. I accordingly did so, and found two examples of Martin's species exhibiting concentric ridges and indistinct interrupted radiating lines; but, as a rule, the surface of *Sp. glabra* is quite smooth. Some time previously Mr. A. Champernowne sent for my inspection a beautifully perfect specimen of *Sp. glabra* from Little Island, Cork, covered with close equidistant rows of concentric ridges; and this specimen I found it impossible to distinguish from similar-shaped examples of *Sp. curvata*. I therefore feel inclined to concur in the opinion expressed by Prof. Williams, that *Sp.*

[1] 'Carboniferous Supplement,' p. 275.

[2] 'Annals of the New York Academy of Science,' vol. ii, 1881.

glabra and *Sp. curvata* may be one species or varieties of a single type; and I have but little doubt that several more so-termed distinct species will eventually have to be united to it in a similar manner.

Professor M'Coy, in 1844, proposed a genus (*Reticularia*[1]) to include *Sp. imbricata, Sp. lineata,* and similar shells "having a reticulated or striated surface combined with the general form and cardinal area of *Martinia*," and added that the genus is Carboniferous and Devonian. It will, therefore, be a matter for consideration whether his genus should be retained for those reticulated species with a perforated shell-structure, *Sp. lævis, Sp. imbricata, Sp. lineata,* &c. Should it be definitely determined that *Sp. glabra,* Martin, 1809, and *Sp. curvata,* Schloth., 1822, be united into one species, Martin's name would have to be retained.

19. Spirifera undifera, *F. Roemer.* Dav., Dev. Mon., Pl. VII, figs. 1—10; and Dev. Sup., Pl. I, fig. 33.

Since the publication of my description of this species at p. 36 of my 'Devonian Monograph' the Rev. Norman Glass has developed its spirals, and of these I give a figure.

20. Spirifera lævicosta, *Val.,* apud *Lamarck,* 1819. Dav., Dev. Mon., Pl. VIII, figs. 4, 5; and Dev. Sup., Pl. II, figs. 2, 3.

Terebratulites ostiolatus, *Schloth.* Nachträgen zur Petrefactenkunde, pl. xvii, fig. 3, 1822.

At p. 28 of my 'Devonian Monograph' I described this species, and gave reasons why I had adopted Valenciennes' name. In a paper by Prof. Gosselet, entitled "De l'usage du droit de priorité et de son application aux noms de quelques Spirifères,"[2] the distinguished French geologist finds great fault with my having made use of Valenciennes' name in preference to that given to the species by Schlotheim in 1822, and adds that Valenciennes' description—"T. testâ trigona gibbâ, lateribus sulcatâ; in medio valvæ majoris, sinu, et minoris costâ latâ, utribusque lævibus, transversa striatis: cardine recto, nate incurvâ. Habite Fossile de Bemberg, près de Cologne. . . Rapportée' par M.

[1] 'A Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland,' 1844.

[2] 'Annales de la Société Géologique du Nord,' vol. vii, 1880.

Valenciennes"—is too short, and would be applicable to several species of *Spirifera.* The original specimen so named is in the Museum of the Jardin des Plantes, and is known to French palæontologists.

Dr. Gosselet is quite right when he objects to the law of priority being enforced when a species has been too briefly described and is unaccompanied by a figure; but, if this reasoning is to hold good in the present case, how many specific names would have to be expunged that are now generally adopted under similar circumstances! Until some international law has been established in which no new species that is unaccompanied by a figure can hold claim to priority we cannot, I should think, deprive Valenciennes of the same privilege which has been allowed to so many others.

Good specimens of *Sp. lævicosta* have been found by Mr. Champernowne at the Railway Cutting at Ashridge, near Totnes. Distorted examples have also been collected by the same geologist in slate at Hanger's Quarry, near Sandwell, in Devonshire, as well as in slate at Englebourne Slate Quarry, near Harbertonford. Along with it were found distorted specimens of *Sp. primava* and *Sp. speciosa.*

In pl. 52, figs. 1 and 2, of the Atlas of his work, 'Die Brachiopoden,' 1871, Quenstedt gives two excellent figures of the spiral appendages of the species under description, one of which we have reproduced so as to complete its history.

Mr. Whidborne has met with distorted fragmentary examples of *Sp. lævicosta* in the Middle-Devonian limestone at Hope's Nose, near Torquay.

21. Spirifera cultrijugata? *Roemer.* Dav., Dev. Mon., Pl. VIII, figs. 1, 2, 3.

It was with much uncertainty that I referred some specimens found at Looe to Roemer's species. Perhaps *Sp. primæva,* Steintinger, 'Geol. Beschreibung der Eifel,' p. 72, pl. vi, fig. 1, is the species to which our English specimens should be referred. The material at my command was so incomplete that it prevented my arriving at any positive conclusion.

22. Spirifera Urii, *Fleming.* Dav., Dev. Mon., Pl. IV, figs. 25—28.

Since describing this species at p. 41 of my 'Devonian Monograph' I learn that several well-preserved specimens of the shell have been found by Mr. Whidborne in the Middle Devonian at Lummaton, near Torquay.

23. Spirifera Verneuilii, *Murch.* Dav., Dev. Mon., Pl. V, figs. 1—12; Pl. VI, figs. 1—5; and Dev. Sup., Pl. II, fig. 1.

At p. 23 of my 'Devonian Monograph' I described this species by the name *disjuncta, Sow.*, but soon after discovered that Murchison's name *Verneuilii* held priority over that given to the same species by Sowerby very shortly after.

In a letter Dr. Kayser inquires of me if the casts and impressions that occur in the Budleigh-Salterton pebbles are really referable to *Sp. Verneuilii,* or if they might not belong to a closely allied species to which M. de Verneuil had given the name of *Trigeri;* and he notes that in France and Germany the true *Sp. Verneuilii* occurs in the Upper Devonian only. Mr. Œhlert likewise informs me that Murchison's species has never, with certainty, been found in the Lower Devonian of the West of France, and that it seems special to the Upper Devonian of the Boulonnais.

Having compared a large number of impressions and casts of the Spirifer found at Budleigh-Salterton with a fine series of specimens of *Sp. Verneuilii* from Ferques I am unable to detect any specific differences whereby to distinguish them, and feel compelled to maintain the opinion I have already published upon the subject. In order to obtain Mr. Œhlert's opinion I sent him two gutta-percha impressions from specimens taken from the quartzites in question, and without informing him as to their derivation. He answered, "Les deux échantillons dont vous m'envoyez le moulage appartiennent au *Spirifera Verneuilii*, et le petit à la variété *Archiaci*."

As has been already remarked, *Spirifera Verneuilii* varies considerably in shape; its small narrow ribs are numerous and simple, with interspaces of about equal breadth. On each valve of a specimen measuring one inch and a half in breadth I have counted seventy-seven ribs, of which seventeen occupied the fold; and on another example three inches in breadth the number was one hundred. In 1850 M. de Verneuil gave the name *Trigeri* to a closely allied form, of which the valves were, according to his statement, covered with some thirty-six or thirty-seven ribs, of which four or five occupied the fold.[1] Thanks to the kindness of Messrs. Œhlert and Guillier I have been able to examine a number of specimens of the Lower-Devonian *Sp. Trigeri* from different localities, and I found that the number of ribs was very variable in different individuals, and that in some specimens they were considerably coarser than in others, and often exceeded the number put down by M. de Verneuil. I was also able to compare these specimens of *Sp. Trigeri* and *Sp. Davousti,* de Verneuil,[2] with a numerous series of

[1] 'Bull. Soc. Géol. de France,' 2nd ser., vol. vii, p. 781, 1850, also vol. xv, p. 408, 1854; 'Appendice à la faune Devonienne du Bosphore,' p. 41, pl. xxi, fig. 1, 1869.

[2] 'Bull. Soc. Géol. de France,' 2nd ser., vol. vii, p. 781, 1850; 'Appendice à la faune Devonienne du Bosphore,' p. 43, pl. xxi, fig. 2, 1869, and 'Explication de la Carte Géologique de la France,' par Bayle, vol. iv, pl. xv, figs. 1 and 2, 1873.

Budleigh-Salterton specimens of *Sp. Verneuilii;* and I found no reason for attributing the Lower-Devonian specimens that occur in the quartzite boulders of Budleigh-Salterton to *Sp. Trigeri,* for they presented all the forms we find *Sp. Verneuilii* to assume at Ferques in the Boulonnais.

Mr. G. F. Whidborne has also found in the Middle Devonian at Lummaton a ventral valve of a Spirifer (Sup., Pl. II, fig. 1) which I am unable to separate from *Sp. Verneuilii;* and I expect it will have to be admitted that *Sp. Verneuilii* is not absolutely restricted to the *Upper Devonian,* but occurs also in the middle and lower portions of that system.

In June, 1877, the presence of *Sp. Verneuilii* in the Upper Devonian rocks under Tottenham-Court Road, London, at Messrs. Meux and Co.'s Brewery, and at a depth of 1140 feet, was announced by Mr. R. Etheridge. The Devonian rocks were also reached in another boring carried down by the New-River Company at Turnford or Wormley, six miles south of Ware, at a depth of 980 feet (see a paper by Mr. R. Etheridge in the 'Popular Science Review' for July, 1879). Having myself examined the specimens attributed to *Sp. Verneuilii,* I am able to corroborate Mr. Etheridge's identification. Some of the cores may be seen in the Museum of Practical Geology, London, and others in the Brighton Museum.

Genus—Cyrtia, *Dalman,* 1828.

24. Cyrtia ? Whidbornei, *Dav.* Dav. Dev. Sup., Pl. II, figs. 6, 7.

Shell transversely semicircular, broader than long; hinge-line straight, slightly less than the greatest width of the shell; cardinal angles rounded. Dorsal valve moderately convex, divided along the middle by a broad, flattened, mesial fold, slightly indented along the middle. On each of the lateral portions of the valve there exist two or three wide rounded ribs, of small elevation, sometimes bifurcating. Ventral valve conical, divided by a deepish mesial sinus, margined by a somewhat prominent rounded elevation. Area large, triangular, almost flat, and bent backwards at right or obtuse angles to the plane of the dorsal valve, divided along the middle by a narrow fissure arched over by a convex pseudo-deltidium. Surface of the valves covered with very fine radiating striæ. Interior not completely known. A large specimen measured—length 7, width 12, depth 7 lines.

Obs.—This species was first pointed out to me by Mr. Whidborne as intermediate in shape between *Sp. nuda* and *Sp. simplex,* and with markings different from either. It seems, however, referable to the genus or sub-genus *Cyrtia,* and most nearly resembles the Silurian *Cyrtia exporrecta* of Wahlemberg. It differs from *Sp. simplex* by the presence of a well-defined mesial fold. Its narrow-arched deltidium is partly seen in one specimen. The largest and best examples are preserved in the Torquay Natural History Museum, and were kindly lent to me, with many more species, by my old and valued friend Mr. W. Pengelly. Several specimens were also found by Mr. Whidborne, after whom it gives me much pleasure in naming the species. They are all from the Middle Devonian of Lummaton, near Torquay.

Genus—Cyrtina, *Davidson,* 1858.

25. Cyrtina heteroclita, *Def.*, sp. Dav., Dev. Mon., Pl. IX, figs. 1—10; and Dev. Sup., Pl. I, figs. 35, 36, 37.

When describing this important species in my 'Devonian Monograph' I was not acquainted with its spirals or their attachments. Prof. King, in vol. iv, pp. 254—256, of the 'Geological Magazine,' 1867, describes and figures the perforated shell-structure of *Cyrtina heteroclita,* and adds that one of his specimens exhibited the spiral appendages very distinctly, but he gives no figure of them. In 1853 Dr. Carpenter stated that he had determined the existence of perforations in the shell under description. In 1871, in tab. 52 of his 'Die Brachiopoden,' Prof. Quenstedt gave a figure of *Cyrtina heteroclita,* in which one of the spirals is drawn. Recently the Rev. Norman Glass has experimented on a large number of specimens procured by Mr. G. F. Whidborne from the Middle Devonian at Lummaton, near Torquay, and has been able to develop the spirals and their connections. After being attached to the hinge-plate, the two primary lamellæ extend to within a short distance of the front before forming the first convolution. About their middle they are connected by a V-shaped lamella. The spiral coils also vary a good deal in their direction, but in general each spiral cone is directed upwards, and extends for some distance into the rostral cavity of the ventral valve, as may be seen in Sup., Pl. I, figs. 37, 37*a*. Each spiral seems composed of from ten to twelve convolutions.

Mr. Glass informs me that the specimens of *Cyrtina heteroclita* from Lummaton are composed of a light-coloured limestone, which seems to be of a somewhat sparry nature, and which when worn thin at any part becomes semi-transparent. Many of the Terebratuloid specimens from the same locality are composed of a similar material, which is easily worked with the knife. The spirals of *Cyrtina heteroclita* were developed by first splitting the specimen in half from the umbo to the anterior margin, and then by working out the spiral in each fragment separately, and as a transparency. In another preparation the primary coils of the spirals and the process connecting them were also shown as a transparency.

In our description of the species at p. 49 of the 'Devonian Monograph' we have alluded to the differences in shape it assumes, as well as its variability in the number of ribs that ornament its surface. In some examples there are but six large ribs in each valve, the dorsal valve being as long as wide; but in other specimens this same valve becomes more and more transverse, and at the same time the ribs become smaller and more numerous, passing thus into the variety *multiplicata*, upon which as many as twenty-two ribs may be counted on each valve (Dev. Sup., Pl. II, fig. 8, 8 *a, b, c.*).

Besides the localities already named in the description of the species, I may mention that Mr. Whidborne has found the shell in blackish shales at Hope's Nose, near Torquay, where the inclination of the cleavage-planes has much distorted the fossils. Hope's Nose is a very rich fossiliferous locality for Brachiopoda, but good and perfect specimens with their natural shape are very uncommon there.

In the Middle Devonian of the Oarstone, near Torquay, Mr. Whidborne found several specimens of a small form of *Cyrtina* (Dev. Sup., Pl. I, fig. 38), which he believes to be distinct from *C. heteroclita*. It is smaller and more regular in shape, with fewer and more rounded ribs, but it may be only a smaller variety of Defrance's species.

Genus—Glassia, *Dav.*, 1881.

26. Glassia Whidbornei, *Dav.* Dev. Sup., Pl. I, figs. 10 to 14.

Shell elongated, oval, as long or longer than wide, nearly straight in front; valves moderately convex, ventral valve the deepest; beak incurved, with a small circular foramen; surface smooth.

Length 7, breadth 6, depth 1 line.

In the interior of the dorsal valve the principal lamellæ forming the first coils of the spirals are, at a short distance from the attachment to the hinge-plate, connected together by a ribbon-shaped lamella or loop. This loop, commencing on each side from the principal lamellæ, converges downwards in the shape of the letter **V**. The principal coils of the spirals directly face the lateral margins. The ends of the spirals meet each other in the centre of the shell. Each spiral consists of four coils.

Obs.—The discovery of this genus in the Devonian is entirely due to the Rev. Norman Glass, who, while experimenting upon some small specimens sent to him by Mr. G. F. Whidborne, was struck by the spirals presenting the same characters which he had already discovered in the Silurian *Glassia obovata* and *elongata;* and, having communicated with me on the subject, I sent him a larger specimen of the same shell, and this I have drawn (Dev. Sup., Pl. I, fig. 10).

Glassia Whidbornei is the largest of the three species of the genus with which we are at present acquainted, and its shape and the arrangement of its spirals resemble more those of *Glassia elongata* than *G. obovata,* which are both from the Upper-Silurian rocks of Shropshire. We are now acquainted with the genus, therefore, both from the Upper Silurian and Middle Devonian.

Glassia Whidbornei occurs in the Middle-Devonian limestone at Lummaton, near Torquay; and I have much pleasure in naming it after Mr. G. F. Whidborne, who has zealously assisted Mr. Glass and myself by placing his entire Devonian collection at our disposal, and in liberally allowing Mr. Glass to operate upon any of his specimens.

Genus—Atrypa, *Dalman,* 1828.

27. Atrypa reticularis, *Linné.* Dav., Dev. Mon., Pl. X, figs. 3, 4; and Dev. Sup., Pl. I, fig. 16.

At page 53 of my 'Devonian Monograph' I described the exterior character of this species, and gave a figure of its vertical spiral coils. At that period the connections of the spirals had not been worked out, nor even discovered, hence my figure in that respect was incomplete and defective. Since then all the characteristics pertaining to the genus and species have been fully elaborated, and will be found described in my Silurian Supplement. Some few remarkably well-weathered specimens, and sections of the shell, with the edges of the spiral coils sharply defined and projecting, have been picked up at Hope's Nose by Mr. Whidborne, and of one of these a figure has been added to this Supplement.

28. Atrypa desquamata, *Sow.,* sp. Dav., Dev. Mon., Pl. X, figs. 9—13; Pl. XI, figs. 1—9; and Dev. Sup., Pl. I, figs. 15, 15*a.*

Since I described this fine large species at page 58 of my 'Devonian Monograph' Mr. Glass has been able to develop in the most complete manner the attachments of the principal lamellæ to the hinge-plate, the spirals, and their connection or loop. In my Monograph I described *A. desquamata* as a distinct species with some uncertainty, but both Mr. Whidborne and myself have observed such a difference in the young specimens of the two forms—the broad hinge-line, median depression, and fine striation in *A. desqua-*

mata, that I continue to maintain Linné's and Sowerby's species as distinct. Dr. Kayser maintains *A. desquamata,* Sow., *A. flabellata,* Goldf., *A. latilinguis,* Schnur, and *A. aspera,* Schl., as named varieties of *reticularis.*

29. ATRYPA ASPERA, *Schloth.,* sp. Dav., Dev. Mon., Pl. X, fig. 5.

A large Woolborough specimen of this species or variety, measuring eleven lines in length by the same in breadth, and ornamented with some fifteen strong rounded ribs, crossed by concentric foliaceous expansions about a line apart, was presented by Dr. Battersby to the Torquay Natural History Museum. From its ribs rise strong tubular spines two lines in length; and in this respect and in general aspect it resembles the *Atrypa longispina* of Bouchard, a form that occurs in the Upper Devonian at Ferques, near Boulogne, and which attains one inch and three quarters in length by the same in breadth, and has spines projecting from its ribs half an inch in length.

The resemblance between the Woolborough specimen above described and others of *A. longispina* of equal dimensions is striking; and the differences between these, *A. aspera* and *A. reticularis,* are apparent. I have not myself seen any tubular spines, similar to those observable in *A. aspera* and *A. longispina,* projecting from the ribs of *A. reticularis* proper, a form that occurs also at Ferques in a perfect state of preservation.

30. ATRYPA? TRIGONELLA, *Dav.* Dev. Sup., Pl. I, figs. 19, 19*a*, *b*.

Shell subtrigonal, broadest anteriorly, with rounded angles, tapering posteriorly; ventral valve very gently convex; dorsal valve longitudinally grooved or depressed; the ventral rather more convex than the dorsal valve, gently keeled; beak small, slightly incurved, and truncated by a circular foramen, separated from the hinge-margin by a small deltidium in two pieces. Surface of valves irregularly marked by a small number of comparatively largish, rounded, bifurcating ribs.

Length 5, width 4, depth 2 lines.

Obs.—Nothing being known of the interior characters of this little species, it is provisionally placed with *Atrypa,* from which it can be removed, if necessary, as soon as its interior arrangements have been determined. In exterior shape and sculpture this small species differs from those known to me. It was found by Mr. G. F. Whidborne in the Middle Devonian at Lummaton, near Torquay, where the shell seems to be exceedingly rare.

31. ATRYPA LATILINGUIS, *Schnur*, sp. Dav., Dev. Sup., Pl. II, figs. 9, 9*a*.

TEREBRATULA LATILINGUIS, *Schnur*. Programm der vereinigten höhern Bürger und Gewerbsch., 1851; and Beschreibung d. Eifel. Brachiopoden, p. 183, pl. xxv, figs. 1 *a—f*, 1853.

ATRYPA RETICULARIS, *Kayser*. Die Brach. des Mittel- und Ober-Devon. der Eifel (Deutschen Geol. Gesel.), p. 543, 1871.

Shell almost circular, about as broad as long; valves very convex, ventral valve most so, and slightly depressed near the front; beak much incurved; dorsal valve with a slight mesial elevation or feebly defined fold commencing near the front. Front line presenting a broad convex curve. Surface of valves marked with numerous fine radiating riblets, nine or ten in the breadth of a quarter of an inch.

Length $1\frac{1}{2}$ inch, breadth about the same, depth 1 inch and 2 lines.

Obs.—Five specimens of this species were obtained by Mr. W. Vicary from a stone or piece of Devonian limestone built into the wall of a house; and Mr. Vicary informs me that similar specimens were subsequently found *in sitû* in the Middle Devonian at Chercombe Bridge Quarry, near Newton Abbot. Mr. Vicary's specimens were identified by Mr. G. F. Whidborne with the *T. latilinguis* of Schnur, and quite agree with the figures given by the German palæontologist in pl. xxv of his work, as well as with some Eifel examples obtained from the Eifel district by Mr. Whidborne. Dr. Kayser, at p. 543 of his excellent work on the 'Eifelian Brachiopoda,' places Schnur's species among the synonyms of *Atrypa reticularis*, Linné, but I cannot concur in this identification, for the English specimens and Schnur's figures seem to me to differ very much from *Atrypa reticularis* in their shape and character. The umbo of the dorsal valve is much more prominent, the ventral valve is so much more convex, and the bifurcating rays hardly crossed by concentric markings are so much more regular, and seem to give a different facies to the shell. Many years ago these same specimens were shown by Mr. Vicary to Mr. Salter, who wrote a label for them inscribed "*Retzia* new." Mr. Glass has developed the spirals in two German specimens, and found them to be arranged as in *Atrypa*.

Genus—Pentamerus, *Sow.*, 1813.

32. Pentamerus biplicatus, *Schnur.* Dav., Dev. Mon., Pl. XIV, figs. 31, 32; and Dev. Sup., Pl. II, fig. 22.

At page 73 of my 'Devonian Monograph' I figured and described a small specimen of Schnur's species. Since then Mr. G. F. Whidborne has obtained from the Middle-Devonian limestone of Lummaton, near Torquay, several much larger and better examples, which agree in every respect with those described by the German author. The largest specimen, of which I give a figure, measures one inch in length and breadth, by three quarters of an inch in depth. Other examples have been also kindly lent to me by Mr. Pengelly out of the Museum of the Torquay Society of Natural History. *P. biplicatus* occurs in the same locality with *P. brevirostris*, the only other species of the genus that has been hitherto discovered in our British Devonian rocks. This last-named species is much less common in the dark shale at Hope's Nose, near Torquay.

At page 537 of his valuable memoir, 'Die Brach. der Mittel- und Ober-Devon. der Eifel,' 1871, Dr. Kayser considers Schnur's *Pent. biplicatus* to be a synonym of *Pent. galeatus*, to which he would also refer the figures of the *P. biplicatus* which are represented and described at p. 73, and Pl. XIV, figs. 31 and 32, of my 'Devonian Monograph.' I regret to feel obliged to differ from Dr. Kayser in this respect, and consider *Pent. biplicatus*, Schnur, and *Pent. brevirostris*, Phillips, to be specifically distinct, and neither to be referable to Dalman's species. The interiors of the dorsal valve in *P. galeatus* and *P. brevirostris* do not agree.

Genus—Rhynchonella, *Fischer*, 1809.

33. Rhynchonella parallelepida, *Bronn.* Dav., Dev. Mon., p. 66, Pl. XIV, figs. 4—6. (Not *Ter. primipilaris*, Von Buch, according to Dr. Kayser).

Terebratula parallelepida (non Wilsoni var.), *Bronn.* Lethæa, p. 71, 1837.
Atrypa primipilaris, *Sow.* (*von Buch*). Trans. Geol. Soc., 2nd ser., vol. v, p. 57, figs. 5, 6, 1840.
Tereb. — *d'Archiac et De Verneuil.* Trans. Geol. Soc., 2nd ser., vol. vi, p. 392, 1842.
— angulosa, *Schnur.* Brach. Eifel, p. 185, t. 25, fig. 5, 1853.

TEREB. SUBCORDIFORMIS, *Schnur*. Eifel. Brach., p. 186, t. 25, fig. 6, 1853.
RHYN. PARALLELEPIDA, *Sandberger*. Rhein. Schicht. Nassau, p. 339, t. 33, fig. 12, 1856.
— PRIMIPILARIS, *Dav*. Br. Dev. Mon., p. 66, t. xiv, figs. 4, 5, 6, 1865.

At page 507 of his 'Die Brachiopoden des Mittel- und Ober-Devon. der Eifel,' 1871, Dr. Kayser gives the above synonyms of the *Ter. parallelepida* of Bronn, and assures me by letter that the species described and figured by myself and others as the *R. primipilaris*, Von Buch,[1] is in reality Bronn's *R.* (*T.*) *parallelepida*; also that in Von Buch's species the ribs are dichotomous, but simple in *parallelepida*. If therefore, Dr. Kayser is quite correct in his assertion, it will be necessary to erase the *observations* at p. 67 of my 'Dev. Mon.'

Rh. parallelepida is a common shell in Middle Devonian at Lummaton, near Torquay, and occurs also at Hope's Nose. In order to feel certain with respect to this identification I forwarded one of our English specimens to Dr. Kayser; and in his answer he says, "It is the true *Rh. parallelepida* of Bronn, and exactly similar to the specimens of the shell that are found at Velmar, in Nassovia, as well as to the variety which Schnur called *angulosa*, with the exception that the dimensions of this last are greater."

34. RHYNCHONELLA PHILLIPSII, *Dav*. Dev. Sup., Pl. II, fig. 14.

Shell subpentagonal, rather wider than long; dorsal valve moderately convex, divided longitudinally into three almost equal portions, the central one consisting of a moderately elevated, flattened, mesial fold, presenting in profile from the middle of the shell a straight line to the front; lateral slopes of the fold wide; lateral portions of valve regularly curved; ventral valve not quite as convex or deep as the dorsal one; sinus deep, wide, and flat; beak much incurved. Surface of the valves ornamented with from twelve to fifteen simple angular ribs, which commence at a little distance from the beak and umbo; five strong ribs occupy the fold, four the sinus. The ribs on the lateral portions of the shell are not as strong as those on the fold.

Length 11, width 12, depth 6 lines.

Obs.—This species has puzzled me much. I have seen three examples of the shell all agreeing in shape and character. One was found by Mr. Whidborne, another by Mr. Lee, and a third belongs to the Torquay Natural History Society, all from the Middle Devonian of Lummaton, near Torquay. It is certainly not *Rh. Daleidensis*, Schnur, or *Rh. inaurita*, Sandberger, with which I have compared it. Dr. Kayser, from a drawing I sent him, would not venture upon any decided opinion as to the species to which it might

[1] 'Über Terebrateln. Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin,' p. 88, tab. 2, fig. 6, 1834.

be referable, but suggested the possibility of its being a depressed form or variety of *Rh. pugnus* of Martin. After, however, comparing it with a large number of specimens of the Carboniferous species, I could not match the Devonian specimens with any in my collection. Viewed in profile the dorsal valve of *R. pugnus* presents a regular convex curve, while in the three Devonian specimens I have been able to examine the dorsal valve in profile presents, at a short distance from the umbo, an almost straight line. I have, therefore, preferred to give the Lummaton shell a distinct denomination, and have named it after the distinguished geologist who did so much good work amongst our English Devonian fossils. Specimens of *Rhynchonella* agreeing in every particular with the Carboniferous *Rh. pugnus* of Martin occur in the same quarry along with *Rh. Phillipsii*, and can be easily distinguished. Mr. Whidborne informs me that he has since seen several specimens in Mr. Champernowne's collection, which he had found in one day.

35. Rhynchonella protracta, *Sow.*, sp. Dav., Dev. Mon., Pl. XIV, figs. 27—29; and Dev. Sup., Pl. II, fig. 17.

= T. proboscidialis, *Phillips.*

Since publishing my description of this species Mr. Champernowne has found a larger and better specimen in the Middle-Devonian Limestone at Lummaton, near Torquay. I did not previously know of its existence in that locality. Kayser with some uncertainty places it in the genus *Camarophoria,* and adds that *Ter. subtetragona* of Schnur and *T. ascendens* of Steininger are synonyms. Not being acquainted with its interior arrangements, I can pronounce no opinion upon the subject.

36. Rhynchonella Ogwelliensis, *Dav.* Dev. Mon., Pl. XIV, figs. 23—26; and Dev. Sup., Pl. II, fig. 16.

Among a number of specimens collected by Mr. Whidborne from the Middle Devonian Limestone of Lummaton I found a largish and well-characterised specimen of this species. It measures six lines in length by six and a half in width and three and a half in depth. It seems to be a distinct and well-marked species.

37. RHYNCHONELLA SUBRENIFORMIS, *Schnur*, sp.

TEREBRATULA SUBRENIFORMIS, *Schnur*. Programm der höh. Beirgersch., 1851.
— — — Beschreibung Eifel vorkommenden Brachiopoden (Pal. von W. Dunker und H. Von Meÿer), p. 174, pl. xxii, fig. 5, 1852.
RHYNCHONELLA — *Sandberger*. Die Brach. Rheinischen Schichtensystems in Nassau, p. 46, pl. xxxiii, fig. 11, 1855.
CAMAROPHORIA — *Kayser*. Die Brach. des Mittel- und Ober-Devon. der Eifel; Zeitschr. Deutschen Geol. Gesel. für 1871 p. 534.

Shell subpentagonal or transversely oval, wider than long; valves almost equally and moderately convex; dorsal valve with a slightly produced, flattened, broad, mesial fold, commencing to rise at about a third of the length of the valve; ventral valve with a broad, moderately deep, longitudinal sinus, commencing at the beak, and widening as it approaches the front; beak very small, much incurved; surface of valves covered with from ten to sixteen small, rounded, radiating riblets, commencing at a little distance from the beak and umbo. Of these, four or five occupy the fold, three or four the sinus. Some specimens are almost smooth throughout, or at the beak and umbo. In other specimens there is present a slight longitudinal groove along the middle of the fold. Dimensions very variable.

Length 5, width 7, depth 4 lines.

Obs.—This well-marked species has been well described and figured by Schnur and Sandberger. Dr. Kayser places it in the genus *Camarophoria,* but the internal casts I have seen from Büdesheim, near Gerolstein, in the Eifel, show no indication of *Camarophoria* characters. It is seemingly a very variable shell, for some specimens appear to be almost smooth, while others are distinctly ribbed. A specimen from Büdesheim measured—length $6\frac{1}{2}$, width $8\frac{1}{2}$, depth $4\frac{1}{2}$ lines.

One poor specimen of this species, not perfect enough for figuring, was found by Mr. Whidborne in the Upper Devonian at Saltern Cove, a locality the importance of which was first recognised by Mr. J. E. Lee, and which was described by him in the 'Geological Magazine' for 1877.[1]

The beds here consist of dull brick-red argillaceous sandstone, much jointed, and with apparently a slight westward dip. They occupy the second small headland south of Goodrington Sands, in the centre of Torbay, and are faulted down against some Lower Devonian red shales containing *Pleurodictyum problematicum*.

[1] See also Lee, 'Note-book of an Amateur Geologist,' p. 85, pl. cciii, 1881.

The general facies of the fossils found in them corresponds almost exactly with that of Büdesheim in the Eifel. They are small, and have not suffered much injury before fossilisation. In neither place is the number of species at all great, and yet there are at least seven species (and probably more) common to both localities.

The most characteristic shell in both places is *Cardiola retrostriata* (von Buch), and this also occurs in an equivalent position in the Devonian rocks near Convin, in Belgium, in beds called "Schistes de Matagne" by Professors Gosselet and Malaise.

Mr. Lee has collected very large numbers of fossils at Saltern, but he has discovered only one single specimen of a Brachiopod there, and although this fossil is unfortunately at present mislaid, it is probable that it belongs to the species under notice, since *Rh. subreniformis* is the only Brachiopod that is at all common at Büdesheim.

I have also compared the Saltern Cove specimen with examples of *Rh. subreniformis* sent to me by Dr. Sandberger, and which he obtained from the Upper Devonian of the Cobrières (Hérault) France.

38. RHYNCHONELLA ANISODONTA, *Phillips*. Dav., Dev. Mon., Pl. XII, figs. 12—14: not Pl. XIII, figs. 8—10, which belong to *Rh. pugnus*.

TEREBRATULA ANISODONTA, *Phillips*. Pal. Foss. of Devon., p. 87, pl. xxxv, fig. 156, 1841.

At page 63 of my 'Devonian Monograph' I considered Phillips's species as a variety of *Rh. pugnus* of Martin. Having subsequently been able to re-examine and compare a number of specimens of *R. anisodonta*, I feel disposed to agree with Mr. Whidborne that they present a defined, fixed, and not very variable form, sufficiently different from *Rh. pugnus* to lead us to believe the two to be specifically distinct.

Specimens agreeing in every respect with Martin's *R. pugnus* have, however, been found in the Middle-Devonian Limestone at Woolborough Quarry, near Newton Abbot. It will, therefore, be desirable to retain the two forms as specifically distinct. Several examples of this shell have been found by Mr. J. E. Lee in a Devonian limestone at Dunscombe, near Chudleigh, on one of Lord Clifford's farms.

39. RHYNCHONELLA CUBOIDES, *Sow*. Dav., Dev. Mon., Pl. XIII, figs. 16—21; and Dev. Sup., Pl. II, figs. 18, 19.

Some very good examples of a variety of this species with large ribs have been recently found in the Middle Devonian at Lummaton, near Torquay. Of one of these I give a figure. Some well-preserved internal casts of both valves have also been found by Mr. Champernowne, east of Mudstone Bay, near North End. The beds there dip north, and are nearly vertical at the point where this fossil occurs.

40. Rhynchonella acuminata, var. platiloba, *Sow.* Dav., Dev. Sup., Pl. II, fig. 20.

Some specimens of this variety of *Rhynchonella acuminata*, undistinguishable from similar Carboniferous specimens, have been found by Mr. Whidborne at Lummaton, near Torquay.

41. Rhynchonella triloba, *Phillips.* Dav., Dev. Mon., Pl. XII, figs. 1—7; and Dev. Sup., Pl. II, fig. 21.

Some very much flattened specimens, which I refer with some uncertainty to *Rh. triloba*, have been found by Mr. Whidborne in the Middle Devonian at Lummaton.

42. Rhynchonella Leei, *Dav.* Dev. Sup., Pl. II, figs. 15, 15*a*.

Shell transversely oval, broadly rounded anteriorly, obtusely acuminated posteriorly; dorsal valve very convex, without fold or sinus, deepest about the middle; ventral rather less convex than the opposite valve; no sinus; beak small, incurved. Surface of valves marked by radiating ribs, which extend to only about two thirds of the length of the valve; the anterior third ornamented with about eight short rounded ribs, with concave interspaces of about equal breadth. Interior not known.

Length $1\frac{1}{2}$ inches, breadth $1\frac{3}{4}$ inches, depth 1 inch.

Obs.—This is a very remarkable shell, and, as far as I am aware, specifically distinct from its Devonian congeners. One specimen, somewhat decorticated, was found by Mr. G. F. Whidborne in the Middle Devonian at Lummaton, near Torquay.

I have much pleasure in naming this species after Mr. John Edward Lee, F.G.S., to whom I am indebted for much kind help. Mr. Lee indeed has been one of our best workers among the Devonian rocks in the neighbourhood of Torquay, and has collected steadily for more than forty years both in England and upon the Continent; and this has been most important, as it has enabled him to bring out the sequences of strata in a way that would have been otherwise nearly impossible in so disturbed a locality as that of Torquay.

Genus—Camarophoria, *King*, 1846.

43. Camarophoria rhomboidea, *Phillips*, sp. Dav., Dev. Mon., p. 70, Pl. XIV, figs. 19—22.

At page 529 of his 'Die Brach. des Mittel- und Ober-Devon. der Eifel,' 1871, Dr. Kayser considers *Ter. bijugata* and *T. brachyptycta*, Schnur, *Ter. subdentata*, Geinitz, and *Rhyn. ? Lummatoniensis*, Dav., to be synonyms of Phillips's *T. rhomboidea*. I am not prepared to admit the specific identity of *R. Lummatoniensis* with Phillips's species, but it may be possible that I am mistaken.

Genus—Skenidium, *Hall* (Gr. Σκηνίδιον, *tentoriolum*, a little tent).

Hall, 'Thirteenth Annual Report of the Regents, on the State Cabinet &c.,' p. 70, 1860.

Mystrophora, *Kayser*. Die Brach. des Mittel- und Ober-Devon. der Eifel, p. 612, 1871.

"Shell subpyramidal, somewhat semicircular, with or without median sinus and elevation. Area large, triangular, divided by a narrow deltoidal foramen, which is sometimes closed at the summit by a concave deltidium; valves articulating by teeth and sockets, which are often obscure and obsolete; dorsal valve flat or varying from depressed convex to concave; beak entire, or indented by the foramen. Cardinal line straight, and usually equalling the width of the shell. Cardinal plates broad and well developed, marked by the imprints of the peduncular muscles, and produced in the middle in a pointed process. *The cardinal process extends as a median septum through the length of the shell, and may be simple or divided at its extremity.* Ventral valve elevated, subpyramidal; beak straight or slightly arched. Muscular impressions undetermined. Exterior surface covered with radiating striæ. Type *Skenidium insigne*, Hall."

44. Skenidium areola, *Quenstedt*, sp.? Dav., Dev. Sup., Pl. III, figs. 11 to 14.

Orthis areola, *Quenstedt*. Brachiopod, p. 589, and Atlas, tab. 57, fig. 27, 1871.
Mystrophora areola, *E. Kayser*. Die Brachiopoden des Mittel- und Ober-Devon. der Eifel, Zeitschr. Deutschen Geol. Gesellschaft für 1871, p. 612, tab. xiii, fig. 5, 1871.

Shell small, subpentagonal, wider than long, anteriorly rounded and indented in front; hinge-line a little shorter than the breadth of the shell; dorsal valve very gently convex, with a deepish median longitudinal depression, commencing at the umbo, and widening and deepening as it nears the front; hinge-area narrow; ventral much more convex and deeper than the dorsal valve, somewhat longitudinally keeled; beak very slightly incurved; area large, triangular, bent backwards at an obtuse angle to the plane of the dorsal valve, and divided by a fissure partially arched over by a pseudo-deltidium. Surface of valves covered with small radiating riblets, numerous, with one or two shorter ones here and there interpolated between the larger pairs. In the interior of the dorsal valve, under the cardinal process, extends a large triangular median plate or septum, extending throughout the length of the shell, and dividing it into two chambers. Hinge-plate large, saucer-shaped, and extending to nearly half the length of the septum, to the upper portion of which it is attached (see Sup., Pl. III, fig. 13).

Length 3, width $3\frac{1}{2}$, depth nearly 2 lines.

A specimen from the Eifel measured—length 5, width 6, depth 3 lines.

Obs.—When Mr. Whidborne sent me the specimen under description, which he had found in the Middle-Devonian Limestone at Lummaton, near Torquay, I was at once struck with its resemblance to the *Mystrophora areola* of Kayser. In order to be certain, I forwarded drawings of our English specimen to Dr. Kayser, and in answer he says, "I have no doubt that it is my *M. areola*. In the Eifel it occurs in the Crinoid bed, which constitutes the base of the upper part of the Middle Devonian, *i.e.* the Stringocephalus Limestone." He likewise kindly sent me typical examples of the Eifel species. They were similar to those found by Mr. Whidborne at Lummaton, only larger or more developed individuals. From Dr. Kayser's figure I had been led to suppose that the ribs were simple and of equal width, but the specimen sent to me by Dr. Kayser showed that the ribbing is exactly similar to that observed on our English specimens, one or two smaller ribs being interpolated between the larger ones. I am likewise indebted to Prof. Dewalque for specimens from Nimes, in Belgium. *Skenidium areola* occurs also in a similar bed and position at Lummaton. It bears a resemblance to the *Skenidium* (*Orthis*) *Lewisii* of our Wenlock limestone and shales; and this resemblance did not escape Dr. Kayser's observing eye, for he alludes to the fact at p. 614 of his work on the 'Brachiopoda of the Eifel,' and describes and figures my Silurian species with the name *Mystrophora Lewisii*. Prof. Hall, however, had previously, in 1860, proposed the genus *Skenidium* for *O. Lewisii*, and other similarly characterised species. The median septum in Kayser's figure of the interior of *Sk. Lewisii* seems to be smaller than in that of *Sk. areola*. In *Orthis* we do not find a similar septum. At Ferques, near Boulogne-sur-Mer, we find another small species of *Skenidium*, which has been described and figured by M. E. Rigaux, with the name of *Orthis Deshayesei* (Bouchard), in the first volume of the 'Bulletin de la Société Académique de Boulogne,' 1872.

Genus—Orthis, *Dalman*, 1828.

45. Orthis Eifliensis, *De Verneuil*. Dav., Dev. Sup., Pl. III, fig. 16, 16*a*—*e*.

Orthis Eifliensis, *De Verneuil*. Note Géologique sur les Terrains de Sabero (Spain), Bull. Soc. Géol. de France, 2nd ser., vol. vii, 1850.

— — *Schnur*. Beschreibung sämmtlicher im Uebergangsgebirge der Eifel-vorkommenden Brachiopoden; Palæontographica von W. Dunker und H. von Meÿer, p. 213, pl. xxxvii, fig. 6, 1853.

— sacculus, *F. Sandberger*. Die Brach. der Rheinischen Sch. in Nassau, pl. xxxiv, fig. 3, 1855.

— Eifliensis, *E. Rigaux*. List of the Fossils found in the Lower Boulonnais, Geol. Mag., 2 ser., vol. v, p. 437, 1878.

Shell elliptical, as wide or a little wider than long, broadly rounded anteriorly, and slightly indented in front. Hinge-line straight, less than the width of shell. Dorsal valve very gently convex, and divided longitudinally by a median depression; hinge-area narrow. Ventral rather deeper than the dorsal valve, and longitudinally divided by a mesial fold; beak incurved; area triangular, half a line in breadth, and divided by a triangular open fissure. Surface of both valves finely radiately striated with one, two, or three shorter and smaller ribs interpolated between the larger ones. Interior not known.

Length 5, width 6, depth 2 lines.

Obs.—The proportions above given are taken from the largest English specimen that has come under my notice. Schnur figures an Eifel specimen as measuring 7 lines in length by the same in breadth. I picked up a finely-preserved specimen in the "Beaulieu shales" or Upper Devonian at Ferques, measuring 7 lines in length by 8 in breath and 3½ in depth.

Our English specimens are from the Middle Devonian of Lummaton, near Torquay, and exactly agree with those from the Eifel and from France. One specimen was found by Mr. Whidborne at Lummaton, and another may be seen in the Museum of the Torquay Natural History Society. Dr. F. Sandberger has also sent me specimens of this *Orthis* from the Middle Devonian of Skaly, Poland.

46. ORTHIS TETRAGONA, *De Vern.* Dav., Dev. Sup., Pl. III, figs. 17, 17*a*.

ORTHIS TETRAGONA, *De Verneuil.* Geol. of Russia, vol. ii, p. 179, 1845.
— — *C. F. Roemer.* Rheinisch. Ueberg., t. 5, fig. 6, 1844.
— — *Schnur.* Beschreibung Eifel. Brachiopoden; Palæontographica, von W. Dunker and H. V. Meÿer, p. 214, pl. xxxvii, fig. 8, 1856.

Shell wider than long, semi-elliptical, broadly rounded anteriorly, gently indented in front. Hinge-line straight, slightly less than the breadth of shell. Dorsal valve very gently convex, with a median flattened depression, commencing at the umbo, and widening as it gets to the front; hinge-area narrow. Dorsal rather more convex than the ventral valve. Area narrow, divided by an open fissure. Surface of valves covered with very fine, radiating, raised striæ, with shorter ones interpolated between the larger pairs.

Length 11, breadth 12 lines.

Obs.—Mr. A. Champernowne found five specimens of this species in a railway-cutting one mile and three quarters west of Totnes, at Ashridge, in the Parish of Harberton, and identified them with the *O. tetragona* of De Verneuil. Although larger, Mr. Champernowne's specimens agree with the figures published by Schnur. It may be distinguished from *O. Eifliensis* by its more numerous and finer striæ.

47. ORTHIS? PENGELLIANA, n. sp. Dav., Dev. Sup., Pl. III, fig. 19.

Shell transversely oval, wider than long; valves very gently convex, deepest at the umbo, posteriorly much flattened, the ventral one somewhat the deepest; no fold, elevation, nor depression in either valve; hinge-line straight, a little shorter than the breadth of the shell; beak slightly incurved; area narrow, divided by an open triangular fissure. Surface covered with numerous small, bifurcating, radiating, raised striæ, crossed by equidistant concentric lines. Interior not known.

Length 12, width 17, depth 2 lines.

Obs.—Mr. Champernowne found this *Orthis* in great abundance in calcareous shales at Meadfoot, close under the Torquay Limestone, but generally crushed and out of shape. We have named it after the distinguished Devonshire geologist, to whom we are deeply indebted for much valuable help and information.

48. Orthis (vel Strophomena) Champernownei, *Dav.* Dev. Sup., Pl. III, fig. 18.

Shell transversely oval, rounded anteriorly, wider than long; hinge-line straight, shorter than width of shell; valves very gently convex, and much flattened; dorsal valve divided by a slight longitudinal depression; beak gently incurved; area narrow. Surface of valves finely striated longitudinally, with a smaller riblet between each pair of the larger ones, and interspaces of about equal width. Interior not known.

Length 7, width 9, depth 2 lines.

Obs.—Mr. Champernowne found this species in great abundance in calcareous shales at Meadfoot, close under the Torquay Limestone, but generally much crushed and out of shape. Not having seen any specimen in which the area was well preserved, I cannot say whether it had an open fissure, as in *Orthis*, or a fissure covered by a deltidium, as in *Strophomena*, and consequently I am uncertain as to its genus. I have named it after my valued friend Arthur Champernowne, Esq., of Dartington Hall, Totnes, and to whom I feel deeply indebted for the liberal and zealous help he has given me in my Devonian researches.

Genus—Strophomena, *Blainville,* 1825.

49. Strophomena rhomboidalis, var. nodulosa, *Phillips.* Dev. Sup., Pl. III, fig. 15.

Leptæna nodulosa, *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset p. 56, pl. 24, fig. 94, 1841.

At page 76 of my 'Devonian Monograph,' while describing *Strophomena rhomboidalis,* var. *analoga,* Phillips, I placed Phillips's *Leptæna nodulosa* as a synonym. Mr. Whidborne has suggested to me the possibility of Phillips's *nodulosa* being a well-defined variety, if not a distinct species. Phillips states that with the general shape of his var. *analoga,* its disc is flat from the beak to the border, and that the surface, irregularly rather than concentrically ridged and furrowed, is radiated by extremely fine flexuous striæ, and adds, "I have always been much disposed to believe this distinct from the last species [*L. analoga*], and this opinion is rather strengthened by inspecting Mr.

Sowerby's figure (' Geol. Trans.,' 2nd ser., vol. v, pl. 56, fig. 3), which represents the same form and characters. The radiating striæ are beyond all comparison finer, and require a lens to be distinctly traced. They are remarkably close, *numerous,* and *flexuous.* The front margin shows no *mesial concavity* (which I find to be generally more distinct in *P. analoga* than in pl. 7, fig. 10, ' Geol. of Yorkshire'), the reflected border is much undulated, so as to be even nodular, and the concentric rugæ are so very *irregular* and discontinuous as to give quite a different air to the whole."

We all know how very variable *Strophomena rhomboidalis* is in shape and character; and it may, therefore, be perhaps desirable to maintain the shell under description as a named variety.

Genus—LEPTÆNA, *Dalman,* 1828.

50. LEPTÆNA ? NOBILIS, *M'Coy,* sp. Dav., Dev. Mon., Pl. XVIII, figs. 19—21.

Since describing this species at p. 86 of my 'Devonian Monograph,' a few fine large examples have been found by Mr. G. F. Whidborne in the Middle Devonian at Lummaton, near Torquay. One measured two inches in length, by two and three quarters in breadth. The dorsal valve is concave, and marked in the same manner as the ventral.

51. LEPTÆNA ? LOOIENSIS, *Dav.* Dev. Mon., p. 84, Pl. XVIII, figs. 13, 14.

Described but not named at p. 84 of my ' Devonian Monograph,' and named *Looiensis* in the Explanation of Plate, this species seems to me distinguishable from *Lept. ? laticosta* by the absence of the wider median rib. As already stated, it is common in the brown grits at Looe, in Cornwall,[1] but it has been subsequently found in abundance by Messrs. J. G. Grenfell and Whidborne in Lower-Devonian shales at the Saltern Railway-cutting, behind Saltern Cove, Paignton. Another example in sandstone was found by Mr. J. E. Lee at Smuggler's Cove, near Torquay.

[1] Looe Harbour, in Cornwall, is from thirteen to fourteen miles almost due west from Plymouth.

Genus—Productus, *Sowerby*, 1814.

52. Productus subaculeatus, *Murch.* Dav., Dev. Mon., Pl. XX, figs. 1, 2; and Dev. Sup., Pl. III, fig. 22.

In my description of this species, p. 101 of my 'Devonian Monograph,' I say, "In none of the British specimens that I have been able to see were the spines in place, but some of the French examples still preserved their spines, which were slender, and sometimes exceeding half an inch in length; some may even have attained an inch." Since then Mr. G. F. Whidborne has found at Hope's Nose a specimen in which the spines are seen in place, and these slightly exceed half an inch in length. I have added a figure so as to complete the description of the species.

Genus—Chonetes, *Fischer*, 1837.

53. Chonetes Hardrensis, *Phillips.* Dav., Dev. Mon., Pl. XIX, figs. 6—8, not 9; and Dev. Sup., Pl. III, fig. 24.

This species is described at p. 94 of my 'Devonian Monograph.'

At page 639 of his 'Die Brach. des Mittel- und Ober-Devon. der Eifel,' 1871, Dr. Kayser considers *Chonetes Hardrensis* and *sordida*, Phillips, to be synonyms of the *Chonetes* (*Terebratulites*) *sarcinulata* of Schlotheim. *Chonetes plebeia*, Schnur, and *Orthis semiradiata* and *biradiata* of Quenstedt, are likewise added to the synonyms.

It is probable that Dr. Kayser may be right in his identification and views; but, not being myself quite certain, I prefer to retain Phillips's species, at all events provisionally.

Some good examples, with the shell preserved, were found by Mr. Whidborne in the Middle Devonian at Hope's Nose, near Torquay, and of one of these I give a figure.

54. Chonetes? Phillipsii, *Dav.* Dev. Sup., Pl. III, figs. 23, 23*a*.

Shell transversely semicircular, somewhat wider than long; hinge-line straight, as long as the greatest breadth of shell; ventral valve very convex and convolute, flattened towards its auriculate cardinal extremities; beak much incurved; dorsal valve not known. Surface of ventral valve ornamented with about twenty simple rounded ribs, crossed by numerous coarse, prominent, equidistant, concentric ridges.

Length $4\frac{1}{2}$, breadth 5 lines.

Obs.—Of this remarkably ornate species Mr. Whidborne found a very few examples in the Middle-Devonian Limestone at Lummaton, near Torquay. Unfortunately only the ventral valve could be seen, the dorsal one remaining embedded in the coarse limestone that surrounded the shell. No spines could be detected. On account of its shape this is provisionally put with *Chonetes*, which it resembles. The coarse concentric ridges give to the shell a beautifully sculptured appearance. It is with much pleasure that I name it in remembrance of my much-esteemed old friend Prof. John Phillips, F.R.S., who did so much good work among the fossils from the neighbourhood of Torquay.

55. Chonetes convoluta, *Phil.*, sp. Dav., Dev. Mon., Pl. XIX, fig. 9 (not *C. Hardrensis*, Phil.).

Leptæna convoluta, *Phillips*. Figures and Descriptions of Palæozoic Fossils of Cornwall, Devon, &c., p. 57, pl. 24, fig. 96, 1841.

At page 94 I described this shell as a form of *Chonetes Hardrensis*, but since then Mr. Whidborne has found several examples in the Middle Devonian at Lummaton, which agree so nearly with Phillips's description and figure that it may, perhaps, be desirable to keep the two forms separate. The shell is semicircular, with a long hinge-line, the wings or cardinal extremities projecting laterally into two rather pointed "cones;" and the umbo does not project above the hinge-line. The ribs number about twenty in number, most of them simple, a few only bifurcating.

Genus—Lingula, *Bruguière*, 1792.

56. Lingula squamiformis, *Phillips?* Dav., Dev. Mon., Pl. XX, figs. 11, 12.

Subsequent to the publication of my description of this species at p. 105 of my 'Devonian Monograph,' Mr. Townsend M. Hall published in the 23rd vol. of the 'Quart. Journal of the Geological Society,' p. 371, 1867, a paper "On the Relative Distribution of Fossils throughout the North-Devon Series," in which he gives a list of the

Brachiopoda. At p. 380 he adds a "Note on the Species of *Lingula* from Sloly Quarry," and says, "The small *Lingula* which is found in such abundance at Sloly Quarry was named by Mr. Salter *L. mota* ('Quart. Journ. Geol. Soc.,' vol. xix, p. 480), and in the 'Catalogue of Fossils in the Museum of Practical Geology' it is called *L. hybrida*. Mr. Davidson, in his 'Monograph of the Devonian Brachiopoda,' refers it to the Carboniferous species *L. squamiformis*, and remarks that 'it is difficult to obtain specimens preserving their natural shape, almost every example being deformed or put out of shape from the effects of pressure or cleavage.' *L. squamiformis* is described as 'longitudinally oblong, one third or less longer than wide; valves slightly convex, with their external surface covered with numerous fine concentric striæ or lines of growth. Usual dimensions 9 lines in length by 5 in width.' Taking this as the specific character of the shell, we find at Sloly that, besides *L. squamiformis* there is also another *Lingula*, which must be either a new species or, at least, a well-defined variety. A comparison of a great number of specimens shows that the breadth of this shell is equal to its length, or nearly so. Dimensions 5 lines in length by 5 in width. Valves convex, and generally marked with two lines of growth. Numerous fine intermediate striæ cover the surface of the valves, and give them a peculiar laminated appearance. Should this *Lingula* prove to be a new species, the name *L. circularis* might be appropriate, since it differs so materially from the other *Lingulæ* in having a form which is nearly orbicular. I should, perhaps, add that the difference in shape from *Ling. squamiformis* could scarcely be due to distortion, effected by either cleavage or pressure; and I have observed, that when several individuals of the two species occur on the same slab of slate they in every case have retained their independent and characteristic form."

Lingulæ appear to be rare in the Devonian rocks of Great Britain. Schnur, in his 'Beschreibung Eifel. Brachiopoden,' p. 229, pl. xliii, fig. 6, describes and figures a *Lingula* by the name of *Lingula Konincki* which bears some resemblance to some of the Sloly specimens. Dr. Kayser also, in p. 642 of his 'Brach. des Eifel,' alludes to the subject. *Lingulæ*, where the genus occurs, should be abundant; but it is not always so; for, although many thousands of specimens of Brachiopoda have been collected in the Devonian rocks at Ferques, near Boulogne, only one or two examples of a *Lingula* were procured by Mr. Bouchard; and, although I spent many months in searching those quarries, and their *débris*, I never saw a trace of the species. *Discina* was equally rare, but *Crania* was not so scarce, although found only in one or two places.

Genus—Davidsonia, *Bouchard*, 1849.

57. Davidsonia Verneuilii, *Bouchard*. Dav., Dev. Mon., Pl. XI, figs. 13—16, and Pl. XV, fig. 18.

This shell is still found to be very rare in our British Devonian rocks. I have never seen more than three or four examples of its attached valve; the upper or unattached valve never having turned up. A complete example has, however, been described and figured by Dr. Kayser in pl. xii, fig. 9, of his 'Die Brach. des Mittel- und Ober-Devon. des Eifel,' 1871, which will serve to complete the characters of the species.

Genus—Calceola, *Lamarck*, 1799.

58. Calceola sandalina, *Linné*, sp. Dav., Dev. Mon., Pl. XX, fig. 13.

Calceola seems still to be a very problematical fossil, but it is by almost general consent excluded from the Brachiopoda. *Calceola sandalina* was for a long time considered to be a very rare English Devonian fossil, but it has since been found by Mr. Arthur Champernowne to be tolerably abundant in the Middle Devonian at Daddyhole Cove, Torquay, east side, Devonshire; see a paper by Mr. Champernowne in the 'Transactions of the Devonshire Association for Advancement of Science and Art,' March, 1874.

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(*An asterisk is placed before those Species that are noted or described in this Supplement.*)

RHYNCHONELLA Pengelliana, *Dav.* Dev. Mon., p. 61, pl. xii, figs. 8, 9.
* — Phillipsii, *Dav.* Dev. Sup., p. 43, pl. ii, fig. 14.
— pleurodon, *Phil.* Dev. Mon., p. 62, pl. xiii, figs. 12, 13.
* — ? protracta, *Sow.* = proboscidialis, *Phil.* Dev. Mon., p. 69, pl. xiv, figs. 27—29 ; Sup., p. 44, pl. ii, fig. 17.
— pugnus, *Martin.* Dev. Mon., p. 63, pl. xii, figs. 12—14, pl. xiii, figs. 8—10.
— reniformis, *Sow.* Dev. Mon., p. 62, pl. xiii, figs. 6, 7.
— sphærica, *Sow.* Dev. Mon., p. 66, pl. xiii, fig. 14.
— subreniformis, *Schnur.* Dev. Sup., p. 45.
* — triloba, *Sow.* Dev. Mon., p. 64, pl. xii, figs. 1—7 ; Sup., p. 47, pl. ii, fig. 21.

*SKENIDIUM areola, *Quenstedt*, sp. Dev. Sup., p. 49, pl. iii, figs. 11—14.
SPIRIFERA canalifera, *Var.* = aperturata, *Sch.* Dev. Mon., p. 26, pl. vi, fig. 9.
? — cultrijugata, *Roem.* (S. primæva, *Steininger*). Dav., Mon., p. 35, pl. viii, figs. 1, 2, 3 ; Sup., p. 34. (The form figured by me is, I believe, Stein. species, not that of Roemer.)
* — curvata,[1] *Schloth.* Dev. Mon., p. 39, pl. iv, figs. 29—32, 33 ? ; pl. ix, figs. 26, 27 ; Sup., p. 32, pl. i, fig. 34 ; pl. ii, fig. 4.
? — hysterica, *Schloth.* Dev. Mon., p. 34, pl. viii, figs. 16, 17, 18 ?.
* — lævicosta, *Val.* = ostiolatus, *Schloth.* Dev. Mon., p. 28, pl. viii, figs. 4, 5 ; Sup., p. 33, pl. ii, figs. 2, 3.
* — lineata, *Martin.* Dav., Mon., p. 43, pl. iv, figs. 13—16 ; Sup., pl. ii, figs. 5, 5 *a*.
? — megaloba,[1] *Phil.* Dev. Mon., p. 28, pl. ix, fig. 23.
? — mesomala,[1] *Phil.* Dev. Mon., p. 27, pl. vi, fig. 8.
? — Newtoniensis, *Dav.* Dev. Mon., p. 40, pl. ix, fig. 21.
— nuda, *Sow.* Dev. Mon., p. 38, pl. iv, figs. 17—24.
? — obliterata,[1] *Phil.* Dev. Mon., p. 27, pl. vi, fig. 10.
? — rudis,[1] *Phil.* Dev. Mon., p. 28, pl. ix, figs. 24, 25.
— simplex, *Phil.* Dev. Mon., p. 46, pl. vi, figs. 18—22.
— speciosa, *Schl.* Dev. Mon., p. 29, pl. viii, figs. 6—8.
* — subcuspidata, *Schnur.* Dev. Mon., p. 33, pl. viii, figs. 14, 15.
* — undifera, *F. Roemer.* Dev. Mon., p. 36, pl. vii, figs. 1—10 ; Sup., p. 33, pl. i, fig. 33.
— var. undulata, *F. Roemer.* Dev. Mon., p. 37, pl. viii, figs. 11—14.
— Urii. *Fleming.* Dev. Mon., p. 41, pl. iv, figs. 25—28 ; Sup., p. 34.
— Verneuilii, *Murch.* (= Sp. disjuncta, *Sow.*). Dev. Mon., p. 23, pl. v, fig. 1—12 ; pl. vi, figs. 1—5 ; Sup., p. 35, pl. ii, fig. 1.
SPIRIFERINA cristata, *Schloth ?.* Dev. Mon., p. 46, pl. vi, figs. 11—15.
* — insculpta, *Phil.* Dev. Mon., p. 48, pl. vi, figs. 16, 17 ; Dev. Sup., pl. i, fig. 32.
*STREPTORHYNCHUS crenistria and var. arachnoidea, *Phil.* Dev. Mon., p. 81, pl. xviii, figs. 4 and 7.
? — gigas,[2] *M'Coy*, Dev. Mon., p. 83, pl. xvi, figs. 1—3.
? — persarmentosus,[2] *M'Coy.* Dev. Mon., p. 84, pl. xvi, fig. 5.
— umbraculum, *Schl.* Dev. Mon., p. 76, pl. xvi, fig. 6, and pl. xviii, figs. 1—5 ; Sup., pl. iii, fig. 20.
*STRINGOCEPHALUS Burtini, *Def.* Dev. Mon., p. 11, pl. i, figs. 18—22 ; Sup., p. 19, pl. iii, figs. 2, 3.
STROPHALOSIA productoides, *Murch.* Dav., Mon., p. 97, pl. xix, figs. 13—21.
STROPHOMENA rhomboidales, *Wahl.* (var. analoga, *Phillips*). Dev. Mon., p. 76, pl. xv, figs. 15—17.
* — var. nodulosa, *Phillip.* Dev. Sup., p. 52, pl. iii, fig. 15.

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[1] (I know nothing of these four so-termed species, which appear to be very doubtful.)

[2] (These two so-termed species are doubtful.)

[1] Genus uncertain.

SUPPLEMENT

TO THE

BRITISH SILURIAN BRACHIOPODA.

The first part of my 'Silurian Monograph' was published in December, 1866, the fifth and concluding part in January, 1871; and, although I had then devoted fully six years to the study of the Cambrian and Silurian Brachiopoda of Britain, I felt that very much more material would be forthcoming with time and continued research. Now, as expected, I have very much more to add to what I had so far completed in 1871.

Changes and improvements have been effected from time to time in the subdivision of the Cambrian and Silurian systems; but it is not my province, in the pages of the Palæontographical Society, to enter upon any lengthened detail or discussion with respect to the geology of the Lower-Palæozoic formations, beyond assigning to each species its proper place and range. In the main I still adhere to Sir Roderick Murchison's classification, as he was the first to establish his divisions as "identified by organised fossils," thus carrying out the principles so ably laid down by William Smith in 1816. Whatever may be said to the contrary, I firmly maintain that it is to Sir Roderick's exertions, continued research, travel, and influence, that the study of the Lower Palæozoic rocks and fossils was so successfully spread over the whole of Europe and America.[1]

Changes were no doubt necessary to perfect the classification propounded by Sir Roderick Murchison in his 'Silurian System,' published in 1839, and Sir Roderick himself was fully aware of that necessity as the result of continued research; and he himself proposed alterations in his own classification in his subsequent work, 'Siluria.'

I am far from wishing to undervalue the very valuable and important researches of the Rev. Adam Sedgwick; but it is much to be regretted that that eminent geologist left,

[1] See Mr. Barrande's important paper "Du Maintien de la nomenclature établie par Mr. Murchison," 'Congrès International de Géologie,' p. 101, Paris, 1878.

during so many years, his fossils undescribed, whilst Sir Roderick Murchison was having his specimens described and illustrated by competent palæontologists.[1]

Different schemes of classification have been proposed from time to time, but the generality of geologists, both at home and abroad, have continued to maintain the *upper* and *lower* divisions of the Silurian System, with some slight modifications; and this arrangement has been followed by the Geological Survey.

I would refer the reader to Mr. R. Etheridge's valuable and important Anniversary Address as President of the Geological Society, delivered on the 18th of February, 1881, for an analysis and distribution of British Palæozoic fossils, as shown in their geological sequence.

Mr. Etheridge has recently informed me that he adopts the following arrangement of the Lower Palæozoic rocks, commencing with the—

1. Pre-Cambrian, comprising the *Lewisian, Dimetian, Argovian,* and *Pebidian;* and follows these in the ascending order by the
2. Lower Cambrian: *Longmynd, Harlech,* and *Llanberris.* Few Brachiopoda.
3. Upper Cambrian, comprising the *Menævian, Lower* and *Upper Lingula-Flags, Lower Tremadoc,* and *Upper Tremadoc.* Brachiopods abundant in some of the sub-divisions.
4. Lower Silurian, comprising the *Arenig rocks, Llandeilo, Caradoc-Bala,* and *Lower Llandovery.* In all these divisions Brachiopods are very abundant.
5. Upper Silurian, comprising the *Upper Llandovery* or *May-Hill Group, Wenlock Series,* and *Ludlow Series,* wherein Brachiopoda abound.

While following the above arrangement, Mr. Etheridge gives the approximate number of species that occur in each subdivision. I am also informed by that distinguished palæontologist that the Geological Survey would propose the following scheme for the division of the Upper and Lower Silurian:

Cambrian	Longmynd. Harlech.
Lower Silurian of Survey	Lingula-flags; lower, middle, and upper. Tremadoc. Arenig. Llandeilo. Caradoc. Llandovery.

[1] Twelve years after the publication of the 'Silurian System' Prof. Sedgwick engaged Prof. M'Coy to describe his fossils in a large volume, entitled 'A Systematic Description of British Palæozoic Fossils in the Geological Museum of the University of Cambridge,' 1855. This important work contains many beautiful plates and full descriptions of new or little known species. Subsequently Prof. Sedgwick further employed the late Mr. J. W. Salter to prepare 'A Catalogue of the Cambrian and Silurian Fossils contained in the Geological Museum of the University of Cambridge.' This catalogue, completed by Prof. Morris, was published in 1873.

UPPER SILURIAN.	Tarannon shales. Denbighshire grit. Woolhope beds. Wenlock beds. Lower Ludlow. Aymestry. Upper Ludlow.

At p. 60 of his Address Mr. Etheridge, alludes to Mr. Lapworth having proposed a tripartite division of the Lower-Palæozoic rocks, and having suggested the name ORDOVICIAN for all that group of strata, in the Bala district, to which Murchison had previously applied the name of *Lower Silurian,* and Sedgwick that of *Upper Cambrian.* I can see no advantages in substituting the synonym *Ordovician* for the well-known name *Lower Silurian* adopted by the Survey and by far the larger number of geologists, at home as well as upon the Continent.

Since 1871 I have never ceased to be on the look-out for every new species that occasionally turned up, and in improving my knowledge of those already described. Very much in this respect remained to be discovered in 1871, and no doubt very much more will have to be found out after this Supplement shall have been published, for science is continually on the advance. I am, however, pleased to be able to state that the larger proportion of our British Palæozoic Brachiopoda is now well understood, and has been properly described, figured, and classed; but there still remains a certain number of these that cannot yet claim that advantage, and it is only with more time and with continued research under favorable circumstances that those uncertain or doubtful so-termed species can be definitely determined and placed in their proper genera and families. All we can do is to offer our present knowledge of the subject.

Shropshire was always considered by Sir Roderick Murchison as one of the districts in which his Upper-Silurian rocks could be most advantageously studied; and it therefore occurred to George Maw, Esq., F.G.S., of Benthall Hall, Shropshire, and to myself, that some valuable results might be obtained by washing some twenty or more tons weight of Wenlock and Ludlow shales taken from different places and at different horizons. This expensive and great undertaking was generously and thoroughly carried out by Mr. Maw, who at the same time had the old quarries of Benthall Edge and Wenlock carefully hand-picked for specimens. These laborious operations have brought to hand some 50,000 or 60,000 specimens, some being new to science, while others are better represented than previously.

At my request, in 1880, Mr. Maw kindly forwarded to me the following notes in connection with his washing operations, along with some few remarks on the physical character and thickness of the Upper-Silurian rocks of Shropshire.[1] These observations

[1] These notes were published in the 'Geological Magazine,' New Series, vol. viii, p. 100, March,

I am the more anxious to republish, as it may induce some other geologists, favorably placed, to undertake similar washing operations so beneficial to science.

"The occurrence of cleanly-washed fossils in the *débris* remaining from many of the clays and shales suggested to me that the potter's process of lævigation might be conveniently employed by the geologist for the collection of fossils (especially of the smaller species), from the soft shales, in which hand-picking is at best a most laborious process.

"The potter's object in lævigating clay is to get rid of the coarser matter. The fossil-collector pursues, as it were, the process in reverse, by getting rid of all the clay and fine matter, and obtaining in a condensed form the coarse *débris*, including the organic remains.

"A potter's 'blunging' or clay-lævigating machine, though it greatly facilitates the process, and enables large quantities of material to be quickly lævigated, is not essential, as an experienced worker can in a day easily lævigate several hundredweights of clay or soft shale, with the aid only of a tub and a stout wooden stirrer.

"The operator should provide himself with a set of sieves of the following mesh:—1, 2, 4, 6, 10, and 12 wires to the inch.

"Having digested in water, say, half a ton of material, the 'slip' or liquid clay is poured off through the No. 12 or finest sieve, which catches any very small fossils; and the remaining *débris*, which might weigh about a hundredweight, should be repeatedly washed with fresh water, by which all fine matter will be removed, and the material remaining will in most cases resemble clean coarse gravel, with which the operator will have further to deal. As this will ultimately be the subject of the laborious process of hand-picking,' it is desirable to reduce its bulk as much as possible. The whole is first passed through the sieve of one-inch mesh, which catches all the stones, lumps of undigested shale, and the larger fossils, which are easily picked out. The mass is thus reduced to half or perhaps two-thirds of its weight, and is then dried. It greatly facilitates further operations to sort this into separate sizes by passing the dried material successively through the sieves of $\frac{1}{4}$ inch, $\frac{1}{6}$th of an inch, and $\frac{1}{10}$th of an inch mesh. The fine matter passed through the $\frac{1}{10}$th of an inch mesh seldom contains fossils, and may be thrown away.

"Now comes the final process of hand-picking from the three sorted lots of *débris*. These are spread out *thinly* on a slab of slate or a smooth board, and women, at a wage of 1*s*. 6*d*. a day, quickly perform the operation, and readily learn, not only to pick out the fossils from the gravelly *débris*, but also to roughly sort the species.

"As an instance of the good results of this process, I would mention that from one cartload of the Buildwas Beds of Wenlock Shale no less that 4300 specimens of one species, *Orthis biloba*, were obtained, besides a much greater bulk of other Brachiopods,

1881. Since then I have made several changes and additions to the Table of Species, which I prepared and published at that period.

amounting together to 10,000 specimens at least; but this does not nearly represent the full wealth of life of this rich horizon, as many of the larger species, and others not completely calcified, would get broken up in the washing process, and we have had to supplement the species obtained by washing with a series of hand-picked specimens.

"The whole of the *débris* has been preserved after picking out the Brachiopods, as it abounds in minute Corals and other fossils, which will, we hope, be investigated by other observers.

"The cost of the process, with the aid of a potter's clay-blunging machine, amounts to about 18*s*. per ton of materials. This includes the cartage of the shale two or three miles, the whole process of washing, and the hand-picking of the fossils by paid workers.

"The following estimate of the thicknesses of the several subdivisions of the Upper Silurian rocks of Shropshire is based on the average of three sections from south-south-east to north-north-west, across the north-eastern end of the great Shropshire escarpment. One of these passes through the town of Much Wenlock, and the others at distances of about two miles to the east and west.

"The horizontal distances of the lines of contour from the base of the Upper Llandovery to the base of the Devonian average from $3\frac{1}{2}$ to 4 miles or about 20,000 feet; and taking the general dip at 12°, the total thickness of the Upper-Silurian series can scarcely be less than 4500 feet.

"An estimate of the actual thickness of each of its subdivisions is difficult to arrive at accurately, mainly from the fact that most of the zones, both in mineral character and in the range of species, insensibly graduate one into the other; and it is probable that no two observers would fix exactly on the same lines of demarcation.

"There are perhaps few parts of the country in which the surface features of contours are ruled so closely by their geological structure, enabling the eye at a glance to follow all the main subdivisions. Standing on Benthall Edge or Wenlock Edge, the most prominent points in the escarpment, three parallel valleys and two well-marked intermediate ridges can be made out at almost every part of the long line of exposure extending from Ironbridge on the north-east to Ludlow on the south-west, the three valleys corresponding with the soft shales and the two ridges with the limestones.

"The broad sweeping valley of Ape Dale below the observer to the north-west represents the Wenlock Shale, backed up on its north-western side by the harder beds of Llandovery Limestone and Conglomerate forming the base of the Upper-Silurian series.

"The Llandovery beds on the lines of section may be roughly estimated at a thickness of 160 to 170 feet, of which the conglomerate, closely resembling the Milstone Grit, forms the greater bulk. The overlying Wenlock series attain a thickness of from 2500 to 2800 feet; their principal mass consists of soft shales capped by the Wenlock Limestone, which has determined the beautiful escarpment of Wenlock Edge, overhanging the gentle sweep of Ape Dale, and on the south side forms a regular dip slope into the lower Ludlow valleys of Much Wenlock and Hope Dale.

"No clear line of boundary exists between the limestone and the shale; for the one imperceptibly graduates and dies out into the other.

"From careful measurements made on Benthall Edge I have ascertained that the compact limestone is from 80 to 90 feet in thickness; and it thickens somewhat in the direction of Wenlock to the south-west. Below the compact limestone the rock becomes interstratified with thin layers of shale. Still lower down it assumes a concretionary structure, and gradually dies out into soft shale, through increasingly distant nodular courses, at about 400 or 500 feet below the crest of the limestone ridges.

"On Benthall Edge the Wenlock Limestone dips from 15° to 20° south-south-west; to the westward the dip decreases to from 10° to 15°, and at the eastern extremity of the escarpment at Lincoln Hill, near Coalbrook Dale, the inclination increases to from 45° to 50°. The upturning may have been continuously gradual or interrupted. It commenced *before* the Carboniferous period, for the Coal-measures rest upon it unconformably; and it continued subsequently, as indicated by the fact that the inclination of the margin of the Carboniferous beds is related to the greater or less inclination of the subjacent Wenlock Limestone.

"The following proposed subdivision of the great mass of Wenlock Shale, which at the north-eastern end of the Shropshire escarpment attains a thickness of from 2000 to 2200 feet, has been suggested by the alternation of zones of highly fossiliferous and of comparatively barren strata.

"As stated above, there is an insensible gradation between the Wenlock Limestone proper and the Wenlock Shale, the shales under the limestone containing scattered concretionary courses of nodular limestone; and it will be convenient to term this intermediate zone 'The Tickwood Beds,' which may be roughly estimated to include a thickness of from 300 to 500 feet of strata.

"They are exposed in the deep road-cutting near the railway-bridge between Tickwood and Farley Dingle. There is also a fine natural exposure $2\frac{1}{2}$ miles to the east, by the side of a small stream flowing down the east end of Benthall Edge, opposite Ironbridge; and most of the adjacent cutting on the Severn-Valley Railway passes through the base of these nodular limestones and shales. The Tickwood Beds are highly fossiliferous. They contain all the five species of *Spirifera* found in the Upper Silurians of Shropshire, with a larger proportion of individuals than in any other zone. The Tickwood Beds are also the highest horizon in which the new genus *Glassia* occurs; and *Orthis biloba* here attains its highest limit, with the exception that a few individuals occur rarely in the Wenlock Limestone and Lower Ludlow.

"Below the fossiliferous Tickwood Beds, from 1800 to 1900 feet of soft shales occur, which are comparatively barren in organic remains, and the few individuals that occur are depauperated and smaller than in the higher and lower zones, where they are more abundant, indicating a condition (perhaps increased depth of water), prejudicial to life and multiplication, excepting only that at one third from their base a remarkably rich zone occurs, the horizon of which seems to correspond closely with that of the Woolhope Limestone of Herefordshire, and possibly of the Barr Limestone of Staffordshire, though in Shropshire the calcareous element is wanting. It is exposed on the east bank of the River Severn, a short distance above Buildwas Bridge, in a section including from 70 to 80 feet of shale beds, which we propose to call 'The Buildwas Beds.' They are also exposed further to the west by the side of the brook south of Harley. Just above the fossiliferous zone of the Buildwas Beds, the monotonous 'Mudstone' character of the Wenlock Shale is broken by the occurrence of a few thin bands of a remarkable cream-coloured clay, resembling steatite in texture. The late Mr. David Forbes made for me an analysis of these bands, which were found to consist of—

Water	13·88	
Carbonic Acid	4·88	} = 11·10 of Carbonate of Lime.
Lime	6·22	
Silica	45·48	
Alumina	23·52	
Protoxide of Iron	1·76	
Protoxide of Manganese	0·07	
Magnesia	1·44	
Potash	2·15	
Soda	0·54	
	99·94	

and remarked on the smallness of the percentage of magnesia in the mineral, which so closely resembles compounds which, from their unctuous feel and external characters, are usually considered to be highly magnesian.

"The pale colour of these bands is evidently due to the occurrence of the iron in a state of protoxide, which may perhaps have resulted from the presence of the deoxidising agency of organic matter.

"If we place the Tickwood Beds as forming a connecting link between the Wenlock Limestone and the Wenlock Shale, the remainder of the shale may be subdivided as follows:

Barren shales of Coalbrook Dale and Ape Dale, or "*Coalbrook Dale Beds*"	1100 to 1200 feet.
Fossiliferous zone of Buildwas, or "*Buildwas Beds*"	80 to 100 „
Barren shales of Buildwas Park, or "*Basement Beds*"	500 to 600 „

"The barren 'Basement Shales' in the railway-cutting below Buildwas Park are red in colour; and this is also a character of the beds on the same horizon on the flanks of the Longmynd, exposed in the cuttings of the Craven-Arms and Bishops-Castle Railway, eighteen miles to the west of the Buildwas-Park Sections.

"These soft shales have largely determined the configuration of the contours of the district, and represent the sweeping Ape-Dale Valley of denudation, which spreads out for twenty miles below the supporting ridge of Wenlock Limestone of Wenlock Edge, and in Coalbrook Dale have yielded to the excavation of that picturesque valley.

"Some soft shales, about 100 feet thick, overlying the Wenlock Limestone, and exposed in cuttings by the side of the railway between Buildwas and Wenlock, west of the Bradley Lime-quarries, may also pertain to the Wenlock series: in physical character they more nearly resemble the shales of the Wenlock than the overlying Ludlow Beds.

"The Wenlock Shale in Shropshire, which cannot be much less than 1800 to 1900 feet in thickness, has a development much in excess of the Wenlock Shale in the Malvern district, where Professor Phillips estimated it to be 640 feet thick; indeed, its thickness in Shropshire is greater than in any other district, unless we except its supposed equivalents, the Denbighshire Flags, which I believe will be found to belong to a distinctly lower horizon.

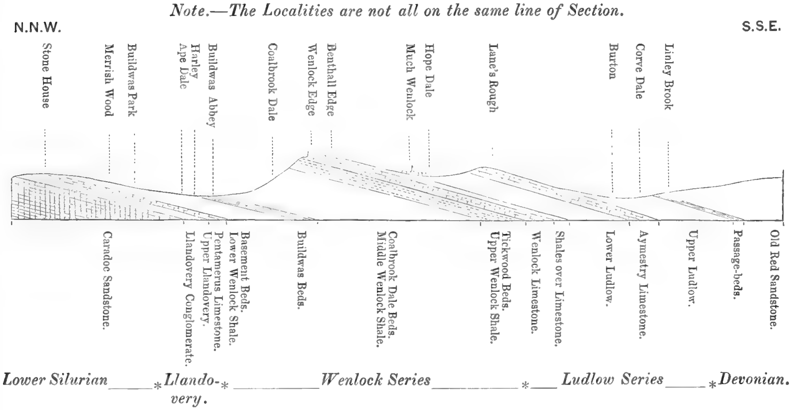
"*The Ludlow Series.*—Any definite estimate of the relative thicknesses of the several members of the Ludlow Beds is difficult to arrive at, as at the eastern extremity of the Shropshire escarpment the Aymestry horizon is ill-defined, here and there represented by isolated thin bands of limestone, and again as thick masses of impure concretionary limestone intermixed with shale. Collectively the Ludlow series attains a thickness of from 1200 to 1400 feet, which the Aymestry band divides nearly equally; the Lower Ludlow being a little thicker than the Upper, and consisting of softer shales. The Upper Ludlow Beds, as at Burton, near Wenlock, often assume the character of fissile tile-stones. The Lower Ludlow Beds are exposed in cuttings of the Wenlock Railway between Wenlock and Presthope, and the very base of these beds is seen in the Wenlock Railway east of Wenlock. The equivalent of the Aymestry Limestone is finely exposed in the road-cutting below the Dunge House, near Broseley, and to the west of the Marsh Farm on the high road between Broseley and Much Wenlock. The Upper Ludlow is to be seen by the roadside at Burton, near Wenlock, and is also exposed in Willey Park, and in the bottom of the valley below the Dean Farm, near Broseley.

"The beds connecting the Upper Ludlow with the Old Red Sandstone, which are well exposed on the banks of a little stream known as Linley Brook, two or three miles south of Broseley, have been described by Messrs. Roberts and Randall in the 'Quarterly Journal of the Geological Society of London,' vol. xix, p. 229. The upper part of their section, given at p. 232, appears to refer to the base of the outlier of the Coal-measures, and the remainder to the base of the Old Red Sandstone and top of the Upper Ludlow. The red micaceous marls in the road-cutting on the Bridgnorth side of the valley clearly belong to the Old Red Sandstone, and these, I suppose, are represented by the bed '*c*' in Messrs. Roberts and Randall's section. Below this the section is described as follows:

		ft.	ins.
d.	Light-coloured grits, with plant-remains	20	0
e.	Hard micaceous grits, somewhat flaggy, and charged with Fish remains ("The Upper Bone Bed")	7	0
f.	Flagstones bearing current-markings	1	9
g.	Micaceous sandy grits with *Lingulæ*	0	11
h	Greenish irregularly laminated rock with conglomerate	1	0
i.	Hard calcareous grit with thickly disseminated greenish grains and many broken *Lingulæ*	1	0
k.	Laminated, light-grey, micaceous, and sandy shales	20	0
l.	Grey micaceous grits	0	6
m.	Micaceous sandy clays coloured by peroxide of iron	6	0
n.	Yellow sandstones (Downton series), with *Beyrichia*, *Lingulæ;* and including two or more ferruginous bands, containing large quantities of the dermal studs of *Thelodus*, fragments of *Lingulæ*, and minute crystals of quartz. Clusters of *Modiolopsis complanata* occur at the base of this rock (The Lower or Ludlow Bone-bed)	8	0
o.	Hard calcareous shales with Fish-remains, *Lingulæ*, &c.	6	0
p.	Flaggy beds of impure limestone, with *Serpulites longissimus;* true Upper Ludlow	4	0
q.	Hard impure limestone; Aymestry series; at base.		

UPPER-SILURIAN SERIES OF SHROPSHIRE.

Note.—The Localities are not all on the same line of Section.



G. Maw delt. Horizontal Scale—One Mile to an inch.

"These are without doubt the passage-beds connecting the Silurian and Devonian series; and the only exception we take to Messrs. Roberts and Randall's determination is the supposed occurrence of Amestry Limestone at the base of their section; as, judging from the thickness of the Upper Ludlow Beds in neighbouring sections, it is improbable that the Amestry Limestone would come within the section here exposed.

"Of Brachiopoda, we believe no species have been found in the Linley Brook section, except *Lingula cornea*, which is abundant."

As already stated, Mr. Maw liberally forwarded to me all the specimens obtained from his extensive washings and hand-pickings; and after having carefully sorted them into species, an operation demanding much time, care, and patience, we were able to ascertain to what horizon each species is peculiar, or what was its stratigraphical range. Of course we limit our conjectures to those species of which we have positively ascertained the presence in each horizon. Some few of them may occur at levels not indicated in my Table, but as they have not come to my knowledge, are necessarily omitted. A glance at the Table will show that species of Brachiopoda were specifically more numerous during the Wenlock than the Ludlow period; that is to say of the eighty species enumerated in the Table, sixty-eight have been obtained from the Wenlock series of Shropshire, while only forty-six were found in that of the Ludlow rocks, thirty-two being common to both. These numbers are the results of my personal investigation, but may require to be slightly modified hereafter, or upon more extended study. Geologists and palæontologists will feel, I am sure, grateful to Mr. Maw for the great trouble he has taken in this matter. It has also been the means of providing the Rev. Norman Glass with an abundance of suitable specimens for his valuable researches relating to the loop- and spiral-bearing species; and these will be described in the sequel.

I have also been greatly aided by the Rev. H. G. Day, of Brighton; and I desire gratefully to acknowledge his devoted assistance in the sorting of the specimens, rendered all the more trying and difficult from the minuteness of many of the shells, and to thank him for many valuable suggestions.

BRACHIOPODA FROM THE UPPER SILURIANS OF SHROPSHIRE.

GENERA AND SPECIES OF BRACHIOPODA. *r*. Rare. *rr*. Very rare. *cr*. Not very abundant. *c*. Common. *cc*. Very abundant.	Ludlow Series.				Wenlock Series.						
	Passage Beds (Linley Brook).	Upper Ludlow.	Aymestry Limestone.	Lower Ludlow.	Shales over Wenlock Limestone.	Wenlock Limestone.	Upper Wenlock Shales (Tickwood Beds).	Middle Wenlock Shales (Coalbrook Dale Beds).	Lower Wenlock Shales (Buildwas Beds).	Basement Beds or Buildwas Park Beds, Lowest Wenlock Shales.	Upper Llandovery.
LINGULA Sysmondsi, *Salter*			*r*				*r*		*c*		
— Lewisii, *Sow.*			*cc*								
— striata, *Sow.*			*cr*	*cr*							
— minima, *Sow.*		*cc*									
— lata, *Sow.*		*c*	*c*	*cc*							
— cornea, *Sow.*	*c*		*r*								

GENERA AND SPECIES OF BRACHIOPODA. *r.* Rare. *rr.* Very rare. *cr.* Not very abundant. *c.* Common. *cc.* Very abundant.	Ludlow Series.				Wenlock Series.						
	Passage Beds (Linley Brook).	Upper Ludlow.	Aymestry Limestone.	Lower Ludlow.	Shales over Wenlock Limestone.	Wenlock Limestone.	Upper Wenlock Shales (Tickwood Beds).	Middle Wenlock Shales (Coalbrook Dale Beds).	Lower Wenlock Shales (Buildwas Beds).	Basement Beds or Buildwas Park Beds, Lowest Wenlock Shales.	Upper Llandovery.
ORBICULOIDEA Forbesii, *Dav.*							*r*		*c*		
DISCINA rugata, *Sow.*		*c*		*c*							
— Morrisii, *Dav.*				*r*							
— striata, *Sow.*		*r*									
PHOLIDOPS (crania) implicata, *Sow.*		*rr*		*rr*	*rr*		*cr*		*rr*		
DINOBOLUS Davidsoni, *Salter*						*rr*					
WALDHEIMIA Mawii, *Dav.*				*rr*	*rr*		*cr*				
— ? Glassii, *Dav.*									*r*		
NUCLEOSPIRA pisum, *Sow.*				*rr*		*cc*	*cc*	*rr*	*cc*		
RETZIA Salteri, *Dav.*				*rr*	*rr*	*c*	*cr*		*cr*		
— Bouchardi, *Dav.*						*cc*	*cc*		*cr*		
MERISTINA didyma, *Dalman*, sp.			*cr*			*r*			*rr*		
WHITFIELDIA tumida, *Dal.*			*cr*	*rr*	*rr*	*c*	*c*		*rr*		
ATHYRIS læviuscula, *Sow.*					*cr*	*c*	*r*		*r*		
DAYIA navicula, *Sow.*				*c*		*r*					
SPIRIFERA plicatella, et var. radiata, *Sow.*			*cr*	*r*	*r*	*c*	*cr*	*cr*	*cr*		
— var. interlineata, *Sow.*			*r*	*cr*	*r*	*cr*	*cr*				
— crispa, *Linné*				*r*	*r*	*cc*	*cc*		*c*		
— elevata, *Dalman*		?				*cc*	*c*				
— sulcata, *Hisinger*						*cr*	*rr*				
CYRTIA exporrecta, *Wahl.*				*rr*		*c*	*c*	*cr*	*cr*	*rr*	
ATRYPA reticularis, *Linné*			*c*	*cc*	*cc*	*cc*	*cc*	*c*	*cc*	*c*	
— asperula, *Dav.*				*rr*	*rr*	*cr*	*r*				
— marginalis, *Dal.*						*cr*	*cr*		*r*		
— imbricata, *Sow.*						*r*					
— Barrandi, *Dav.*				*rr*	*r*	*c*	*cc*		*cc*	*cr*	
— ? Mawei, *Dav.*						*rr*					
GLASSIA obovata, *Sow.*, sp.							*r*	*rr*	*cr*		
— elongata, *Dav.*							*c*	*r*			
STREPTIS Grayi, *Dav.*									*cr*		
EICHWALDIA Capewelli, *Dav.*				*rr*			*rr*		*cr*		
TRIPLESIA Wenlockiensis, *Dav.*						*r*					

GENERA AND SPECIES OF BRACHIOPODA. *r.* Rare. *rr.* Very rare. *cr.* Not very abundant. *c.* Common. *cc.* Very abundant.	Ludlow Series. Passage Beds (Linley Brook).	Ludlow Series. Upper Ludlow.	Ludlow Series. Aymestry Limestone.	Ludlow Series. Lower Ludlow.	Wenlock Series. Shales over Wenlock Limestone.	Wenlock Series. Wenlock Limestone.	Wenlock Series. Upper Wenlock Shales (Tickwood Beds).	Wenlock Series. Middle Wenlock Shales (Coalbrook Dale Beds).	Wenlock Series. Lower Wenlock Shales (Buildwas Beds).	Wenlock Series. Basement Beds or Buildwas Park Beds, Lowest Wenlock Shales.	Upper Llandovery.
PENTAMERUS Knightii, *Sow.*			cc								
— galeatus, *Dal.*				cr	c	c	c				
— linguiferus, *Sow.*						c	c	r		r	
RHYNCHONELLA Wilsoni, *Sow.*		c	c	c	c						
— sphæroidalis, *M'Coy*						c	c		rr		
— Lewisii, *Dav.*						r	r				
— borealis, *Dal.*						cc	c				
— bidentata, *Sow.*				rr		cr	cr		r		
— Stricklandi, *Sow.*							cr				
— cuneata, *Dal.*						c	r				
— Dayi, *Dav.*				c		c	cr		cr		
— deflexa, *Sow.*				r		c	c				
— depressa, *Sow.*									rr		
— sp.								r			
sp.									r		
— nucula				c		r					
STREPTORHYNCHUS nasutus, *Lindström*						rr					
SKENIDIUM Lewisii, *Dav.*				r	r	r	r	c	cc		
ORTHIS biloba, *Linné*		cr		r	cr	rr	c		cc		
— lunata, *Sow.*		c	c								
— elegantula, *Dal.*		cr	?	c	c	c	c	cr	r	r	
— elegantulina, *Dav.*		c					c	r	cc		
— hybrida, *Sow.*				c	cc	cc	cc	cc	cc		
— Bouchardi, *Dav.*						c	cr				
— Walsalliensis, *Dav.*									cr		
— rustica, *Sow.*						cr	cr		r		
— æquivalvis, *Dav.*									rr	r	
— biforata, *Schloth.*									rr		
STROPHOMENA Dayi, *Dav.*									r		
— rhomboidalis, *Wilckens*			r	r		c	cr	r	cr		
— funiculata, *M'Coy*				cr	cr	r	r				
— euglypha, *Sow.*						r					
— imbrex, *Pander*									r		
— pecten, *Linné*						r	r		r		
— filosa, *Sow*		c	c			r					
— ornatella, *Salter*		c									
— Fletcheri, *Dav.*						r					
— antiquata, *Sow.*						r					
LEPTÆNA transversalis, *Dal.*							cr	r	c	r	
— segmentum, *Angelin*				cr		r	c	c	cc		
— lævigata, *Sow*				c							
CHONETES lepisma, *Sow.*				c	cc						
— minima, *Sow*				rr					rr		
— striatula, *Fischer*		c	c	c							

We have omitted from the Table the species that occur in the Upper Llandovery in the County of Shropshire, as we have been unable to complete the list in time; but will refer to them in the sequel. Many most important works and papers relating to British and foreign Silurian Brachiopoda have been published since the time I issued the last portion of my 'Silurian Monograph.' The most extensive and important of all of them is that by Mr. Barrande on the 'Species that occur in the Silurian System of the centre of Bohemia,' 153 plates being devoted by that eminent palæontologist to their illustration (vol. v, 1879). A small number of the Bohemian species occur also in Great Britain, and will be referred to in the sequel.

We must not omit to refer to the many important boring operations that have taken place in England, and especially in the middle and southern portions of the kingdom, during the last few years; especially to that of Ware, in Hertfordshire, so well described by Mr. R. Etheridge, at pp. 290 and 295 of the 'Popular Science Review' for July, 1879. In that valuable communication Mr. Etheridge intimates that the Silurian floor of Wenlock age, dipping at an angle of 40°, was reached at the depth of 800 feet from the surface, and upon it rest the Cretaceous and Tertiary series of Hertfordshire. All the Silurian fossils were obtained from a core less than three feet in length and one foot in diameter. Mr. Etheridge enumerates thirty-three species belonging to the *Protozoa, Echinodermata, Annelida, Crustacea, Brachiopoda, Conchifera, Gasteropoda*, and *Cephalopoda.*

The Brachiopoda, of which I have seen the series of specimens at the Museum of the School of Mines in Jermyn Street, include:—1. *Orthis elegantula*, Dal.; 2. *Whitfieldia tumida,* Dal.; 3. *Cyrtia exporrecta*, Wahl.; 4. *Spirifera plicatella*, Linn.; 5. *Sp. elevata*, Dal.; 6. *Athyris;* 7. *Pholidops* (*Crania*) *implicata*, Sow.; 8. *Rhynchonella cuneata*, Dal., or *R. deflexa*, Sow.; 9. *Atrypa reticularis*, Linn.; 10. *Pentamerus galeatus*, Dal.; 11. *P. linguifer*, Sow.; 12. *Strophomena euglypha*, Dal.; 13. *St. rhomboidalis*, Wilckens.; 14. *St. antiquata*, Sow.; 15. *Leptæna transversalis*, Dal.; and 16. *Chonetes*, sp. Mr. Etheridge quotes likewise *Stroph. reticulata*, M'Coy, and *Leptæna sericea*, Sow., but I do not feel certain that the two last-named identifications are quite correct.

In his 'Thesaurus Siluricus,' published in 1868, Dr. Bigsby enumerated some 1650 species of Silurian and Cambrian Brachiopoda. Since then a large number have been added by Barrande and many European and American palæontologists, so that if we put the number of named species at 1800 we would not exceed the estimate. A very large reduction in that number would, however, have to be allowed for synonyms; and indeed, it would not be possible in the present state of our knowledge to correctly estimate the number of really good species hitherto discovered.

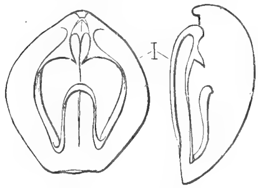
DESCRIPTIONS OF SPECIES.

Genus.—Waldheimia, *King*, 1850.

1. Waldheimia Mawii *Dav.* Sup. Sil. Mon. Pl. IV, figs. 1, 2, 3.

Waldheimia Mawii, *Dav.* Geol. Mag., New Series, vol. viii, p. 145, pl. v, figs. 7, 8, April, 1881.

Shell small, marginally subpentagonal, longer than wide, straight, or slightly indented in front; dorsal valve laterally gently convex, longitudinally concave, with a small median rib commencing at about the middle of the valve, and widening as it nears the front; ventral valve very convex, and keeled along the middle, or divided longitudinally by a groove commencing at about half the length of the shell, and extending to the front; beak small, incurved; foramen minute, beak-ridges strongly marked; surface of valves smooth. In the interior of the dorsal valve, under the hinge-plate, a slightly elevated longitudinal septum or ridge extends to within a short distance of the frontal margin; to the hinge-plate are attached the principal stems of the loop, which, after giving off crural processes, extend to within a short distance of the front, where they become reflected so as to form the loop.



Wald. Mawii, Dav. Developed by the Rev. Norman Glass.

Length 2, breadth $1\frac{1}{2}$, depth $\frac{1}{2}$ line.

Obs.—This small shell was procured by Mr. G. Maw in some abundance from the washings of several tons weight of the "Tickwood Beds," or Upper-Wenlock Shales, from under the railway-bridge at Farley Dingle, also from the upper part of the Wenlock Shale, below limestone; in water-course, under Benthall Edge, and opposite Ironbridge in Shropshire.

Having had placed in his hands a number of specimens filled with a light-coloured, semi-transparent spar, the Rev. Norman Glass was able, after much trouble and patience, to develop the loop in several specimens and in the clearest possible manner; and so like in general character is this loop to that of *Waldheimia* that I have, at any rate provisionally, placed it in that genus. Exteriorly, this small species bears so much resemblance to some forms of *Centronella*, and in particular to *C. Hecate*, Billings ('Canadian Journal,' May, 1861, p. 63), that, previously to having been made acquainted with its loop, I had placed the new English species in Billings' genus. That this new species, however, is not a *Centronella* will be seen by a comparison of its loop with the loop of *C. virgo*, &c., as described in the preceding 'Devonian Supplement.'

In the 'Sixteenth Annual Report of the University of the State of New York,' p. 49, Professor James Hall figures and describes a specimen of *Terebratula melonica*, Barrande, which Dr. Röminger had developed. The lamellæ forming the loop are described by Hall as almost parallel and near together, and he states that the loop extends four-fifths of the entire length of the shell, when it is recurved and, turning back, extends two thirds the distance to the beak of the dorsal valve; and that the crural processes are further from the base of the loop than is represented in the typical figures of *Waldheimia*, and are opposite the recurved extremity of the loop.

In pl. cxli, figs. 24, 25, 26, of his magnificent 'Monograph of the Silurian Brachiopoda of Bohemia,' Barrande reproduces Hall's figure of Dr. Röminger's specimen, and describes it as a *Retzia* (?), but it certainly does not belong to this genus; and I feel disposed to consider both *Wald. Mawii* and *Wald. melonica* as the earliest representatives known of the species of Terebratulæ with long loops, and for whose reception the genus *Waldheimia* was proposed by Professor W. King.

In external shape *Wald. Mawii* resembles more or less nearly several other species, especially *Rhynchonella* (?) *reflexa*, de Koninck; and it is very desirable that the interior of this Carboniferous shell should be examined.

2. Waldheimia ? Glassii. Dav., Sil. Sup. Pl. IV, figs. 4, 4 *a*, *b*, *c*.

Waldheimia Glassii, *Dav.* Geol. Mag., New Series, vol. viii, pl. v, fig. 6, 1881.

Shell small, subpentagonal, broadest posteriorly, slightly truncated in front; dorsal valve slightly convex, curving rather abruptly at the lateral margins, with a median longitudinal groove or depression commencing about half the length of the shell, and extending to the front; beak incurved, truncated by a small foramen, hinge-ridges well defined; surface of both valves smooth, marked by concentric lines of growth.

Length 3, breadth 3, depth 2 lines.

Obs.—About fifteen examples of this species were obtained by Mr. Maw from the washings of some seven tons weight of the Lower-Wenlock Shales of Buildwas. All the specimens procured had about the same dimensions, none exceeding the measurements above given. Only very few of them were in a perfect state of preservation, and none were in a suitable condition for Mr. Glass's operations, consequently all his endeavours to develop the interior characters proved unsuccessful. It is a rather larger shell than *Waldheimia Mawii*, but bears some resemblance to it in external shape; this has prompted me to leave it provisionally with the same genus.

ON SPIRAL-BEARING BRACHIOPODA.

Among the Brachiopoda, one of the most interesting of the groups is that of the spiral-bearing genera and species, or those genera and species that are provided with calcified spirally-coiled lamellæ for the support of the fleshy, brachial, or labial appendages.

Although fleshy labial appendages more or less coiled exist in recent species, such as *Rhynchonella*, *Lingula*, &c., in no recent case have they been found supported by calcified spirally-coiled lamellæ; nor have any, as far as we are aware, been so provided since the commencement of the Oolitic period. Spiral-bearing Brachiopoda are essentially characteristic of the Palæozoic period, though they have continued to appear in diminished numbers up to the close of the Liassic epoch.

It is not yet possible to group the genera definitely into families, for it is only within the last few years that their real characters have been approached and understood; and much further investigation in the right direction, among the various unexamined species, will require to be undertaken before we may venture to generalise definitely upon the subject.

It has been long known that certain species were provided with lamellæ spirally coiled, and as far back as 1815 the genus *Spirifera* was proposed by Sowerby, although at that period misunderstood by him; but the most important study of their different modes of convolution, loops, and attachments to the hinge-plate, is an almost new kind of investigation, requiring much skill, acumen, and patience, as these attachments have in most cases to be sought for in specimens filled with a hard, and often intractable matrix, and many examples have in some cases to be sacrificed before a satisfactory result is attained. The best mode of operating will be referred to in the sequel.

Prominent in this difficult study has been the Rev. Norman Glass, to whose indefatigable perseverance and consummate skill I am indebted for the possibility of laying before my readers a large amount of positive and most valuable information. I can find no words sufficiently expressive to convey the gratitude I feel towards him for the unrelaxing energy he has displayed during upwards of three years in this difficult kind of investigation. I have also received much help from Mr. R. P. Whitfield, of the American Museum of Natural History in New York, as well as from Herr Zugmayer, of Vienna, both of whom communicated to Mr. Glass and to myself the specimens they had been able to develop. These are described and figured in Professor Hall's monumental work on the 'Palæontology of New York,' and by Herr Zugmayer in his work on the 'Brachiopoda from the Rhætic Rocks of Austria.'

Many genera and several families have been proposed from time to time by different palæontologists,[1] but it seems undesirable and unnecessary to multiply their number; and I therefore propose to distribute the twenty-five or twenty-eight genera we are provisionally disposed to record into the following four families:—1. SPIRIFERIDÆ; 2. NUCLEOSPIRIDÆ; 3. ATHYRIDÆ; 4. ATRYPIDÆ; and I will now review each of them separately, previous to describing in detail those that occur in our British Silurian rocks. It must be borne in mind that it is not sufficient to know that a Brachiopod is possessed of spiral appendages, to be able to determine its genus, but we must be acquainted with its attachments and loop.

[1] Dall, in the 'Bulletin of the United States National Museum,' 1877, proposes the following arrangement of the spiral-bearing Brachiopoda (synonyms being printed in italics):

Family—ATRYPIDÆ.

Atrypa, Dalman.
Spirigerina, d'Orbigny.
Cleiothyris, Phillips.
Cleidothyris, Paetel.
Cliothyris, Agassiz.
Anoplotheca, *Sandberger.*
Zygospira, *Hall.*
Stenocisma, Hall, 1877, not Conrad.
? Cœlospira, *Hall.*
Leptocœlia, Hall, 1857.
Koninckina, *Suess.*
Koninckia, Woodward.
? Davidsonia, *Bouchard.*

Family—SPIRIFERIDÆ.

ATHYRIS, *M'Coy.*
Athyris, Dav., 1856.
Seminula, M'Coy, 1844.
Actinoconchus, M'Coy.
Semiluna, King.
Cleiothyris, King.
Spirigera, d'Orbigny.
Euthyris, Quenstedt.
? *Charionella*, Billings.
Merista, *Suess.*
Camarium, Hall.
Pentagonia, *Coz.*
Goniocœlia, Hall.
Meristella, *Hall*, 1861.
Athyris, Dav., 1853.
— Billings.
? Meristina, *Hall.*
Nucleospira, *Hall.*
Retzia, *King.*
Retzia, Davidson.
Rhynchospira, Hall.
Trematospira, *Hall.*
Acambona, *White.*
Eumetria, Hall.
Uncites, *Defrance.*
Uncinites, Auct.
Spirifer, *Sowerby.*
Spirifera, J. de C. Sow.
Spiriferus, Blainville.
Spirifer, Rafinesque.
Hysterolithus, Quenstedt.
Fusella, M'Coy.
Choristites, Fischer.
— Quenstedt.
Choristides, Keferstein.
Delthyris, Dalman.
Brachythyris, M'Coy.
Trigonotreta, König; Meek.
Trigonotreta, Keferstein.
Reticularia, M'Coy.
Martinia, *M'Coy.*
Ambocœlia, Hall.
Ambocoilia, Quenstedt.
Syringothyris, *Winchell.*
Spirifer, King; Meek.
Cyrtia, *Dalman.*
Cyrthia, d'Orbigny.
Cyrtina, *Dav.*
Cyrtæna, Hall.
? Mentzelia, *Quenstedt.*
Suessia, *Deslong.*
Spiriferina, *d'Orb.*
? Skenidium, *Hall.*[2]

[2] This last is not a spiral-bearing Brachiopod.

1. *Family*—Spiriferidæ, *King*, 1846 (but much restricted).

Much difference in opinion has been entertained as to what genera this family should include.[1] We would restrict to it the following genera:

First Division {
1. Spirifera, *Sowerby*, 1815; type *Sp. striata*, Martin.
2. Cyrtia, *Dalman*, 1828; type *C. exporrecta*, Dal.
3. Syringothyris, *Winchell*, 1863; type *C. cuspidata*, Martin = *S. typa*, Winchell.

Second Division—4. Cyrtina, *Dav.*, 1858; type *C. heteroclyta*, Def.

Third Division {
5. Spiriferina, *d'Orb.*, 1847; type *S. Walcotti*, Sow.[2]
6. Suessia, *Deslongchamps*, 1854; type *S. imbricata*, Desl.

Fourth Division—7. Reticularia, *M'Coy*, 1844; type *T. imbricata*, Sow.

The family *Spiriferidæ* includes a very large number of species, and much remains to be made clear with respect to their character and grouping; and it would be very desirable that some one should undertake a special study of the different species, and prepare a monograph in which they would be grouped according to their natural affinities. Many things have to be considered in the grouping of the *Spiriferidæ*. It has to be determined whether the shell is fibrous or perforated by canals. The shape and character of the deltidium have to be taken into account, and in this particular some important differences seem to exist between *Spirifera* proper and *Cyrtia*. In the first there exists a pseudo-deltidium without any circular foramen, while in *Cyrtia* and perhaps in *Syringothyris*, the deltidium is convex, covers the entire fissure, and is perforated by a circular foramen, as will be seen illustrated in Pl. IX of my 'Silurian Monograph.' Then, again, the shape and character of the septa and shell-structure have to be considered. I am in this respect uncertain whether it is quite correct to retain in the same division *Spirifera*, *Cyrtia*, and *Syringothyris*.[3] *Spirifera* and *Cyrtia* are known to possess a fibrous imperforated shell, while perforations have been shown by Professor King,

[1] King, in 1846, put into his family Spiriferidæ *Spirifer*, *Atrypa*, *Martinia*, and *Stringocephalus*. In 1850 he added to it *Athyris*, *Cleiothyris*, *Retzia*, *Delthyris*, *Trigonotreta*, and *Martinia*, and excluded *Stringocephalus*.

In 1871 Quenstedt proposed a family Delthyridæ, and arranged his genera in two divisions:

a. *Spirifer*, *Choristites*, *Cyrtia*, *Trigonotreta*.

b. *Spiriferina*, *Syringothyris*, *Cyrtina*, *Suessia*.

Phillips, in 1841, placed in the family Delthyridæ *Orthis*, *Spirifer*, *Stringocephalus*, *Pentamerus*, *Cleiothyris* (a strange mixture of completely different and distinct genera).

Other authors have proposed different arrangements, but these need not be here recorded.

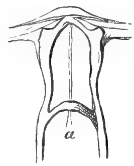
[2] By the means of very diluted acid M. Munier-Chalmas, of the Sorbonne, Paris, has been able to dissolve the entire matrix filling *Spiriferina rostrata* and other species so as to show the spirals and their connections completely and as perfectly as if the shell had just been taken from the Jurassic sea.

[3] King, "Notes on some Perforated Palæozoic Spiriferidæ," 'Geol. Mag.,' vol. iv, p. 351, 1867.

Winchell, and others to be present in the shell of *Syringothyris*. It is probable that the fourth division, including M'Coy's genus *Reticularia*, should be retained for such shells as *Sp. lineata*, Martin, *Sp. imbricata*, Sow., *Sp. Urii*, Flem., *Sp. lævis*, Hall, *Sp. curvata*, Schloth., and others, in which the shell-structure is perforated by canals, and the external surface is closely covered with flattened spines, in some divided internally into two tubes; these will be found to have been minutely described in p. 275 of my 'Carboniferous Supplement.'

The position and direction of the spirals is also somewhat variable, even in specimens of the same species. In the larger number of forms the extremities of the spiral cones are directed towards the lateral portions of the shell; but it has been noticed that in species and specimens with a deep ventral valve and large rostral cavity the spirals, in order to find more accommodation, extend to a considerable distance upwards into the cavity of the beak, and on either side of the median septa. This is particularly observable in some specimens of *Cyrtina heteroclyta*, and in those specimens of Jurassic *Spiriferinæ* which are possessed of a large rostral cavity (see 'Oolitic and Liassic Suppl.,' Pl. XI, and 'Dev. Suppl.,' Pls. I & II).

In all the genera and species of *Spiriferidæ* with which we are acquainted, and which have been internally investigated, the principal stems of the spirals are simply attached to the hinge-plate and run nearly parallel to each other until they form their final convolution.



Spiriferina rostrata, showing the attachment of principal lamellæ to hinge-plate, and lower down the connection of the two stems by means of a curved lamella (*a*).

As far as we are as yet aware, the two principal stems of the spirals in *Spirifera* and in *Cyrtia* are unconnected. At about half their length they give off two short lamellæ, which extend only a little way into the interior of the shell (see 'Sil. Suppl.,' Pl. IV, figs. 10, 11). Mr. Glass has experimented on a number of species and specimens, and has never detected any connection. We do not know yet whether in *Syringothyris* and *Reticularia* the principal stems are unconnected.

In *Cyrtina* Mr. Glass has worked out their connection, which is a simple **V**-shaped band; and it appears to be the same in *Suessia*; while in *Spiriferina* it is in the shape of a curved lamella.

2. *Family*—Nucleospiridæ, *Dav.*, 1881.

The genera placed in this family seem, as far as our present knowledge of them goes, to be nearly connected.

First Division:

- Nucleospira, *Hall,* 1859; types *Ter. pisum,* Sow. = *N. ventricosa,* Hall.
- Retzia, *King,* 1850; type *T. Adrieni,* de Verneuil. The connection of the spirals in this species are unfortunately not yet discovered. King and myself therefore adopted *R. Salteri* as the type, and its interior characters are now well known. *Rhynchospira,* Hall, 1859, we consider to be a synonym of *Retzia*; his type agrees with *R. Salteri.*
- Meristina, *Hall,* 1867; type *T. didyma,* Dalman = *M. nitida,* Hall.
- ? Trematospira, *Hall,* 1857; type, *S. multiplicata.* Of this genus all that has been discovered is that its spiral appendages are directed towards the lateral margins of the valves. Nothing is apparently known with respect to the connection of the principal spiral coils, or of their attachment to the hinge-plate. The genus is consequently only provisionally recorded and placed in the family *Nucleospiridæ,* from which it can be removed when the connections shall have been ascertained.

Second Division—Dayia, *Dav.,* 1881; type *T. navicula,* Sow.

Third Division—Uncites, *Defrance,* 1825; type *U. gryphus,* Defr. In 1849 A. d'Orbigny proposed a family, Uncitides, for this species, but he knew nothing about its interior characters, as they had not been then discovered.

In all these genera the extremities of the spiral cones are directed towards the lateral margins of the shell, and the connections of the principal stems of the spirals are simple and nearly similar.

Nucleospira, *Retzia*, and *Meristina* present such small differences in their interior arrangements that it will probably be desirable to include them all in a single genus. In all of them the primary lamellæ give off short lamellæ, which proceed straight across between the spirals to their ventral side before uniting in a sharp angular point. All of them have their principal lamellæ attached to the hinge-plate in a nearly similar manner, a small difference being observed only in the case of *Nucleospira,* which has its attachment more hook-shaped, as in *Athyris plano-sulcata.*

Dayia differs considerably from the genera already alluded to; but as the principal stems of the spiral cones are connected in a somewhat similar manner to what we find in

Nucleospira, I feel disposed to class it provisionally with the *Nucleospiridæ*. There is this important difference, namely, that the principal stems, instead of running parallel to each other, are widely separate, and, after extending parallel to each other for a short distance, bend at right angles abruptly towards the lateral portions of the beak, and form two large curves facing the lateral portions of the valve. The extremities of the spiral coils are, however, directed towards the lateral portions of the shell.

Uncites we place here also provisionally, although it differs from *Nucleospira* in several particulars, and especially in its simple mode of attachment to the hinge-plate. The principal stems of the spiral coils are, however, connected in a similar manner to those of *Nucleospira*, and the extremities of the spiral cones are directed towards the lateral margins of the shell (see 'Devonian Supplement' for full details and illustrations).

3. *Family*—Athyridæ, *Phillips*, 1841.

This great and important group of spiral-bearing Brachiopoda comprises—

First Division	Athyris, *M'Coy*, 1844; types *A. concentrica*, von Buch.; and *A. plano-sulcata*, Phillips (= *Spirigera*, d'Orbigny). Kayseria, *Dav.*, 1882; type *K. lens*, Phillips. Whitfieldia, *Dav.*, 1881; type *W. tumida*, Dalman. Bifida, *Dav.*, 1882; type *B. lepida*, Goldf.
Second Division	Merista, *Suess.*, 1851; type *M. herculea*, Bar. Meristella, *Hall*, 1860; type *M. arcuata*, Hall.

All these genera are fully described and illustrated in the 'Devonian and Silurian Supplements.' The extremities of their spirals are directed towards the lateral portions of the valves. Their primary lamellæ are generally attached to the hinge-plate in a similar manner, although differing somewhat in detail. The primary stems of the spirals are connected in a variable and more or less complicated manner by a system of lamellæ termed "the loop." In the first division the loop is forked and the accessory lamella more or less extended; in the second division the loop forms two rings.

4. *Family*—Atrypidæ, *Dall*, 1877.

This extensive family may include all those genera which have the apex of their vertical spiral cones directed towards the bottom of the dorsal valve, and might be provisionally divided into three separate groups.[1]

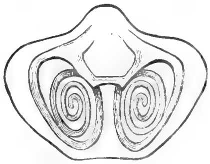
[1] Dall, in his index to the names which have been applied to the subdivisions of the class Brachiopoda previous to the year 1877, includes in his family Atrypidæ *Atrypa*, *Anoplotheca*, *Zygospira*, *Cœlospira*,

First Division:
- Atrypa, *Dalman*, 1828; type *A. reticularis* = Spirigerina, *A. d'Orbigny*, 1847.
- Cœlospira, *Hall*, 1863; type *C. concava*, Hall.

Second Division:
- Thecospira, *Zugmayer*, 1880; type *Thecidium Haidingeri*, Suess.
- Anoplotheca, *F. Sandberger*, 1855; type *A. venusta*, Schnur.
- Koninckina, *Suess*, 1853; type *K. Leonardi*, Wiesman. In 1855 I proposed a family, *Koninckinidæ*, for this and similar species.
- Koninckella, *Munier-Chalmas*, 1880; type *Leptæna Liasiana*, Bouchard. In 1880 M. Munier-Chalmas proposed a family *Koninckidæ*, for *Koninckina* and *Koninckella*; but I had proposed such a family previously.
- Davidsonia, *Bouchard*, 1849; type *D. Verneuilii*, Bouchard.

Third Division:
- Glassia, *Dav.*, 1881; type *G. obovata*, Sow.
- Zygospira, *Hall*, 1862; type *Z. modesta*, Hall.

Atrypa will be found minutely described in the sequel. In this excellent genus the conical spiral appendages, first attached to the hinge-plate, are placed side by side, with their extremities facing the bottom of the dorsal valve. The principal stems of the spiral coils at a short distance from their attachment to the hinge-plate are connected by a narrow band.



Cœlospira concava. After Hall.

Cœlospira, Hall, is so nearly connected with *Atrypa* generically that it must remain a question whether it can be separated.

The second division contains several genera more or less closely related, with a very slightly convex, flat, or concave dorsal valve, and with very little space between the valves for the animal to occupy. The spiral coils have consequently in most cases a very moderate elevation; some are coiled on the same plane, or vertically, the extremities being directed towards the bottom of the ventral valve. This is especially observable in Zugmayer's figures of *Thecospira*, which externally bears so much resemblance to certain species of *Thecidium* that it was placed in that genus by Professor Suess, who was not then acquainted with its spirally coiled lamellæ. It also, as well as *Davidsonia*, attaches itself by a portion of its ventral valve to marine objects. The attachments of the spiral coils in *Thecospira* are very similar to those of *Atrypa*. I have never seen the spirals of *Koninckella*, and their existence is given on the authority of Mr. Munier-Chalmas.

Koninckina, and probably *Davidsonia*; and he would, no doubt, have included *Thecospira* and *Koninckella* had they then been discovered and published.

Distribution of Spiral-bearing Brachiopoda in time.[1]

GENERA.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Liassic.
1. *Family* Spiriferidæ, *King*, 1846.						
Spirifera, *Sow.*, 1815	—	—	—	—	—	
Cyrtia, *Dalman*, 1828	—	—				
Syringothyris, *Winchell*, 1863	...	...	—			
Cyrtina, *Dav.*, 1858	—	—	—			
Spiriferina, *d'Orb.*, 1847	—	—	—	—	—	—
Suessia, *Desl.*, 1854	...	...	...	...	...	—
Reticularia, *M'Coy*, 1844	...	—	—			
2. *Family* Nucleospiridæ, *Dav.*, 1881.						
Nucleospira, *Hall*, 1839	—	—				
Retzia, *King*, 1850	—	—	—	—	—	
Meristina, *Hall*, 1867	—					
? Trematospira, *Hall*, 1857	—					
Dayia, *Dav.*, 1881	—					
Uncites, *Defrance*, 1825	...	—				
3. *Family* Athyridæ, *Phillips*, 1841.						
Athyris, *M'Coy*, 1844	—	—	—	—	—	
Kayseria, *Dav.*, 1882	...	—				
Whitfieldia, *Dav.*, 1881	—					
Bifida, *Dav.*, 1882	...	—				
Meristella, *Hall*, 1859	—	—				
Merista, *Suess.*, 1851	—	—				
4. *Family* Atrypidæ, *Dall*, 1877.						
Atrypa, *Dalman*, 1828	—	—				
Cœlospira, *Hall*, 1863	—					
Thecospira, *Zugmayer*, 1880	...	...	...	...	—	
Anoplotheca, *Sandb.*, 1855	...	—				
Koninckina, *Suess.*, 1853	...	...	...	...	—	
Koninckella, *Munier-Chalmas*, 1880	...	...	...	...	...	—
Davidsonia, *Bouchard*, 1847	...	—				
Glassia, *Dav.*, 1881	—	—				
Zygospira, *Hall*, 1862	—	—				

[1] This Table of classification is provisional, for much still remains to be discovered and explained. The details of classification, upon which Mr. Glass and myself are still at work, will be again referred to in the continuation of this Supplement.

In Pl. VIII of my General Introduction there are figures showing clearly the position and shape of the spirals in *Koninckina*. Figures of these spirals will be found also in Pl. III of the German edition of my General Introduction. The shape of the spirals, as far as the incomplete specimens show, seem similar to those of *Thecospira*. In this last the apex of the spiral coils faces the bottom of the middle of the ventral valve.

Figures of the spirals of *Davidsonia* will be found in Pl. XI of my 'Devonian Monograph.' In this genus, as in *Atrypa*, the apex of the spiral cone is directed towards the bottom of the dorsal valve.

The third division includes *Glassia* and *Zygospira*. In these genera the extremities of the spiral coils face each other towards the middle of the shell. In *Glassia*, as will be seen further on, the principal stems of the spiral coils are connected, as in *Atrypa*, while in *Zygospira* the principal lamellæ are connected lower down by means of a long curved band.

Mr. Glass's description of his *modus operandi* in developing the loops and spirals, to which he has given so much time and labour, will here precede my description of the genera and species of the spiral-bearing Brachiopoda.

On the Development of the Spirals and their connections in the Palæozoic Brachiopoda. By the Rev. Norman Glass.

" In May, 1860, I had the pleasure of discovering at Pen-y-llan, near Cardiff, the furthest Silurian outlier in that direction. Sir Roderick Murchison requested me to send him a number of fossils I had collected in this locality, and on their inspection he declared them to belong *par excellence* to the Wenlock Limestone. Amongst these fossils, which he termed 'very beautiful,' was a specimen of *Meristella tumida*, showing the spirals coated with crystallised carbonate of lime, and in a very perfect state of preservation. I had previously seen Mr. Davidson's figures of the spirals of *Spirifera striata* and *Athyris pectinifera*, &c.; but, though I had worked for some years amongst the Carboniferous and Silurian Rocks, it had never been my good fortune to find any trace of the spiral appendages. Some of my friends, who had great experience in collecting, had been equally unsuccessful in this respect, and it seemed to us—and, indeed, this was the general opinion—that specimens showing the spiral appendages of the Brachiopoda were extremely rare. The specimen of *Meristella tumida* referred to above was embedded in the surface of a mass of friable rock, and was itself evidently full of fractures, the spirals being apparent owing to a small fragment of the dorsal valve having been displaced. Experienced collectors can imagine the interest, blended with anxiety, with which I regarded this remarkable find. The slightest touch would apparently cause it to fall to pieces, and it was only by carefully carrying it in my hand, matrix and all, that I was able to bring it safely home. At last I had it securely embedded on the ventral side in plaster-of-Paris, and it was in this condition that Sir Roderick Murchison saw it. I little thought then of the numberless experiments and of the great trouble this species would cost me before it received its present designation of *Whitfieldia tumida*.

" These details may seem to be of little value to the reader, but they refer to my first connection with the spiral processes of the Brachiopoda, and from that time my interest in the matter has never ceased, and for many years I have made every experiment I could devise to find out a way of developing these interesting and important internal appendages. One thing I discovered most certainly by the fracture of numerous specimens, and that was, that the occurrence of the spiral processes in the Carboniferous and Silurian Brachiopoda was by no means uncommon; but the difficulty still remained of clearly developing them so as to reveal not only their shape but also their connections.

" In 1877, a deep cutting was formed for a railway branch near Walsall, and I had many opportunities there of collecting Silurian Brachiopoda, especially large numbers of *Meristella tumida,* which occurred in an abundance I have rarely seen equalled as to any species of fossil shells. By the careful chipping of the dorsal valve of specimens of *Spirifera plicatella, Atrypa reticularis,* and *Meristella tumida,* found in this locality, I was able in some cases to reveal the spirals in the same condition as in the specimen of *Meristella tumida* I found at Pen-y-llan, but I could not get at the connections, and the spirals were very much obscured by the coating of crystallised carbonate of lime surrounding them. I had observed that in many of the specimens the spirals were entirely surrounded by a solid matrix of spar, and at last I found out the way, by the use of a knife and water and hydrochloric acid, to develop distinctly in such cases not only the spirals but their connections with the hinge-plate of the dorsal valve, and their connection with each other. My first specimen I sent to Mr. Davidson in 1878, and since then I have gradually perfected the process, some of the results of which the readers will see in this Supplement.

" Perhaps it may be as well at first to give a short description of the different conditions as to matrix in which the spirals may be found. Sometimes the shell and spirals are silicified, whilst the matrix involving the spirals is calcareous. It is said that this was the condition of the specimens of *Spirifera striata* in the Cambridge Museum, which, as shown in Mr. Davidson's figures, so perfectly and beautifully reveal the spirals. These specimens were developed, it is stated, by acid, and were found somewhere in England; but after every possible research, and after having had thousands of specimens pass through my hands of the Silurian, Devonian, and Carboniferous Brachiopoda, I have not been able to find a single British specimen in the same condition. Mr. John Young, of the Hunterian Museum, Glasgow, has sent me some siliceous casts of *Athyris Roysii* from which the shell and spirals had been decomposed; and Mr. Davidson, in his 'Carboniferous Monograph,' refers to siliceous casts of *Spiriferina minima* and *Athyris* *ambigua* as occurring in decomposed limestone near Bakewell; but I have never seen nor heard, except in the case of the Cambridge specimens, of any examples of Brachiopoda being found amongst our British rocks in which the shell and spirals were silicified whilst the matrix surrounding the spirals was calcareous. Such examples occur not unfrequently in the Devonian rocks of the United States, and Mr. Whitfield, of the American Museum of Natural History, New York, has developed from these the spirals and their connections in *Meristella arcuata*, *Atrypa reticularis*, &c., with a perfection that leaves nothing to be desired. Indeed, with such specimens a due amount of care is certain to lead to clear and satisfactory results. Mr. Whitfield kindly sent to me a beautiful specimen of *Rensellæria*, in which the shell and loop were silicified—there being no matrix—and the loop being covered with small crystals of silex.

"In those cases, comparatively rare, where the shell is found without matrix, and the spirals are coated with crystallised carbonate of lime, there is little chance of revealing the connections, though the spirals themselves may be clearly seen. Mr. Davidson achieved a great success in his original discovery of the spiral arrangements of *Athyris* under somewhat similar conditions, but the success was without precedent, and seems little likely to have any repetition. The large proportion of the Palæozoic Brachiopoda are filled with a hard limestone matrix, and whether by sections or by any other method the results in such specimens as to the revealing of the spirals and their connections are very unsatisfactory.

"It only remains to notice those specimens, previously referred to, in which the shell is partially or wholly filled with a sparry calcareous matrix. It was in such specimens that nearly all the results given in this and in the 'Carboniferous' and 'Devonian Supplements' were achieved. The specimens having a sparry matrix occur in two general conditions. In some instances, especially in the large Carboniferous examples, the shell is present in a metamorphosed condition of hard limestone. In the majority of cases, especially in Silurian examples, the shell is either absent or changed into the same sparry condition as the matrix.

"In the former instance the sparry matrix is often revealed by a chip or fracture in the shell. When this is the case the first thing is to remove the shell, and, as the result of my experience, I may say that in most cases the spirals are most easily and effectively revealed by removing the dorsal valve. The shell should not be chipped away, as this would probably fracture the specimen, but it should be placed in a saucer, with the dorsal valve downwards, and then just enough of diluted hydrochloric acid should be put in the saucer to cover the dorsal valve. The acid will probably need renewing several times before the valve is removed so as to show the spar behind it. When the surface of the shell is plicated or irregular it should be first of all filed until it is smooth, otherwise the acid will eat away the surface into pits or hollows.

"When the shell is absent in the specimens, or changed into the same sparry condition as the matrix, of course this preliminary use of the acid is not needed. When nothing but calc-spar intervenes between the surface of the specimens and the spirals then the acid must be resolutely set aside, and reliance must be placed solely upon scraping with a knife, with many and repeated ablutions in water, until every trace of film of spar is removed from the surface of the spirals. Success in this operation of course requires practice so as to reveal perfectly the whole of the spirals without scraping away any portion of them. The knife to be used should be a large, single-bladed one, with a rounded and not hook-shaped point, and a part of the blade should be tied round with thick string so that it may be held firmly in the hand, as the end only of the blade should be used. Of course the knife will frequently need to be sharpened. The specimen to be operated upon should be held in the left hand and not rested upon any object. This prevents jarring, and enables the operator to nicely regulate the force which he applies with the knife.

"When the spirals are clearly revealed, free from every film or trace of the sparry matrix, the worked surface should be rubbed still more smooth by fine emery cloth, and then dipped for a few seconds only in the dilute acid in order to remove the dullness produced in working, when the dark lines of the spirals will be seen in clear and beautiful relief in the light matrix.

"In a large number of cases the spirals will be found in the sparry matrix in a fragmentary condition, or broken from the hinge-plate and displaced—specimens in such a condition are rarely worth the trouble of working. Now, it is a comparatively easy task to develop the spirals in the manner above described, but it is much more difficult to reveal their connections with each other, or their connections with the hinge-plate. Each genus requires some modification of method to achieve this end; indeed, for the development of each kind of spiral connection there is one way pre-eminently the best, and this way can only be discovered after many attempts and not a few failures, but once having discovered the right way the task becomes comparatively easy.

"The best way in each case is that which reveals, clearly and openly, in one and the same specimen, and in unbroken sequence, the connections of the spirals with the hinge-plate and their connections with each other, and this of course necessitates the scraping away in various directions of certain parts of the spirals. Mr. Davidson has figured specimens in several cases (*e.g.* of *Whitfieldia tumida* and *Merista Herculea,* &c.) in the exact condition in which I worked them, and the study of these figures will be of more use than any mere verbal description. I may observe in passing that, as a rule, those specimens only are suitable for the developing of the connections of the spirals, the interiors of which are entirely sparry, or which are sparry under the beak. In the figured examples referred to I first of all carefully removed the whole of the sparry matrix from the exterior of the spirals, being very careful in so doing not to injure the connection with the hinge-plate. Then I worked away the spirals from the ventral side until the specimens were in the condition in which they are figured. In very small specimens showing the spirals, and in most of the specimens showing the connections of the spirals, I have omitted the use of emery cloth, because of the danger of destroying some of the fine lines which need to be preserved; but in every case the final dip for a few seconds in the dilute acid is indispensable.

"In working out the smaller spirals, and in developing the connections of the spirals, it is advisable sometimes to use the point of a small pen-knife instead of the larger knife usually employed. It should be noticed, also, that in the case of small specimens the spirals should be worked out from both sides of the shell so as to show transparently, and that in most cases it is by transparency only that the connecting processes of the spirals càn be shown. The transparency is greatly increased by wetting the specimens. I have found nothing better than water for this purpose, though I have had many things recommended. In the preparation of the smaller objects a hand lens must be constantly used. The method above described will apply not only to the working out of the spirals and their connections, but also to the working out of the loops of the *Terebratulidæ*, &c.

"Something must be said here about the use of sections, as some operators not only use sections where they are indispensable, in the case of specimens with a hard limestone matrix, but also where they are entirely needless, in the case of specimens with a sparry matrix. It has become the fashion with some, when they refer to their preparations of the spiral-bearing Brachiopoda, to say that they have 'cut' such and such a specimen. Now, without regard to specimens with a sparry matrix, I object to the mode of operation referred to, and this not only because it is altogether needless, but also, and much worse, because the result of this cutting and making of sections is very often delusive. It must not be forgotten that the publication of a single erroneous figure is an injury to science and a stumbling-block in the path of further investigation. I would advise any one who might desire to cultivate this field of research, to 'cut' all such methods of arriving at results, for their ease is only equalled by their uncertainty.

"Since the first publication of the account of my process in the 'Carboniferous Supplement,' I have found that it had been before observed that those specimens of the Palæozoic Brachiopoda which are filled with spar are peculiarly favorable for working out the internal processes, and that the use of the knife and acid had been previously employed for this purpose, though not, I think, exactly in the same manner as above described. Mr. John Young, more than twelve years ago, operated with a knife and acid upon three sparry specimens of *Athyris ambigua* and one of *Athyris Roysii*, and more recently Mr. James Neilson, jun., of Glasgow, has operated in the same manner upon specimens of *Athyris Roysii* and *Spirifera lineata*. Herr H. Zugmayer, of Vienna, has also been lately engaged in a similar work. The principal credit, however, is due to Mr. Whitfield, who, for many years, has been engaged in developing the spirals and their connections, both in siliceous specimens and in those which are filled with a sparry matrix.

"As the result of my own careful and prolonged researches, I am convinced that specimens with sparry interiors are more or less plentifully to be found of every species of the spiral-bearing Brachiopoda. If, therefore, the method which I have described be assiduously pursued in future investigations, there is nothing to prevent a satisfactory exposition of the internal characters of the whole class referred to; and from being the most obscure, this part of the palæontological field might thus become the most clear and open.

"It has been a great pleasure to me to work with Mr. Davidson. Widely acquainted with all that was previously known on the subject, open to conviction, but exceedingly careful in the trial of evidence, Mr. Davidson has given to my researches all the value that was possible, and I feel persuaded that if any mistakes shall be ultimately found in the results here recorded, these will be both few and slight."

I may add that Mr. Glass has generously presented to me all the preparations which he has made during this investigation, including forty-eight British and thirteen Foreign species.

Genus—Nucleospira, *Davidson,* 1881.

3. Nucleospira pisum, *Sow.*, sp. Dav., Sil. Mon., Pl. X, figs. 16—20; and Sil. Sup., Pl. IV, figs. 15 to 18.

Nucleospira pisum, *Dav.* Geol. Mag., New Series, vol. viii, p. 7, 1881.

At page 106 of my 'Silurian Monograph,' I fully described and illustrated the external characters of this important and abundant Upper-Silurian species. I then also ascertained that *Nucleospira pisum* was provided with spiral processes for the support of the labial appendages, and that these may sometimes be seen through the transparency of its walls, as in the specimen I figured in 1866.

In the 'Twelfth Annual Report of the Regents of the University of the State of New York,' Professor Hall devotes several pages to the description and illustration of his genus *Nucleospira.* Since then the Rev. Norman Glass has, in the most careful and able manner, developed the spirals in this small species, and, what is far more difficult, its connecting processes. The spirals are somewhat oval in shape, and each spiral is found to consist of not more than six or seven convolutions, the extremities of the spirals being directed towards the lateral portions of the shell. The two principal stems of the spiral coils are attached to the hinge-plate, and extend a little way into the interior of the shell between the spirals, when they are suddenly bent backwards and upwards towards the hinge before following the curve of the bottom of the dorsal valve. The hook-shaped processes, which hang downwards from the hinge-plate, and which are formed by the primary lamellæ, are short and slightly bent inwards towards the ventral valve, as in *Merista, Meristella, Meristina,* and *Retzia.* In *Nucleospira* and *Athyris,* however, they are more extended, and form a strong downward curve, the convex side of which is towards the ventral valve. Laterally this process in *Nucleospira* and *Athyris* has a very beak-like appearance—an appearance which is rendered all the more prominent by the primary lamellæ being widened (slightly in *Nucleospira* and still more in *Athyris*) from the end of the hook-shaped processes to the point where the loop commences. The primary lamellæ, as they follow the curve of the bottom of the dorsal valve, converge to a little less than half the length of the spiral, where they give forth short converging lamellæ, which are slightly or more strongly undulated in shape, and which proceed straight across between the spirals to their ventral side before uniting in a sharp angular point. This point is turned upwards more or less gently or abruptly almost immediately behind the primary lamellæ on the ventral side. The end of the loop which is thus turned upwards varies in length in different specimens, never being very long, and sometimes being barely perceptible. The hook-shaped attachments of the primary lamellæ to the hinge-plate descend close to the pointed end of the loop, towards which they converge on either side. The close proximity of the pointed end of the loop to the hook-shaped attachments referred to often gives the appearance of an actual connection between them, and has added not a little to the difficulty of investigation. The two primary lamellæ, after giving off the processes which form the loop, diverge again as they proceed towards the front, and by a gentle curve form the first spiral coil. We are, therefore, now fully acquainted with the interior and exterior characters of this important genus and species. It occurs in immense numbers throughout the Wenlock Limestone and Shales.

Nucleospira pisiformis, Hall, from the Niagara group of Waldron, Indiana, and *Nucleospira ventricosa,* Hall, from the shaley limestone of the Lower-Helderberg group, Albany County, New York, cannot be specifically distinguished from Sowerby's *Nucleospira pisum.* None of the many hundred specimens of *N. pisum* that have passed through my hands exceeded five lines and a half in length by six in breadth and four in depth; only exceptional specimens attained these proportions.

Genus—Retzia, *King*, 1850.

4. Retzia Salteri, *Dav.* Sil. Mon., Pl. XII, figs. 21, 22; and Sil. Sup., Pl. IV, figs. 12, 13, 14.

Nothing further relating to the type of the genus *Retzia*, viz., *Retzia Adrieni*, de Verneuil, is known beyond the fact that the shell was provided with spiral appendages. Mr. Charles Barrois kindly sent for my examination several examples of the fossil he had collected at St. Arnao (Oviedo), Spain, but none of them, unfortunately, were workable.

Professor Hall devotes several pages of the 'Sixteenth Report of the Regents of the University of the State of New York' (1863) to the genus *Retzia* and to his genus *Rhynchospira.*

Retzia Salteri and *R. Bouchardi* have been referred by Professor King, myself, and other palæontologists, to the genus *Retzia;* and this is where I must leave them, at any rate until the internal arrangements of *Retzia Adrieni* shall have been investigated.

At p. 29 of the 'Twelfth Annual Report of the Regents of the State of New York,' Professor Hall describes his genus *Rhynchospira* and his *R. formosa* and *R. evax,* which much resemble, except in size, the *Retzia Bouchardi* of our Upper-Silurian rocks. Mr. Whitfield informs me also that my *Retzia Salteri* is a true *Rhynchospira,* and that he has an undescribed species very like it from Tenessee.

At p. 125 of my 'Silurian Monograph,' I fully described the exterior characters of *R. Salteri,* and noted that it was provided with spiral appendages. The Rev. Norman Glass has, at my request, developed in a most complete and admirable manner the spiral appendages, their attachments to the hinge-plate, as well as their loop, in several examples.

The spirals are somewhat oval in shape, and each spiral is found to consist of about ten convolutions. The two principal stems of the spiral coils are attached to the hinge-plate, and, after extending a little way into the interior of the shell between the spirals, are suddenly bent backwards and upwards towards the hinge, and after forming a curve converge to about half the length of the spiral, giving forth at that place short converging lamellæ, which are slightly or more strongly undulated in shape, and which proceed straight across between the spirals to their ventral side before uniting in a sharp angular point. This point is turned upwards more or less gently or abruptly almost immediately behind the primary lamellæ on the ventral side. The end of the loop which is thus turned upwards varies in length in different specimens, never being very long, and sometimes being barely perceptible. In some exceptional cases the loop differs from the description here given in its having an upward slope, instead of proceeding straight across. Each of the two primary lamellæ diverge again as they proceed towards the front, and by a gentle curve form the first spiral coil.

Mr. Glass has also developed several typical examples of Hall's *R. evax* from the Niagara group of Waldron, Indiana, and has found that its interior characters are exactly the same as above described for *R. Salteri.* (Sil. Sup., Pl. IV, fig. 19.) As we have described to be the case in *Retzia Salteri,* the loop in some cases slopes more upwards than in others.

Retzia principally differs from *Nucleospira* in the larger number of its spiral convolutions, and in the hook-like attachments of the primary lamellæ to the hinge-plate being shorter and not strongly curved. It differs also in the loop being slightly more distant from the hook-shaped processes.

Retzia Salteri occurs throughout the Wenlock series of Shropshire, but is not common in the shales that overlie the Wenlock Limestone, or in the Lower-Ludlow Shales.

The largest specimen of *Retzia Salteri* that has passed through my hands measured—length 6, breadth 8, depth 4 lines.

Retzia Bouchardi, Dav., is generally a much smaller shell with an elongated oval shape, and is far more abundant than *R. Salteri*. One specimen, however, of *R. Bouchardi* attained 7 lines in length by 6½ in breadth. *R. Salteri* and *R. Bouchardi* are therefore well characterised and distinct species.

Genus—MERISTINA, *Suess*, 1851.

5. MERISTINA DIDYMA, *Dalman*, sp. Dav., Sil. Mon., Pl. XII, figs. 1—10; and Sil. Sup., Pl. IV, figs. 20—23.

TEREBRATULA DIDYMA, *Dalman*. K. Vet.-Akad. Handl., pl. vi, fig. 7, 1828.
MERISTELLA DIDYMA, *Dav.* Sil. Mon., p. 112, pl. xxi, figs. 1—10, 1867.
MERISTINA NITIDA, *Hall*. Pal. New York, vol. iv, p. 299, 1867.

At p. 113 of my 'Silurian Monograph' I described the exterior of this species, but all I knew at the time of its interior character was that it possessed spiral appendages for the support of the labial appendages. The spirals are somewhat oval in shape, and each contains about nine convolutions. The two principal stems of the spiral coils are attached to the hinge-plate, and, after extending a little way into the interior of the shell between the spirals, are suddenly bent backwards and towards the hinge. After forming a curve they converge to about half the length of the spiral, giving forth at that place short converging lamellæ, which are slightly or more strongly undulated in shape, and which proceed straight across between the spirals to their ventral side before uniting in a sharp angular point. This point is turned upwards more or less gently or abruptly, almost immediately behind the primary lamellæ on the ventral side. The end of the loop which is thus turned upwards varies in length in different specimens, never being very long, and sometimes barely perceptible. What was said of *Retzia Salteri* may also be said of *Meristina didyma*, namely, that in some exceptional cases the loop differs from the description here given in its having an upward slope instead of proceeding straight across. The two primary lamellæ giving off the processes which form the loops diverge again as they proceed towards the front, and by a gentle curve form the first spiral coil.

Obs.—At p. 299 of the fourth volume of the 'Palæontology of New York,' Prof. Hall proposed a new genus, *Meristina*, for shells in which "*the lamellæ of spires are united by a simple loop*," and mentions *Meristina Maria* and *Meristina nitida*, Hall, as types of his genus.

The beautiful preparations on which this genus was founded were made by Mr. R. P. Whitfield for Prof. Hall's great work on the 'Palæontology of New York.'

From the identity of external shape presented by Prof. Hall's *Meristina Maria* with Dalman's *Atrypa tumida* Mr. Glass and myself felt that with such similar exteriors it was hardly possible to believe they could be possessed of dissimilar interiors. At my request, Prof. Hall kindly sent me several examples of his *Meristina Maria* that Mr. Glass might be able to develop their interior arrangements, this he effected with his usual ability, and was soon able to show that the so-called *Meristina Maria* presented the forked character of the loop of *Meristella tumida*. Under such circumstances, it became necessary to remove *Meristina Maria* from the genus *Meristina*, and to place it among the synonyms of *Whitfieldia tumida*.[1]

Through Mr. Whitfield's kindness we have also been able to examine the prepared specimen of *Meristina Maria* from which the figure at p. 299 of the 'Palæontology of New York' was made, and Mr. Glass soon perceived that Mr. Whitfield had unfortunately destroyed the bifurcating lines at the end of the loop in making a perforation under the beak of the ventral valve, and that this had led to the mistake in Prof. Hall's figure.

Through the kindness of Mr. Whitfield we have been able to examine the admirable preparations made by himself of *Meristina nitida*, Hall; and these agree with the description given of the genus *Meristina* by Prof. Hall, and have the lamellæ of their spires united by a simple loop. This species should consequently be considered as the type of the genus *Meristina*.

I was, however, in error when, at p. 114 of my 'Silurian Monograph,' I considered Sowerby's *Terebratula læviuscula* to be a synonym of Hall's *Meristella nitida*; for, although Mr. Glass has not been able to completely develop the connecting processes of Sowerby's shell, still he has seen enough of it to lead him to believe that it was not possessed of a simple loop, as in *M. nitida*. It will, however, remain to be determined whether Hall's *M. nitida* is specifically distinct from Dalman's *Terebratula didyma*. I believe them to belong to the same species; and Dalman's name is the oldest.

The *Terebratula didyma* of Dalman is decidedly referable to *Meristina*, and should be the type of the genus. An English specimen from the Wenlock Limestone of Lincoln Hill, Shropshire, successfully developed by Mr. Glass, shows the simple loop of *Meristina*.

Several Swedish specimens of Dalman's *T. didyma* having been sent kindly to me by Prof. Lindström, of Stockholm, Mr. Glass has been able to develop the simple loop in them also, and in the most complete and satisfactory manner.

It will remain a question for further consideration whether we are justified in retaining the three distinct generic denominations of *Nucleospira*, *Retzia*, and *Meristina*, for shells possessing the same simple loop. The only differences between them is to be

[1] Mr R. P. Whitfield writes me, on 25th of April, 1881: "There has always been some doubt in regard to the absolute generic identity of *Meristina nitida* and *M. Maria*, not on account of the difference of the loop, for I know of none, as you will see from the specimen sent, but on account of the perforation of the apex of *M. nitida*, which does not occur in *M. Maria*, and I think Prof. Hall always looked upon *Meristina nitida* as the type of *Meristina*."

found in the number of coils in the spirals. *Nucleospira*, however, differs from the other two in its having the beak-shaped attachments to the hinge-plate, as in *Athyris*.

Meristina didyma does not appear to be a very common fossil in our English Upper Silurian rocks; but it occurs both in the Wenlock and Ludlow series in Great Britain.

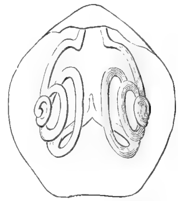
Genus.—Dayia, *Davidson*, 1881.

6. Dayia navicula, *Sow.*, sp. Dav., Sil. Mon., Pl. XXII, figs. 20—23; and Sil. Sup., Pl. V, figs. 1 to 4.

Davidson on the genus *Dayia*. Geol. Mag., new series, vol. viii, p. 291, 1881.
Terebratula navicula, *J. de C. Sow.* Sil. Syst., pl. v, fig. 17, 1839.

At p. 191 of my 'Silurian Monograph' I say: "Surely this shell differs much, both by its external as well as its internal characters, from those peculiar to the genus *Rhynchonella*, so much so that it may hereafter be found desirable to propose for it and similarly characterised shells a separate specific, generic, or subgeneric designation." In 1867 I was acquainted with the interior surface of both valves, and described and figured in detail its very remarkable muscular and other impressions, but I had no idea that the shell was provided with spiral coils for the support of the labial appendages. During the month of March, 1880, the Rev. H. G. Day showed me some fine specimens of the so-termed *Rh. navicula*, and offered to send them to the Rev. Norman Glass that he might see whether the shell was possessed of spiral appendages, and on the 22nd of the same month Mr. Glass wrote me: "I now send you two specimens worked out of *R.? navicula*, showing entirely new spirals and loop." And since all the interior characters are so distinct from what we find in other spiral-bearing genera, Mr. Glass suggested that I should propose a new genus for the shell under description. It is very probable even that we have in our British Silurian rocks other species referable to the same genus, but we are at present certainly acquainted with *Dayia navicula* only, so that the generic characters may be taken from that as the type.

Exteriorly *Dayia navicula* is elongated, oval, or boat-shaped, broadest posteriorly. Ventral valve very deep, convex, arched, and keeled along the middle; beak closely incurved. Dorsal valve slightly convex posteriorly; anterior half of shell concave. Surface smooth. On the interior surface of the dorsal valve a slightly raised ridge extends from under the hinge-plate to about half the length of the valve, and on either side are two scars formed by the adductor muscle. On the internal cast the place occupied by the mesial ridge forms a longitudinal groove, the muscular impressions being slightly in relief on either side. The sockets are widely separate. The primary stems of the spirals are attached to the hinge-plate of the dorsal valve, and after extending parallel to each other for a short distance bend at right angles abruptly towards the lateral portions of the beak, and form two large curves facing the lateral portions of the valve. On approaching the front they form four or five convolutions, which become smaller until they reach their terminal coil, which faces the middle of the lateral portions of the shell. Near the front the primary lamellæ give off two processes, which converge and extend between the spiral coils in an upward and backward direction; after becoming united towards the middle of the shell, they are again prolonged in the shape of a single lamella, which proceeds upwards for a little distance with its extremity directed towards the hinge-plate. The spiral coils are therefore connected by a loop having a somewhat similar position to that described by Professor J. Hall in one of his figures of *Zygospira*, but in this figure the spiral coils have their extremities facing each other in the centre of the shell, while in *Dayia* it is quite the reverse, the extremities of the spiral coils facing the lateral portions of the shell.



Interior of the dorsal valve of *Dayia navicula*. Developed by the Rev. Norman Glass.

In the interior of the ventral valve a mesial groove extends from the extremity of the beak to about the middle of the shell, and on either side, running parallel with the hinge-line, are two broad, rounded projections, at the outer extremity of which is situated the articulating tooth; under these are two obliquely placed or chevron-like, elongated, oval muscular scars, considerably raised from the bottom of the valve, these projecting parts forming corresponding depressions on the internal cast.

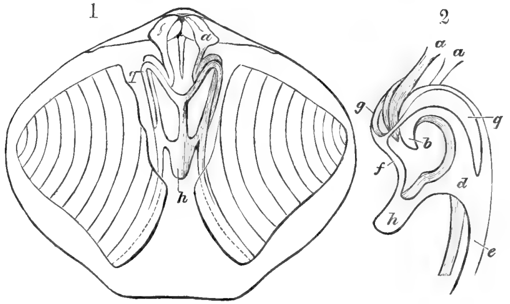
We are therefore now, thanks to the incomparable skill of the Rev. Norman Glass, fully acquainted with the characters of the spiral arrangement of this remarkable genus, which I name after the Rev. H. G. Day in consideration of the important help he has always been ready to offer me in my investigations of the Silurian fossils, with which he is well acquainted.

Placed by Sowerby in 1839 with *Terebratula*, by M'Coy in *Atrypa* in 1846, with *Hypothyris* by Phillips in 1849, with *Rhynchonella* by Salter in 1859, I hope it has now found a resting place in *Dayia*, being entirely dissimilar from any of the genera above quoted. *Dayia navicula*, as we have stated elsewhere, seems confined to the Upper Silurian. It would be very desirable that the interior of the so-termed *Merista? cymbula*, Dav., should be examined, for it bears much exterior resemblance to *Dayia navicula*. The presence, however, of a shoe-lifter process in the ventral valve would make it very doubtful as to the possibility of its belonging to *Dayia*.

Genus—Athyris, *M'Coy*, 1844 = *Spirigera*, D'Orbigny, 1847.

Sup., Pl. V, figs. 14 to 19.

The internal characters of this important genus are now well known. It will be desirable to take the characters of the genus from Mr. Glass's admirably prepared specimens of the Carboniferous *Athyris plano-sulcata* of Phillips. The first attachment of the spirals takes place at the hinge-plate (*a*); thence the two principal stems proceed for a short distance downwards to *b*, then they suddenly bend backwards, forming a broad rounded curve facing the bottom of the dorsal valve (*b*, *d*, *e*). The primary lamellæ between the hinge-plate and the point *b* are slightly curved. The con-



Athyris plano-sulcata. Carboniferous; Castleton, Derbyshire. Developed by the Rev. Norman Glass.

vexity being towards the ventral side. From *b*, the primary lamellæ increase in width, this increased width continuing to a little less than half their length at *d*. At this point each principal stem gives forth a lamella (*d*, *h*,) which projects into the middle space intervening between the two spirals, and here the lamellæ are connected together and become expanded, and roof-shaped (*h*). This roof-shaped projection is broader in some specimens than in others. From the upper portion of the expanded roof-shaped projection (*h*) a curved lamella (*f*) extends upwards, and bifurcating at its extremity gives off on either side a lamella (*g*). The accessory lamella (*q*) curves upwards and backwards to the inside of the primary lamella, the course of which it follows to *d*, and, though it is entirely free from attachment, it is much closer throughout to the first than to the second coil. The accessory lamella is very narrow at its commencement, but it afterwards increases in width and is slightly narrowed again before its termination.

The main features of the above description are the same as those which I have previously given in my 'Permian' and 'Carboniferous' Monographs, and in the 'Geological Magazine' for January, 1881. The new details now given as to the shape and direction of the primary lamellæ near their origin, and also as to the shape of the accessory lamellæ, have been derived from the recent and extended researches of Mr. Glass.

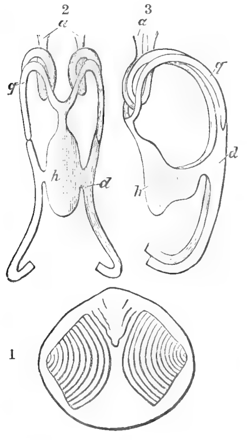
The first description of the connections of the spirals in *Athyris pectinifera* was given in my 'Permian Monograph,' in April, 1858; also I gave a description of the spirals and connections of *Athyris ambigua* in my 'Carboniferous Monograph' in April of the same year. In vol. iv, pp. 282—290, of his 'Palæontology of New York,' Professor Hall described the connections of the spirals in *Athyris spiriferoides* and *A. vittata*, and in 1880 Herr H. Zugmayer described the connections of the spirals of *Athyris* (*Spirigera*) *oxycolpos*.[1] Now, between the descriptions given by myself and Mr. Glass in their completed form, and those given by Hall and Zugmayer, there are some important differences. I may say that there is much more resemblance between the descriptions of Zugmayer and my own than between the latter and those of Hall. The only points in which Zugmayer's description differs from mine are—*first*, that the accessory lamellæ, and the portion of the primary lamellæ which is behind it, are represented by him as having their lower edge denticulated; *second*, that the primary lamellæ are represented by him as descending from the hinge-plate so far forward as to unite with the loop before they curve backwards to follow the contour of the bottom of the dorsal valve. In subsequent correspondence with Zugmayer he has granted, on the inspection of my drawings, that he is in error in relation to the second point, and that the representations I have given are correct;[2] so that the only difference remaining, and not a very important one, is that in Zugmayer's figures of *Athyris* (*Spirigera*) *oxycolpos* the accessory lamella and the portion of the primary lamella which is behind it are denticulated.

Herr Zugmayer has kindly forwarded to me two of his preparations of *A. oxycolpos*, one of which he regards as showing the denticulation of the lower edge of the accessory lamella. Having sent the specimens to Mr. Glass, he writes to me that there is certainly some appearance of denticulation in one of the specimens, but that it is not sufficiently distinct to form the basis of a description, the appearance possibly being accidental and due to peculiarities of the matrix. Mr. Glass is the more inclined to this opinion, because one of the two specimens sent shows nothing of the denticulation of the accessory lamellæ, but closely resembles the preparations of our British *A. plano-sulcata*. Mr. Glass thinks, however, and in this I quite agree with him, that possibly the denticulation may exist as represented. It is to be hoped in his further researches Herr Zugmayer will add a complete determination of this interesting point to the other valuable discoveries which he has already made.

[1] 'Untersuchungen über Rhätische Brachiopoden: Beiträgen zur Paläontologie Oesterreich-Ungarns,' von E. V. Mojsisovics und M. Neumayr, vol. i, pl. iii, figs. 2—23.

[2] Since the above was written Herr Zugmayer has corrected his little mistake in the 'Neues Jahrbuch für Mineralogie,' July, 1881; "Über das Gerüst von *Spirigera oxycolpos*, Emmr."

The Rev. Norman Glass and myself are of opinion that in some of the species of *Athyris* the loop and attachments, whilst on the whole similar to those of *A. plano-sulcata,* are slightly modified in minor details; such modifications, so far as our present knowledge extends, being confined to some of the species in the Devonian rocks of America. For example, in *A. spiriferoides* (a shell much resembling in shape and size the *Athyris concentrica* of von Buch, and extremely abundant in the Hamilton Devonian group at Eighteen-Mile Creek, Lake Erie, and in other places in America), the part of the primary lamella where the curve of the first coil of the spiral commences is not widened as in *A. plano-sulcata;* and the attachment to the hinge-plate lies more backward towards the dorsal side, and does not appear, as in *A. plano-sulcata,* in the ventral aspect of the spirals. In the figure of *A. spiriferoides* given by Professor Hall in vol. iv, p. 284, of his work on the 'Palæontology of New York,' the attachment to the hinge-plate is represented as forming, together with the commencement of the curve of the first coil of the spiral, a perfect circle. Mr. Glass found, however, in some specimens of this species which he worked out, that the attachment to the hinge-plate, together with the commencement of the curve of the first coil of the spiral, forms a somewhat elongated oval, which is slightly angular at its lower part. The loop in *A. spiriferoides,* as given by Professor Hall, differs from that worked out in the same species by Mr. Glass, and this is found to be similar to that of *A. plano-sulcata,* only differing from it, indeed, in the shape and size of the roof-shaped projection in the centre. Professor Hall represents the supplementary lamella of *A. spiriferoides* as being attached to the primary lamellæ. Mr. Glass found, it is true, in some specimens the supplementary lamellæ were in close apposition to the primary lamellæ, as he had also found to be the case in many specimens of *A. plano-sulcata;* but in one specimen of *A. spiriferoides* Mr. Glass discovered the ends of the supplementary lamellæ to be free.



1, 2, 3, *Athyris spiriferoides.*
1. Showing spirals, loop, and attachments to hinge-plate. 2, 3, the loop, attachments to the hinge-plate, &c. Enlarged. Developed by the Rev. N. Glass.

Mr. Whitfield has recently informed Mr. Glass that in the American Devonian species of *Athyris* the ends of the supplementary lamellæ are free. Professor Hall figured, together with *A. spiriferoides,* the loop and attachments of *A. vittata,* and the internal arrangements of the two species are represented as being very similar. Mr. Whitfield, with the greatest kindness, lent me some of the preparations from which the original figures of *A. spiriferoides* and *A. vittata* were taken, but neither Mr. Glass nor myself could determine anything from them. Mr. Whitfield also furnished my friend with a number of unworked specimens of *A. spiriferoides,* but he could not supply him with any duplicate specimens of *A. vittata*. All the specimens of *A. spiriferoides* which Mr. Glass and myself have seen are either filled with a limestone matrix or with a dark bituminous spar, which is sometimes quite black and entirely impervious to light, and which even when in a more favorable condition is very difficult to work with satisfactory results. In this respect we have been very fortunate in our British Carboniferous *Athyris;* for the specimens at Castleton, in Derbyshire, are filled with a spar beautifully transparent and peculiarly favorable for working. Other slight modifications of the form of the loop and attachments of *Athyris*, as represented by *A. plano-sulcata*, may still be discovered, but as this species has been so fully and clearly worked out, the task of comparison with it will be easy.

At page 23 of my 'Monograph of British Oolitic Brachiopoda,' published in 1851, I mentioned, while describing the spiral coils of *Spiriferina*, that the lamellæ are always thicker on the inner side of the circumference than on the outer, which tapers out into an acute edge, and this character I find to prevail in all the spiral-bearing species that have come under my notice. In some, however, the thickest part of the lamella is towards the middle. I have also observed that spines often appear on the edge and the face of the lamella fronting the sides of the shell. These spines, arising from an expanded base, are implanted very irregularly, always directing themselves towards the exterior of the spire and in general horizontally to it. The same character is seen on the loops of the Terebratulidæ. Spines have been detected by Mr. Glass under similar conditions on the spirals of *A. plano-sulcata*.

The genus *Athyris* is represented in the Devonian, Carboniferous, Permian, and Triassic formations, and now, resulting from the investigations of Mr. Glass, it is proved also to exist in the Silurian formation. Experience has abundantly shown in our later researches that until we are acquainted with the loops and connections of the spiral-bearing species it is hazardous to determine to which genera or divisions any of them should belong. Those species, therefore, that are classed with *Athyris* in my 'Silurian Monograph' must be considered so provisionally, the only British Silurian *Athyris* with which we are certainly acquainted at present being *A. læviuscula*.

7. ATHYRIS LÆVIUSCULA, *Sow.*, sp. Dav., Sil. Mon., Pl. X, figs. 28—32; and Sil. Sup., Pl. IV, figs. 24 to 26.

TEREBRATULA LÆVIUSCULA, *Sow.* Sil. Syst., pl. xiii, fig. 14, 1839.
MERISTELLA NITIDA, *Dav.* Sil. Mon., p. 114 (not *Atrypa nitida*, Hall), 1867.

Marginally of a somewhat elongated, pentagonal shape, truncated, and slightly indented in front, broadest about the middle, tapering posteriorly. Valves almost equally convex, with a slight median depression near the front in the ventral valve. Beak strongly incurved and truncated by a minute oval foramen; surface smooth, marked by a few concentric lines of growth. In the interior of dorsal valve the spirals are composed each of not more than six or seven convolutions.

Length 6, breadth 5 lines, but the generality of specimens are much smaller.

Obs.—The small dimensions attained by this species caused the Rev. Norman Glass much trouble in his patient endeavours to work out its interior arrangements. A great number of English specimens were operated upon, as well as a number of Swedish ones kindly contributed by Professor Lindström, of Stockholm. Mr. Glass has shown in a very plain manner the accessory lamellæ, also the hook-shaped attachments to the hinge-plate; but, on account of the smallness of the specimens, it was not possible to expose the loop or its attachments to the primary lamellæ in the same manner he had so successfully achieved in *Athyris plano-sulcata*. We are both convinced that Sowerby's species is an *Athyris*. It is probable also that some other of our British Silurian spiral-bearing species may be referable to *Athyris*, only the material for proving this has not been hitherto obtained.

I was completely mistaken when, at p. 115 of my 'Silurian Monograph,' I considered Sowerby's *T. læviuscula* to be an immature form of Hall's *Meristina nitida*. Since then, thanks to Mr. Maw's extensive washings of Lower-Wenlock Shales, as well as hand pickings from the detritus of the Wenlock Limestone in the old quarries of Benthall Edge, I have been able to examine a large number of specimens of Sowerby's species. I have also, thanks to Professor Hall and Mr. Whitfield, been able to study a number of specimens of the so-called *Meristina nitida* from the Niagara group, Waldron, Indiana; and I have come to the conclusion that *Meristina nitida* is a synonym of *Meristina didyma*, and that *Athyris læviuscula* is both generically and specifically distinct from Dalman's species as well as from Professor Hall's. The searching examination of the interior of both these species by the Rev. Norman Glass has left not a shadow of doubt upon this subject.

In a specimen one line and a half in length, cleared out by Mr. Glass, there were only three coils in each spiral. In another, four lines in length, four coils; and none of the largest specimens have shown more than six or seven in each spiral. *Athyris læviuscula* varies a good deal in shape. Some young specimens are as wide as long, but full-grown specimens are elongated, oval, truncated in front, and tapering at the beak. Large examples, measuring six lines in length, seem extremely rare; most of the specimens average from three to four lines in length. A few examples were also obtained by Mr. Maw from the washings of some three tons weight of Lower-Ludlow Shales from the railway-cutting between Wenlock and Presthope in Shropshire. It appears likewise not to be very rare in the Wenlock series of the Island of Gothland in the Baltic.

Genus—MERISTA, *Suess*, 1851. Dav., Sil. Sup., Pl. V, figs. 10 to 13.

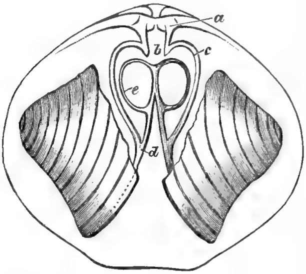
Davidson, On the Genus *Merista*, Geol. Mag., New Series, vol. viii, p. 289, 1881.

In his memoir, 'Brachiop. der Kössener Schichten,' p. 17, Professor E. Suess proposed his genus MERISTA, giving as its type the *M. Herculea*, Barrande; and at p. 85 of the German edition of the General Introduction to my work on 'British Fossil Brachiopoda' Professor E. Suess redescribes his genus, and in pl. iii figures its spirals and shoe-lifter process; but neither the connections of the spirals nor their attachments to the hinge-plate had then been discovered. Professor Suess also includes in his genus *Merista* the *Whitfieldia* (*Atrypa*) *tumida* of Dalman, the internal and differential characters of which were then likewise unknown. In our Devonian rocks the genus *Merista* is represented by the *Merista plebeia* or *scalprum*; but, although Mr. Glass was able in several specimens to develop its spirals, he entirely failed to expose its loop, on account of the difficult nature of the limestone or opaque spar which fills most of the specimens.

Considering it to be very desirable that the internal characters of this important genus should if possible be discovered, I wrote to my old and valued friends, M. Barrande and Prof. Kregie, of Prague, and to Professor Suess, of Vienna, requesting them to kindly send me some specimens of *Merista Herculea*, that the Rev. Norman Glass might endeavour to work out the loop and the attachments to the hinge-plate which had not been hitherto discovered; and, thanks to his great skill and patience, we are now acquainted with the whole characters belonging to the genus under description.

We are not positively acquainted with any certain representative of the genus in our British Silurian rocks, unless *Merista ? cymbula* and *M. ? Circe* belong to the genus. The well-developed shoe-lifter process in the former is that of *Merista;* but we are not acquainted with its spirals or their connections, and I have not been able to procure specimens of it suitable to Mr. Glass's operations. We have therefore to describe the internal character of the genus from our examination of foreign examples of the type, *Merista Herculea* of Barrande.

The principal stems forming the spirals are attached to the hinge-plate (*a*); thence they proceed for a short distance into the interior of the shell with a very gentle inclination forwards, and at *b* they are abruptly bent backwards at an acute angle towards the bottom of the lateral portions of the beak. Thence they form a broad rounded curve facing the bottom of the dorsal valve (*c*), and after converging to about half their length again diverge towards the front, and thus form the first spiral coil; again at about half their length (at *d*) the principal lamellæ widen and give off another lamella. These lamellæ converge from both sides towards the middle of the interior of the shell between the spiral coils, and after the two extremities have come into contact the lamella thus formed proceeds in a straight direction for a short distance to near the hinge-plate, and then bifurcates and curves round on each side, forming two slender rings (*e*), the anterior border of these rings being attached a little below the place where the converging lamellæ of the loop become united. The outer edges of the rings slope gently towards the bottom of the dorsal valve. The rings are rather less in width than the width of the primary branches to which they are attached. The spiral cones are composed of ten or twelve convolutions, the number, however, varying in different specimens and at different stages of growth. The extremities of the spirals are directed towards the middle of the lateral portions of the shell.



Merista Herculea, Barrande.
Interior of the dorsal valve, exposed by the Rev. Norman Glass.

In the ventral valve, under the beak, are two roof-shaped plates, fixed by their lateral margins to the medio-longitudinal region of the valve, and with their narrow end fitting under the extremity of the beak. Prof. King compared these plates to a shoe-lifter.

With very small differences the loop of *Meristella*, Hall, is similar to that we have described in *Merista;* and, were it not that *Meristella* has no shoe-lifter process, it would be impossible to distinguish the two genera. Again, *Whitfieldia tumida* is distinguishable from both *Merista* and *Meristella* by the absence of those peculiar ring-shaped processes attached to the loop, and has instead only a short bifurcating process where in both the last-named genera the rings are formed. These three genera seem, indeed, closely allied, although each contains peculiarities by which it may be distinguished from the others. I am also indebted to Dr. C. Röminger for the sight of a specimen of *Merista Herculea* he has endeavoured to develop, but in which, although he succeeded in exposing the spirals, he failed in obtaining the attachments of the spirals or loop.

Mr. R. P. Whitfield writes me that in American Silurian rocks the genus *Merista* is hitherto known to be represented by one species only, namely, the *Merista* (*Camarium*) *typus,* Hall, of which the *M. elongata* is a variety. It is consequently as rare in that part of the world as it is in Great Britain. In Bohemia, on the contrary, the species of the genus are numerous, and are figured in Barrande's magnificent work on the Silurian fossils of that kingdom.

The genus *Merista* appears to be largely represented in the Devonian and Silurian rocks of different countries, although rare in Great Britain. Since the discovery made by Mr. Glass of the complete interior of *Merista Herculea,* its rings, connections, &c., Herr Zugmayer has devoted considerable time and patience to developing the interior of several specimens of Quenstedt's *Merista cassidea-prunulum* from the Devonian rocks of the Eifel. He has worked out the spirals, attachments to the hinge-plate, loop, rings, and shoe-lifter process; and these, although apparently differing slightly in minor details from what we find to be the arrangements in *M. Herculea*, have all essential characters the same. Herr Zugmayer writes me that the specimens from the Eifel are very difficult to examine, as only in very few cases he has found them to contain a suitable or workable matrix.

8. Merista ? Circe, *Barrande* (?). Dav., Sil. Mon., Pl. X, figs. 33—35.

At p. 116 of my Silurian Monograph I described and figured a small spiral-bearing Brachiopoda as the *Meristella Circe* of Barrande. In 1881 I asked Mr. Barrande to kindly send me some typical examples of his species, and the Rev. Norman Glass discovered rings in one specimen and the shoe-lifter process in another.

Until English specimens referred by myself *with much uncertainty* to Barrande's species have been developed, nothing can be stated as to the probability of our English so-called *M.* (?) *Circe* being the same as Barrande's *Merista Circe.*

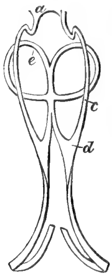
The English shell we have provisionally referred to *Merista Circe* occurs in several of our localities of Wenlock Limestone and Wenlock Shales, such as Dudley, Holyhead, near Walsall, in the Woolhope Limestone, &c. Any gentleman possessing or able to procure duplicates of the shell would render a service to science in sending them to the Rev. Norman Glass at Manchester, that he may be able to develop its interior so as to ascertain the *genus* to which it belongs. A species similar to our own occurs also in rocks of the same age in the Island of Gothland; and although Dr. Lindström kindly sent to me three or four examples, Mr. Glass was unable to work out their interiors. Renewed efforts may be more successful: all that is required is suitable material to operate upon.

Genus—Meristella, *Hall*, 1860. Dav. Sil., Sup., Pl. V, figs. 7, 8, 9.

Thirteenth Annual Report of the University Regents on the Condition of the State Cabinet of Natural History, 1860; and Pal. of New York, vol. iv, p. 295, 1867. Type *Meristella arcuata*, Hall.

The genus *Meristella* was proposed by Prof. Hall for several species of Brachiopoda possessing a very peculiar internal arrangement of the process or loop by which the two spiral coils are connected.

In external shape *Meristella* is said to be oval, ovoid, or suborbicular, elongate or rarely transverse; valves unequally convex, with or without a median fold or sinus; beak much incurved, sometimes with a small circular foramen; surface smooth. In the interior of the dorsal valve the primary stems of the spiral coils are attached to a strong hinge-plate at *a*. After extending slightly downwards under the beak of the ventral valve, they suddenly bend backwards at and towards the lateral portions of the shell. From thence (as in *Merista* and *Whitfieldia*) they form a broad rounded curve facing the bottom of the dorsal valve (*c*), and after converging to about half their length again diverge towards the front, and thus form the first spiral coil. At about half their length (at *d*) the principal lamellæ widen and they each give off another lamella. These lamellæ converge from both sides towards the middle of the interior of the shell between the spiral coils, and after the two extremities have come into contact, the lamella thus formed proceeds in a straight direction for a short distance to near the hinge-plate, and then bifurcates and curves round on each side forming two slender rings (*e*). The outer sides of the rings slope gently downwards towards the primary branches to which they are attached.



Meristella arcuata, Hall.
Dorsal view of the central parts of the spiral lamellæ (after Hall).

From this description it will be seen how completely the loop and connections in *Meristella* agree with those of *Merista*. Prof. Hall was not, however, acquainted with the loop or its attachments in *Merista*, and consequently could not point out their identity.

Meristella differs, however, from *Merista* by the absence of a shoe-lifter process in the ventral valve. It shows, as observed by Prof. Hall, "a triangular fissure below the beak, which joins a semicircular perforation at the apex . . . . . . and there is sometimes a thickening of the shell at the base of the rostral cavity, which limits the muscular impressions; but there is neither septum nor rudiment of one, as in *Merista*."

With his usual liberality and desire to afford help in our researches, Mr. Whitfield forwarded to the Rev. N. Glass a specimen of *Meristella arcuata*, in which the spirals and their connections were silicified, and Mr. Glass was able to dissolve the matrix surrounding the lamellæ and to expose the rings of the loop in the most clear and beautiful manner. In the specimen developed by Mr. Glass the rings are not as large as they are figured by Mr. Whitfield, that is to say, they do not appear to extend beyond the outer margin of the primary stems of the spirals, but are rather within them.

I have likewise, thanks to Mr. Whitfield's liberality, been able to examine a developed specimen of Prof. Hall's *Meristella Barrisi* from the Marcellus shale and Hamilton group of Southern Indiana, and which showed the rings of the loops in great perfection.

In my 'Silurian Monograph' I placed with the genus *Meristella A. tumida.* Dal., *M. angustifrons,* M'Coy, *M. didyma,* Dal., *M. læviuscula,* Sow., *M. Circe,* Bar., *M. ? Maclareni,* Haswell, *M. ? crassa,* Sow., *M. furcata,* Sow., and *M. ? subundata* M'Coy; but it is very uncertain whether any of these are really referable to Prof. Hall's genus.

We know that *M. tumida* is a *Whitfieldia, M. didyma* a *Meristina,* and *M. læviuscula* probably an *Athyris.* Unfortunately, we know as yet nothing concerning the attachments of the spirals in British specimens referred to *M. ? Circe* and the others; and until their interiors shall have been properly investigated it is not possible to determine the genus to which they belong. None of the British Silurian spiral-bearing species developed by Mr. Glass have shown the rings of *Meristella,* consequently we cannot at present assert that the genus occurs in our English rocks, and, indeed, recent investigations have proved beyond doubt that until the internal characters have been determined in any spiral-bearing species it is hazardous to speak confidently on what may be the character of the loop from the mere inspection of the exterior. The presence or absence of the shoe-lifter process is often revealed on the exterior of the beak or posterior portion of the ventral valve by the presence in *Merista* of two deviating lines, which do not occur in *Meristella,* and which may so far be of help, although they do occur in *Whitfieldia.*

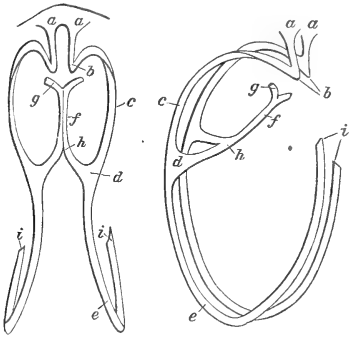
Genus—Whitfieldia, *Dav.*, 1881.

9. Whitfieldia tumida, *Dalm.*, sp. Dav. Sil. Mon., Pl. XI, figs. 1—13; and Sil. Sup., Pl. V, figs. 5, 6, Pl. VI, figs. 1 to 9.

Atrypa tumida, *Dalman.* Vet. Akad. Handl., p. 134, pl. v, fig. 3, 1828.
Meristella tumida, *Dav.* Sil. Mon., p. 109, 1866.
Meristina Maria, *J. Hall.* Pal. New York, vol. vi, p. 299, 1867.
Whitfieldia tumida, *Dav.* Geol. Mag., New Series, vol. viii, p. 156, April, 1881.

The external characters of this species have been fully described at p. 109 of my 'Silurian Monograph,' and I gave one figure showing the spiral appendages, and others exhibiting the muscular impressions. Since then the Rev. Norman Glass has been able not only to expose the spirals, but to take them entirely out of the shell, or from the hard, sparry matrix with which they were surrounded, so that they can be examined in every direction (see 'Sup.,' Pl. VI, figs. 3, 3*a*, 3*b*, 3*c*). He has also completely excavated the inner side of one of the spiral cones, so that when held up between the eye and the light the various convolutions can be seen as a transparency.

He has likewise been able to work out the attachment of the principal stems to the hinge-plate and their complicated system of connecting lamellæ.



Whitfieldia tumida.
Loop and attachments to the hinge-plate, after Mr. Glass's preparation.

In the interior of the dorsal valve the principal stems are attached to the hinge-plate (at *a*). After extending slightly downwards under the beak of the ventral valve for a short distance, their extremities (*b*) suddenly bend backwards towards the lateral portions of the valve in the shape of the letter **V**, the outer branches forming a broad curve facing the bottom of the dorsal valve. These primary stems gradually converge to about half their length, and then diverge again near the front, thus forming the first coil of the spirals. At about half their length (at *d*) the lamellæ widen, and they each give off another lamella (*d*, *h*). These lamellæ converge from both sides, and in an inward direction towards the middle of the interior of the shell and between the spiral coils. After the two extremities have come in contact at the point *h*, the conjoined lamella continues in a straight direction towards the beak (*h*, *f*,) and after coming to within a short distance of the point where the primary lamellæ are attached to the hinge-plate, it bifurcates and forms a short **V**-shaped process (*g*).

In addition to the specimens figured, Mr. Glass made several additional preparations in order to discover whether the lamellæ forming the **V**-shaped or forked process (*g*) had any further extension, as figured by Professor Hall in his genus *Meristella* (*M. arcuata*); but he could discover no trace of any similar extension.

In 1880 Professor Hall kindly sent me some specimens of his so-termed *Meristina Maria*, and I was at once struck by the complete identity of its exterior form with the *Atrypa tumida* of Dalman; and Mr. Whitfield agreed with Mr. Glass and myself in thinking that they belonged to the same species. Shortly afterwards Mr. Glass worked out a typical specimen of the American species which had been given to me by Professor Hall for that purpose ('Sil. Sup.,' Pl. V, fig. 6), and it very plainly showed that the connections of the spirals are identical in *Whitfieldia tumida* and its synonym, *Meristina Maria*. In the American description of the interior of *Meristina Maria* the loop is said to be simple; but it is now proved by Mr. Glass that the end of the loop was bifurcated, and in exact agreement with the figure we have given of the same part in *Whitfieldia tumida*. Through the kindness of Mr. Whitfield we have been able to examine the original specimen from which Professor Hall's figure and description were taken, and this evidently shows that the mistake had arisen through Mr. Whitfield having made a perforation in the American type just at the place where the bifurcated end of the loop should occur.

Merista, *Meristella*, and *Whitfieldia* are evidently closely related. If the forked part of the loop in *W. tumida* were prolonged in the shape of a ring it would be a *Meristella*, but since it is never so in *Wh. tumida*, it is even better distinguished than *Meristella* is from *Merista*. I have therefore proposed for the *A. tumida* of Dalman and similarly-constructed species a new genus or sub-genus, *Whitfieldia*, after Mr. R. P. Whitfield, of the American Museum of Natural History, New York, who during many years assisted Professor Hall by developing in an admirable manner the interiors of the spiral-bearing genera of several Brachiopoda described by him in his magnificent work on the 'Palæontology of New York,' and by drawing for that work many of the beautiful plates.

Professor James Hall has worked very earnestly for many years on the Brachiopoda, and has been able, not only to contribute largely to our knowledge with respect to the species that occur in the Palæozoic rocks of the United States, but also to establish many new genera from a careful study of their internal characters, a work that will ever give him great credit. Much more, however, still remains to be discovered, and I trust that both he and other palæontologists will continue the work so successfully carried on and for so long a period. I wish also on this occasion to acknowledge the highly valued help I have at all times received from Professor Hall.

Family—Atrypidæ, *Dall*, 1877.

Genus—Atrypa, *Dalman*, 1828 = *Spirigerina*, d'Orb., 1847.

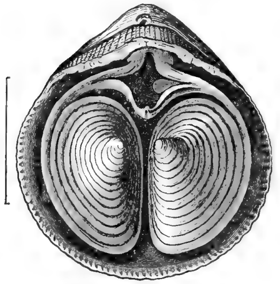
10. Atrypa reticularis, *Linné*, sp. Dav., Sil. Mon., p. 129, Pl. XIV, figs. 1, 2; and Sil. Sup., Pl. VI, figs. 14, 15, and Pl. VII, figs. 1—6.

Atrypa reticularis, *Dav.* Geol. Mag., New Series, vol. viii, January and April, 1881.

The external characters of this well-known species have been described at p. 130 of my 'Silurian Monograph;' but in June, 1867, when I published my description, specimens showing the whole internal characters were not in my possession. In the explanation of Pl. XIV, in a footnote, I, however, referred to Mr. R. P. Whitfield's 'Observations on the Internal Appendages of the Genus Atrypa,' published in 1866.[1] The position

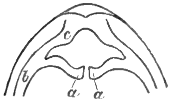
[1] Printed in advance for the 'Nineteenth Report on the New York State Cabinet,' December, 1866.

and shape of the spiral appendages, at first attached to the hinge-plate of the dorsal valve, and placed side by side, with their extremities facing the middle of the bottom of the dorsal valve, may be seen in the accompanying figure.



Atrypa reticularis, from the Lower Hilderberg group of Albany County, New York, developed by Mr. R. P. Whitfield, and lent to me by Prof. J. Hall, showing the form of the loop and spires as attached to the dorsal valve.

Mr. Glass has also developed the complete interior of *A. reticularis* from English specimens, and they show all the characters so well described and illustrated, in 1866, by Professor J. Hall and Mr. R. P. Whitfield. The principal stems of the spiral coils, at a short distance from their attachment to the hinge-plate, are connected by a narrow band, the branches from either side converging downwards into a **V** shape, and each branch slightly turned up at its extremity. This band seems continuous in many specimens that have been operated upon; but, as stated by Mr. W. Gurley,[1] in some individuals this loop or band would appear to be disunited, the inner ends opposing each other without being actually connected. This act is also corroborated by Professor Quenstedt, who, in the Atlas of his 'Brachiopoden,' pl. xlii, fig. 87 *a*, draws the disunited band as described and figured by Gurley. Through the kindness of Professor James Hall I have been able to examine two perfect specimens from the Lower Helderberg group near Clarkesville, Albany County, in which the crural processes or loop seem so close as almost to come in contact at their turned-up extremities, but I question whether they formed always a continuous uninterrupted band. Again, in another specimen, *Atrypa spinosa*, Hall, from the Hamilton group, Darien, New York, the crural processes seem to form an uninterrupted band, as is the case likewise with some admirably prepared specimens of British *A. reticularis* worked out by the Rev. Norman Glass, and of which we have given figures in two of the plates of the 'Silurian Supplement.'



Atrypa reticularis, from Lower Helderberg group, near Clarkesville, United States. *a*. Disunited extremities of the loop or crural processes; *b*, first coil of the spire; *c*, point of attachment to the hinge-plate.

Having, thanks to the liberality of Mr. G. Maw, been able to examine several thousand specimens of *A. reticularis*, I have ascertained how much it varies in shape, and especially at different stages of growth. The smallest or youngest examples measured not much more than half a line in length and breadth, and every stage was obtained up to shells measuring one inch and a half in length and breadth. When quite young the dorsal valve is nearly flat, with a strongly-marked longitudinal mesial depression; this

[1] 'Proceedings of the American Philosophical Society,' vol. xvii, p. 337, pl. xiv, 1878. In 1873 Mr. Salter, at p. 55 of a 'Catalogue of the Collection of Cambrian and Silurian Fossils in the Woodwardian Museum,' gave a good figure of the interior of *Atrypa reticularis*, showing the crural processes united.

same valve with age becomes gradually more and more convex or gibbous, and loses by degrees all trace of the longitudinal depression.

The front line is also either straight or more or less curved upwards, so much so that many specimens show in the dorsal valve a well-developed mesial fold, with a corresponding sinus in the ventral one. The ribbing varies also to a very considerable extent in different specimens. In young individuals the ribs are few in number, and in this condition it approaches in shape and character to similar-sized examples of *Atrypa Barrandei*. The number of ribs seems also to increase rapidly with age. Some specimens with very convex or gibbous dorsal valves are covered with numerous fine radiating ribs, while others of the same size show a much smaller number, and these more close and prominent. The intersecting concentric lines or ridges due to growth are also much stronger, closer, or more widely apart in some individuals than in others, still these varied individuals are linked one to the other by gradual passages. Feeling anxious to acertain whether there existed interiorly any gradual increase in the number of spiral coils from the young up to the adult condition, I placed in the hands of the Rev. Norman Glass a number of well-preserved specimens at different stages of growth, and some of these he developed with his usual ability, and was soon able to show, and in the most distinct manner, that the number of coils increased with the growth of the shell. In a specimen measuring four lines in length and breadth there were only five convolutions in each spiral cone, and these specimens much resemble those of *Atrypa Barrandei*, and in all probability, if not certainly, in still younger specimens, Mr. Glass would have found not more than three or four coils.

In a specimen measuring five lines in length he found six coils; in another six lines in length seven coils, and so on; no doubt the increase would proceed up to sixteen convolutions in each spiral, the usual number found in full-grown specimens. Mr. Glass showed also that the spiral appendages in full-grown Dudley specimens commence by forming very large coils, that these are succeeded by others smaller in diameter, forming two comparatively narrow cones, that the extremities of these cones are closer together in some specimens than in others, and that sometimes one spiral cone seems a little longer than the other, one cone, for example, showing only fourteen convolutions, whilst its companion cone has as many as sixteen. Mr. Glass ascertained likewise that the basis of the spiral cones in young specimens with flattened dorsal valves is not level, the two inner sides of the principal coils being slightly higher up than the two outer sides and turned towards the margin of the shell, which is exactly what we find to be the case, and have represented, in *Atrypa marginalis* and *Atrypa Barrandei*, the dorsal valves of which are also nearly flat. As the shell grows and the dorsal valve becomes more convex, the basis of the spirals becomes more level and the spiral cones more elevated, as we have figured them in our plate, Sup., Pl. VII, figs. 4 to 6. The principle of variation of shape in the spirals of certain genera and species of *Atrypidæ* seems to be the providing of such a form of spirals as should allow the greatest length of coil possible in the interior of the shell; for example, in *Glassia obovata* and *G.*

elongata the ventral valve is, if anything, slightly more convex than the dorsal, and consequently the spirals are slightly more convex on the ventral side, and the length of the coils on that side is still further increased by the notch or indentation on the ventral slope of the posterior border of the spirals. Again, as we shall see in the sequel, in *Atrypa marginalis*, *A. Barrandei*, and young specimens of *A. reticularis*, the dorsal valve is nearly or quite flat; and this being the case there are several differences between their spirals and those in the full-grown specimens of *A. reticularis*, the dorsal valve of which is ventricose. First, there is a less number of spiral coils; but to allow space even for these some changes were necessary in the arrangement of the spirals, and therefore the principal coils, instead of being level, are slightly higher on their inner than on their outer sides, whilst, unlike the majority of the full-grown specimens of *A. reticularis*, the principal coils are some little distance apart, and the ends of the spirals bend over to meet each other.

It will be seen at once that these peculiarities in the arrangement of the spirals (the coils being only few in number) make them on their dorsal side to be almost level, and suitable, therefore, to the interior space which they have to fill.

Atrypa reticularis is one of the most abundant fossils in the Wenlock and Ludlow rocks of England.

11. Atrypa asperula, *Dav.* Sil. Mon., Pl. XIV, fig. 22; Sil. Sup., Pl. IV, figs. 8, 8 *a.*

Atrypa reticularis (*Linn.*), var. *Davidson.* Sil. Mon., p. 129, 1867.

Shell small, transversely oval or wider than long; valves equally and moderately convex, with sometimes the indication of a small mesial elevation or large central rib in the dorsal and a corresponding small depression in the ventral valve; beak very small and but slightly produced, increased and truncated by a small circular foramen, laterally margined with small deltidial plates. Surface of both valves covered with from eight to eleven large, strong, radiating ribs, with interspaces of about equal breadth; the valves are likewise crossed by numerous regular projecting concentric laminæ, to some extent overlapping each other, and giving to the valves a strong imbricated appearance.

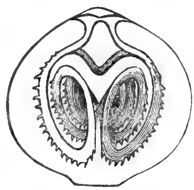
Length 5, breadth 6, depth 3 lines.

Obs.—When describing *Atrypa reticularis*, at p. 130 of my 'Silurian Monograph,' I considered this little shell as a variety of Linné's species. Since then Mr. Maw has collected a considerable number of specimens of this shell from the *débris* of old Wenlock Limestone quarries at Benthall Edge, and these have enabled me to see that it differs materially and constantly from *A. reticularis* by its small dimensions and persistent few strong scabrous ribs. Young species of *A. reticularis* of similar dimensions differ from it materially, and if one looks at Schlotheim's figures of his *Terebratulites aspera* in pl. i of Leonhard's 'Tashenbuch' for 1813, the difference is obvious, Schlotheim's figures recalling certain small varieties of *Atrypa reticularis*. I therefore propose to distinguish the species under description by a separate name, that it may no longer be confounded with Linné's species.

12. Atrypa marginalis, *Dal.* Dav., Sil. Mon., p. 133, Pl. XV, figs. 1, 2; Sil. Sup., Pl. VII, figs. 8, 8 *a*, 8 *b*.

We are indebted to Mr. Glass for the knowledge we now possess with respect to the spiral appendages and connecting process in this remarkable species.

The dorsal valve does not present the same degree of convexity or depth observable in *Atrypa reticularis*, so that the spirals are smaller, and less convex. They do not show more than five convolutions, these being also more widely separated one from the other than is the case with Linné's species. The principal stems (in the two specimens cleared out by the Rev. Norman Glass) after their attachment to the hinge-plate are soon connected, as in *A. reticularis*, by a **V**-shaped lamella. The extremities of the spirals are close to each other and face the middle portion of the bottom of the dorsal valve. As in *Atrypa Barrandei*, the two principal coils are not level, but slightly higher on their inner than on their outer sides.



Atrypa marginalis, developed by the Rev. Norman Glass, and enlarged.

Mr. Glass has also shown that the outer edge of each convolution, whether facing the lateral or the frontal margin of the shell, gives off numerous small spiny projections, in the same manner as in many examples of *Spirifera, Athyris, Waldheimia*, &c.

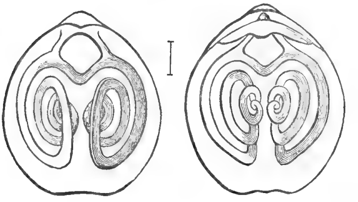
While *Atrypa reticularis* and *A. Barrandei* are exceedingly abundant in the Wenlock series of Shropshire, *A. marginalis* and *A. imbricata*, Sow., are by no means common.

13. Atrypa Barrandei, *Dav.*, sp. Sil. Mon., Pl. XIII, figs. 10 to 13; Sil. Sup., Pl. VII, figs. 7, 7 *a*, 7 *b*.

Retzia? Barrandi, *Dav.* Sil. Mon., p. 128, 1869.
Atrypa Barrandei, *Dav.* Geol. Mag., New Series, vol. viii, January, 1881.

During an excursion I made near Walsall in 1847 I picked up several specimens of the small species under description. Knowing nothing of its interior characters, I provisionally described it as a *Terebratula*, but subsequently I thought it might be referable to *Retzia*, on account of Dr. Lindström having found that the shell was possessed of spiral coils. In 1879 Professor James Hall, at p. 162 of the 'Twenty-eighth Annual Report of the New York State Museum of Natural History of New York,' states that the *R. Barrandei* seems to be very closely related if not identical with his *Cœlospira disparialis;* and in the same year M. Barrande, in the fifth volume of his magnificent work on the 'Silurian Fossils of Bohemia,' describes *T. Barrandei* as a species of *Athyris*, but in his figure represents it with the spiral coils of an *Atrypa*.

It was, however, left to Mr. Glass to entirely investigate and determine the internal characters of this species, so abundant and characteristic of the Wenlock Shales of Shropshire. The shell in size does not exceed four lines in length and the same in breadth, by three in depth, with nearly a flat or even slightly concave dorsal valve (see 'Sil. Mon.,' Pl. XIII, fig. 10 to 13). Still, notwithstanding its small dimensions, after great trouble Mr. Glass has succeeded in completely exposing in four specimens its spirals and their connecting process. These in the main agree pretty closely, although differing slightly in detail, with those of *Atrypa marginalis;* and Mr. Glass's specimens show that soon after the principal stems of the spirals leave their attachment to the hinge-plate they give off a V-shaped lamella, by which they become connected, as in *Atrypa*.


Atrypa Barrandei. Spira developed by Mr. Glass.

The principal coils, however, are not quite level, as in *Atrypa*, the two inner sides of these coils being slightly higher than the two outer sides and turned towards the margin of the shell. The ends of the spires curl over to meet each other, but the amount of convexity of the spirals on the side facing the bottom of the dorsal valve is very slight, because there are but four or five convolutions, and this slightness of convexity is necessitated by the very small depth of the valve.

I therefore believe that the spiral arrangement in *A. Barrandei* is only a slight modification of that of *Atrypa reticularis* and *A. marginalis*, and that with this genus *A. Barrandei* should be classed. Thanks to the kindness of Mr. Whitfield I have been able to examine nine or ten typical specimens of Professor J. Hall's *Cœlospira disparialis* from the Niagara group, Lockport, New York. In dimensions the specimens forwarded were a little smaller than full-grown examples of *Atrypa Barrandei*, and their dorsal valve was generally a little more concave. Mr. Whitfield also kindly sent for my examination the only specimen he had been able to develop of the American shell. It agrees in every respect with the figures we have given of the spirals of *Atrypa Barrandei*.

In 1852 Professor Hall described the American species with the name *Atrypa disparialis*, 'Pal. New York,' vol. ii, p. 277. In the 'Tenth Annual Report of the State Cabinet of Nat. Hist. of New York' he altered the generic name to *Leptocœlia*, 1857; and in the 'Twenty-eighth Annual Report,' p. 162, 1879, he referred the genus to *Cœlospira*, adding that this species is comparatively rare, and stating that "The specimens from the Waldron locality show considerable variation in form, convexity of valves, and number of plications. Compared with specimens of *Retzia Barrandei* (Davidson, 1848) from Dudley, England, they seem to be very closely related, if not identical." In these conclusions I quite agree with Professor Hall, but at the same time would place both *A. Barrandei* and *C. disparialis* with the genus *Atrypa*. In Bohemia *Atrypa Barrandei* was found by M. Barrande in his Étage E. at Hinter-Kopanina. The Bohemian specimens are exactly of the same size as those that occur in England.

14. Atrypa imbricata, *Sow.* Dav., Sil. Mon., Pl. XV, figs. 3—8; and Sil. Sup., Pl. IV, fig. 7.

At p. 135 of my 'Silurian Monograph' this species is fully described, and I stated that interiorly two broad coiled lamellæ are attached to the hinge-plate, with vertical spires, closely adpressed, and directed towards the disc of the valve. At that period I had no specimen I could figure, but since then the Rev. Norman Glass has made a section through one of them showing exactly the position of the spires, and of this a figure has now been given.

15. ATRYPA? MAWII, *Dav.* Sil. Sup., Pl. IV, figs. 6, 6 *a*, 6 *b*, 6 *c*.

MERISTELLA? or ATRYPA MAWII, *Dav.* Geol. Mag., New Series, vol. viii, p. 149, pl. v, fig. 5, 1881.

Shell almost circular, as wide as long; valves moderately convex; ventral valve rather the deepest; no fold nor sinus, but a slight longitudinal groove divides the dorsal valve into two equal lobes; beak not much produced, with a small circular foramen. Surface of valves marked at intervals by a few slightly projecting concentric ridges.

Length 6, breadth 6, depth 3 lines.

Obs.—A single specimen of this shell was found by Mr. Maw among the *débris* from the old Wenlock quarries at Benthall Edge in Shropshire. It is not possible to determine to what genus the shell should be referred, as its internal characters have not been ascertained, and it was not considered right to sacrifice the only specimen known in an attempt to discover the characters of its spiral appendages. Externally the shell is well characterised, and it is with much pleasure I name it after Mr. Maw its discoverer.

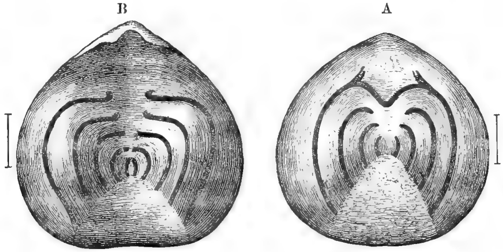
Genus—GLASSIA, *Dav.*, 1881.

16. GLASSIA OBOVATA, *Sow.*, sp. Sil. Mon., Pl. XII, fig. 19, and Pl. XIII, fig. 5; and Sil. Sup., Pl. VII, figs. 11 to 20.

ATRYPA OBOVATA, *Sow.* Sil. Syst., pl. viii, fig. 9, 1839.
GLASSIA — *Dav.* Geol. Mag., New Series, vol. viii, January, 1881.

At p. 121 of my 'Silurian Monograph' I described the exterior and the interior of the ventral valve of this species with Sowerby's name *Atrypa obovata*, remarking at the same time that all my efforts to obtain a sight into the interior of the dorsal valve had proved unsuccessful, although I felt almost certain that the shell was provided with spiral lamellæ.

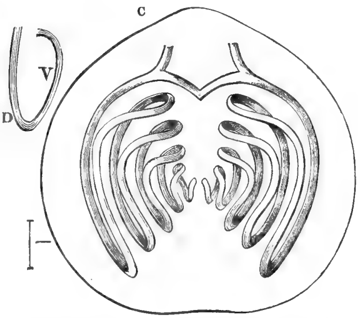
While sorting some of the Brachiopoda obtained by Mr. Maw from the washings of some seven tons weight of Lower-Wenlock "Buildwas Shales," Mr. Glass observed amongst them a few specimens of a circular, smooth Brachiopod, resembling in shape Sowerby's *Atrypa obovata*, and at once began to operate upon them. To his surprise he found that the shell was provided with spirals, but completely different in their arrangement to those of any other spiral-bearing species with which he was acquainted, and at once forwarded to me his first developed specimens. So interesting and new did they appear to both of us that no labour or pains were spared by Mr. Maw in procuring more specimens, or by Mr. Glass in working on them—a most difficult process, on account of their complicated details, and requiring great patience, skill, and experience.



Glassia obovata. Prepared by the Rev. Norman Glass. Seen as a transparency.
A. Dorsal; B. Ventral valve view.

Externally the shell of *Glassia obovata* is small, rarely attaining with us quite five lines in length, by six in breath and three in depth. It is marginally circular, straight, rounded, or slightly indented in front; beak small, incurved; surface smooth. In the interior of the dorsal valve there are spirals for the support of the lateral or brachial appendages.

The principal lamellæ forming the first coils are, at a short distance from the attachment to the hinge-plate, connected together by a riband-shaped lamella or loop (as in *Atrypa*). This lamella, commencing on each side from the principal coil, converges downwards in the shape of the letter **V** (figs. A and C), and its two extremities are sometimes turned very slightly upwards before uniting. The principal coils directly face the lateral margins. The ends of the spirals meet each other in the centre of the shell; and their close apposition sometimes serves to depress and thicken the end of the spirals and to conceal the final coil on either side.



C. An outline sketch of the arrangement of spiral coils in *Glassia obovata* ventral aspect, restored, from specimens developed by the Rev. N. Glass. The dorsal side of the coils in each spiral cone is somewhat displaced from its natural position in order to show the continuity of the coils. B, edge view of a spiral; V, ventral; D, dorsal.

The spirals, which consist of from four to five coils, are compressed; and their compressed and oval shape, together with the distance that always occurs between the base of the spirals and the lateral margins, allows the necessary room for the first convolutions.

The dorsal side of the spirals is flattened, whilst the ventral side is somewhat ventricose. The spirals are narrow anteriorly, but broader on the posterior side; and the principal coils on the hinder side are slightly notched or indented, the notch or indentation being in the direction of the end of the spiral, and occupying in most cases the whole breadth of the posterior border. This edge of the spirals, including, of course, the notch referred to, slopes slightly downwards on the ventral side towards the anterior margin; and arising from this the notch is partly seen in the ventral aspect of the spirals. The slope of the posterior border of the spirals also accounts for the upper part of the coils on the ventral side being more depressed and less oval than the corresponding part of the coils on the dorsal side. As already observed, the discovery of this new genus, and of all its internal characters, is due to the indefatigable exertions and persevering researches of the Rev. Norman Glass, who, after many trials and immense trouble and patience, was enabled gradually to expose the spiral coils, their mode of attachment to the hinge-plate, and their connecting process in the most unmistakable manner. I therefore had (in 1881) much pleasure in naming this genus after its discoverer.

The shells belonging to the genus *Glassia* are not very rare in some places; but, although comparatively not uncommon in the Buildwas Shales, they occur very often in an incomplete and crushed condition. Good examples suitable for Mr. Glass's operations did not occur in any great number.

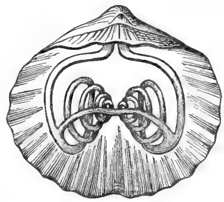
As some uncertainty prevailed in my mind whether the specimens of *Glassia* here described from the Buildwas bed were referable to Sowerby's species, I borrowed from the Geological Society's Museum Sowerby's type specimens of both *Atrypa obovata* and *A. compressa* (see my 'Sil. Mon.,' Pl. XII, figs. 16 and 19), also a series of specimens so named (from the Wenlock Shales of Woolhope) in the Museum of Practical Geology, in addition to a large and illustrative series of twenty specimens from the Wenlock Shales in a railway-cutting near Dudley, lent to me by Mr. John Gray, of Hagley.

After a very careful study of all this material it appeared to me that the so called *Atrypa obovata* and *A. compressa*, of Sowerby, are nothing more than modifications, in shape, of a single species, and referable to my new genus.

The muscular and vascular impressions in the ventral valve of *Glassia obovata* are shown in Pl. XIII, fig. 5, of my 'Silurian Monograph.' On the internal cast of the dorsal valve of a specimen from Buildwas can be seen a longitudinal indented line extending from the umbo to half the length of the shell and denoting the presence of a short ridge or septum in that valve.

Having received, through the kindness of Prof. Lindström, of Stockholm, a number of small shells from the Wenlock formation of the Island of Gothland, which had all the appearance of young individuals of *Glassia obovata*, or of a closely allied species, I asked the Rev. Norman Glass to develop a few of them so as to ascertain to what genus they belong. They proved to be all perfectly characterised specimens of *Glassia*.

The genus *Glassia* belongs to the family *Atrypidæ* although it differs materially from both *Atrypa* and *Zygospira*. In *Atrypa* the spiral coils are placed side by side, with their apices directed towards the cavity of dorsal valve in a vertical manner, and its coils are very numerous. In *Glassia* the coils, on the contrary, are few in number and are not vertical, as in *Atrypa*, but laterally placed, so that their extremities have their ends facing and touching each other towards the centre of the shell. The character of the shell itself also is in the two cases materially different.



Zygospira modesta, after Hall's fig. 1.

Glassia differs from *Zygospira* in the direction of its spirals, the bases of the spiral coils in *Zygospira* being somewhat as in *Atrypa*, and not directly facing the lateral margins, as in *Glassia*. The loop also of *Glassia*, whilst like that of *Atrypa*, differs from the loop of *Zygospira*. The loop of the latter genus stretches right across the top of the spiral cones from the primary lamellæ on either side. Hall gave two figures of *Z. modesta*. His fig. 1 is here copied for comparison; but the loop in this figure, as proved by Mr. Glass's researches, is misplaced. Hall's fig. 2 correctly represents the spiral arrangement of *Z. modesta*, and corresponds with the figure I have given at p. 124 of this Supplement.

17. Glassia elongata, *Dav.* Sil. Sup., Pl. VII, figs. 9, 10.

Glassia elongata, *Dav.* Geol. Mag., New Series, vol. viii, p. 148, pl. v, figs. 3, 4, April, 1881.

Shell small, elongated oval, or obscurely pentagonal; valves very gently convex, straight, gently rounded or slightly indented in front, tapering posteriorly, broadest anteriorly; beak small, incurved; surface smooth. Spirals, &c., exactly as in *Glassia obovata*.

Length 4, width 3, depth $1\frac{1}{2}$ lines.

Obs.—While sorting a lot of specimens which Mr. Maw had obtained from extensive washings of the upper part of the Upper Wenlock Shales (Tickwood beds) from below the limestone, at the watercourse under Benthall Edge, Mr. Glass observed several specimens of a small shell somewhat resembling *Athyris læviuscula*, but broader in proportion to length, and more flattened than in the last-named species. On experimenting upon these, and after removing the shell and scraping the matrix, he was surprised to find that the shell was provided with spirals arranged as in *Glassia obovata*, but usually with only three convolutions.

After the preceding sheets were put in type, Mr. Glass was favoured by a large parcel of fossils from Mr. George J. Hinde, Ph.D., F.G.S., kindly sent at our request. These fossils consisted of more than thirty species of spiral-bearing Brachiopoda from North America, principally collected by Dr. Hinde himself. Of each species sent to Mr. Glass there were a good number of specimens, in some cases more than a hundred. In the most generous manner Mr. Hinde gave Mr. Glass permission to select out of these fossils the specimens most suitable for his operations, and the result has been a number of interesting discoveries including two new genera.

In order to make more complete the history and characters of the spiral-bearing genera, which Mr. Glass and myself have endeavoured to treat with some detail in this Supplement, we have added descriptions and figures of the following preparations from Dr. Hinde's specimens, either as directly representing species we possess in Britain, or as reflecting light upon the proper classification of the spiral-bearing Brachiopods, a subject which will be further considered in subsequent pages of this Supplement.

Genus—Athyris, *M'Coy*, 1844 = Spirigera, *d'Orb.*

I have previously referred in this Supplement to *Athyris spiriferoides*, an American species, and have shown that its spirals and their attachments are similar to those in the other species of *Athyris*, with the exception that in *A. spiriferoides* the roof-shaped projection in the loop is rather larger, and the hook-shaped attachments of the primary lamellæ to the hinge-plate are more curved and open. Dr. Hinde sent to Mr. Glass a number of shells of a species of *Athyris* from Widder, Ontario. They are smaller than *A. spiriferoides*, and exactly agree in shape with a type-specimen of *A. vittata* sent to me by Mr. Whitfield, and they also agree with Prof. Hall's figures of this species in 'Pal. New York,' vol. iv, pl. 46, figs. 1—4. Mr. Glass has worked out very clearly and perfectly several of these Widder specimens, and they show a spiral arrangement of the ordinary *Athyris* type, with the single exception that the hook-shaped attachments of the primary lamellæ to the hinge-plate are still more curved, open, and loop-like than in *A. spiriferoides*, but not perfectly circular, as represented in Hall's figure of the interior of *A. vittata*. The loop in the Widder specimens is exactly like that I have figured in *Athyris planosulcata*, and does not agree with the figure of the loop of *A. vittata* as given by Hall.

ATHYRIS SUBQUADRATA, *Hall.* Report on the Geol. Survey of the State of Iowa, p. 703, pl. xxvii, 1858. Carboniferous; Chester, Illinois.

This species has been worked out by the Rev. N. Glass, and found to be possessed of a true *Athyris* loop.

Mr. Glass has also developed the interior of another species, nearly related to *A. Roysii,* from the same formation and from Ellettville, Illinois, and found it also to be possessed of a true *Athyris* loop. The surface of the shell is covered with concentric lines and closely-packed spiny projections.

Genus—NUCLEOSPIRA, *Hall,* 1859.

NUCLEOSPIRA CONCINNA, *Hall.* Geol. 4th District New York; Devonian. Hamilton group, Hamburg, near Buffalo; also from Ontario, Canada.

This species has been developed by the Rev. N. Glass, who found its spirals, loop, and attachments to be like those of *N. pisum.* Externally it has the same shape as the Silurian species, and the surface of its valves is also covered with spines.

Genus—ATRYPA, *Dalman,* 1828.

ATRYPA LARA, *Billings,* sp. = ATHYRIS LARA, *Billings.* Catalogue of the Silurian Fossils of Anticosti; Geol. Survey of Canada, p. 47, 1866.

This small species is lenticular in shape and obscurely subpentagonal; both valves moderately convex; beak small and closely incurved; surface smooth. Length 3 lines, by about the same in breadth.

Dr. Hinde having sent Mr. Glass several specimens of this interesting little shell he was able to expose its spirals in a very beautiful manner, and these entirely resemble those of *Atrypa,* the apex of each vertical cone being directed towards the middle of the bottom of the dorsal valve. Dr. Hinde informs me that he found it near Jupiter River, Anticosti, in a Silurian rock at about the horizon of the Wenlock.

Mr. Glass has likewise developed the spirals in a specimen of *Atrypa marginalis* from the Upper Silurian Limestone of Anticosti, and found them to agree with those in similar specimens from the Wenlock of Shropshire.

Genus—Spirifera *Sow.*, 1815.

Spirifera Maia, *Billings,* sp. = Athyris Maia, *Billings.* Can. Journal Ind. Sci. and Arts, 1860.

Mr. Glass has opened out the interior of several specimens of this species, and found them to contain spirals similar to those of *Spirifera* type, but of a somewhat new and very elegant shape. The specimens so examined were found by Dr. Hinde in the Corniferous (Middle Devonian) at St. Mary's, Ontario, Canada.

Genus—Zygospira, *Hall,* 1862.

ζυγός, a yoke, *σπεῖρα*, a spire. Type *Z. modesta*, Say, MS.[1]

Shell bivalve, equilateral, inequivalve; surface plicate in the typical species; a sinus on the dorsal valve.

The primary lamellæ of the spiral cones are attached to the hinge-plate of the dorsal valve. After descending almost parallel to each other for a short distance, they are bent outwards, nearly at right angles towards the lateral margins of the shell, and thence form a broad curve to the anterior margin, where they recurve, making about four convolutions, with the apices of the spires directed obliquely into the cavity of the dorsal valve. The loop commences on each side from about the centre of the primary lamella. It

[1] *Atrypa modesta*, Hall, 'Pal. New York,' vol. i, p. 141, pl. xxxiii, fig. 15, 1847, and 'Thirteenth Annual Report of the University of the State of New York,' p. 69, 1860.

Zygospira modesta, Hall, 'Fifteenth Annual Report of the Regents of the University of New York,' 1862, and 'Twentieth Annual Report,' p. 267, 1868.

stretches across the upper part of the spiral cones on their dorsal side, and is in close proximity to them. Each end of the loop first curves upwards, nearly to the top of one of the spiral cones, and then the two parts of the loop are united by a descending **V**-shaped curve, following the direction of the posterior border of the two spiral cones. The following points may be noticed in the comparison of the spiral arrangement of *Zygospira* with that of *Atrypa*.

In *Zygospira* the primary lamellæ, shortly after their origin, are bent outwards towards the lateral margins of the shell, more at a right angle than in *Atrypa*. In the loop of *Zygospira*, the point of origin from the primary lamellæ on either side is lower down than in *Atrypa*, and thus the loop in *Zygospira* is broader, and crosses the upper part of the two spiral cones. I have previously observed that in full-grown specimens of *Atrypa reticularis*, the basis of the spiral cones is quite level, and faces the bottom of the dorsal valve, but that in young specimens of the same species this is not the case, the two inner sides of the principal coils being slightly higher than the two outer sides, and turned towards the margin of the shell. I observed, also, that in this respect the spirals of *A. marginalis* and *A. Barrandei* resemble the spirals in the young specimens of *A. reticularis*. The same direction of the spiral cones also occurs in *Z. modesta*, as will be seen in the accompanying figure, only the irregularity between the inner and outer sides of their principal coils is still more marked. The generic difference, therefore, between *Zygospira* and *Atrypa*, so far as their spiral arrangement is concerned, must be looked for in the shape and position of the loop, rather than in the direction of the spiral cones.

Obs.—When describing *Atrypa modesta* in vol. 1, p. 141, 1847, of his 'Palæontology of New York,' Professor Hall says, "This species, *A. recurvirostra*, *A. deflexa*, and *A. exigua* form a group presenting characters which may require a separation from the true typical *Atrypæ*."

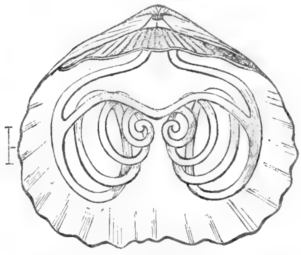
At page 69 of the 'Thirteenth Annual Report,' 1860, Professor Hall again called attention to the characters of *A. modesta*, and to the internal spirals of that fossil. At p. 154 of the 'Fifteenth Report,' published in 1862, he proposes for such shells as *A. modesta* a new generic name, *Zygospira*. "Shell bivalve, equilateral, inequivalve; surface plicate in the typical species; a sinus in the dorsal valve. Internal spires arranged somewhat as in *Atrypa*, with a broad loop passing from the outer limbs of the spiral band entirely across from side to side, near to or above the centre, and close to the inner side of the dorsal valve."

Professor Hall accompanies his description by two figures showing the spirals and loop taken from two different specimens, said to be of the same species, and representing the dorsal and ventral aspects. In his observations on these two very dissimilar specimens he adds "The direction of the spires is nearly the same as in *Atrypa*, differing in the presence of the strong loop; while the shell, in its interior character, is quite unlike *Atrypa*. In the two specimens examined there is a slight variation in the direction and extent of the loop. In one it rises from below the middle of the outer curve of the spiral, and curving gently passes over the apices of the spires. In the other the origin of the loop appears to be at a higher point, or otherwise it lies parallel with the outer curve of the spiral for some distance, and stretches from one side to the other between the spires and the base of the crura. This difference may be accidental, or may be caused by displacement of the loop in the one case; in both, however, the essential features are preserved."

In page 367, 1868, of the 'Twentieth Annual Report,' Prof. Hall reproduces his description and figures, adding: "At that time the spires of *Atrypa* were not known to be connected by a loop, as has since been ascertained; and this renders the analogy between the genera still more close. In *Zygospira* the spirals are more obliquely directed towards the centre of the dorsal valve than in *Atrypa;* the loop is attached much lower down on the limb of the spire, and is more direct, as is shown in the accompanying figure of *Atrypa reticularis*, and the spiral coils are much more lax. These features might not be of generic importance."

Feeling very uncertain, as Prof. Hall himself appears to have been, as to which of his figures was the correct one, I asked Dr. G. J. Hinde to kindly send to me and to the Rev. N. Glass some specimens of *Zygospira modesta* he had collected from several Canadian localities, that Mr. Glass might examine their spiral characters so as to determine without doubt which of Prof. Hall's figures was the correct one.

Dr. Hinde, with his usual liberality, placed in the hands of Mr. Glass a large number of the specimens of *Zygospira modesta* peculiarly favorable to Mr. Glass's operations, being filled with spar, and Mr. Glass was thus enabled to develop the spirals, loop, and attachments to the hinge-plate in six specimens, and found that they all agreed, and that in none of them was the loop placed so low down as in Prof. Hall's fig. 1, which figure we have reproduced at page 111 of this Supplement. His fig. 2 is, in the main, the more correct representation.[1]



Zygospira modesta, Hall, from the Hudson-River Group; Cincinnati, Ohio; showing spirals, loop, and attachments to hinge-plate. Developed by the Rev. N. Glass.

In the description of the species *recurvirostra*, given a few pages further on, it will be seen that the loop in that species bears some resemblance to the supposed loop of *Z. modesta* in Prof. Hall's fig. 1. It might therefore have been imagined that Prof. Hall had seen some preparations of *recurvirostra*, and had based his fig. 1 upon it; but this could hardly have been the case; first, because the shell, as given in fig. 1, is the same as in fig. 2; and, secondly, because the loop in Prof. Hall's fig. 1, taken in connection with the primary lamellæ on each side of it, is wide and extended, and not oval and compressed, as is the case in *recurvirostra*. So far as *Z. modesta* is concerned, Hall's fig. 2 must be

[1] Since the above was in type Mr. Whitfield has sent me a prepared specimen agreeing in every particular with those cleared out by the Rev. Norman Glass.

taken for a true exposition of its interior, instead of his fig. 1; and, so far as the latter figure is concerned, it seems to have been based, as he himself suggests it might have been, upon some accidental displacement of the loop. Prof. Hall states that he based his figures of *Z. modesta* upon preparations by Dr. C. Rominger, of Ann Arbor, Michigan.

ZYGOSPIRA HEADI, *Billings*, sp.

ATHYRIS HEADI, *Billings*. Geol. of Canada; Palæozoic Fossils, vol. i, p. 147, fig. 125, 1865 (var. *borealis*, *Anticostiensis*, and *Anglica* excluded).

ZYGOSPIRA HEADI, *Hall*. Notes on some new or imperfectly known forms among the Brachiopoda, extracted from 'Twenty-seventh Report State Cabinet,' pl. 13, figs. 21—25, 1872.

ZYGOSPIRA HEADI (*Billings*), *Miller*. The American Palæozoic Fossils: A Catalogue of the Genera and the Species, &c., p. 140 (varieties excluded), 1877.

Mr. Billings describes his species as "Broad, oval, or sub-pentagonal; both valves convex; sides and front occasionally somewhat straight. Ventral valve [our dorsal] rather strongly convex, most elevated about the middle or a little above; beak closely incurved, in contact with the umbo of the dorsal [our ventral] valve; umbo somewhat carinated. An obscure mesial sinus, which is usually so slightly impressed as to constitute only a flattening of the shell, extends from the front margin to within one third of the length from the beak, where it becomes obsolete. On each side of the sinus the shell descends with a somewhat flat slope to the sides. Dorsal [our ventral] valve not so convex as the ventral [our dorsal], often with an obscure median sinus. Surface with fine, rounded, radiating ridges, closely crowded together, of a nearly uniform size, from eight to ten in the width of two lines.

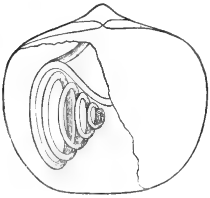
"Length 10 lines; width a little less than the length."

Locality and Formation.—"On the south shore of the St. Lawrence, opposite Three Rivers, Hudson-River formation."

Obs.—In Pl. XXII, figs. 1—7, of my 'Silurian Monograph,' 1866, I figured some English and Irish specimens as a variety of Billings' species; since then I have had reason to believe that we have not hitherto discovered in our Silurian rocks the true *A. Headi* of Billings, and that the British shell I referred to that species is specifically distinct from Billings' type, and referable to his so-termed variety *Anticostiensis* (see p. 127).

In 1866 Mr. Billings informed me that the spirals in *A. Headi* are arranged as in *Atrypa*.

In 1872 Prof. Hall published some notes on *Z. Headi* in the 'Twenty-seventh Report of the State Cabinet.' In these notes Prof. Hall gives the accompanying outline figure, by Mr. Whitfield, "showing the characters of the spire as actually seen in a specimen partially filled with crystalline matter, and cut to show the internal arrangements of one half of the spire and loop." The direction of the spirals in this figure is the same as in the genus *Zygospira*. The loop, however, differs from that of *Z. modesta* as much as the loop of the latter differs from that of *Atrypa*. According to Prof. Hall's figure of *Z. Headi* its loop is attached to the primary lamellæ higher up than the loop of *Z. modesta*, and, in this respect, the loop of *Z. Headi* is shown to be similar to that of *Atrypa*. Prof. Hall's figure indicates, however, that the loop of *Z. Headi* differs from that of *Atrypa* in the breadth and depth of the **V**-shaped process, which in *Z. Headi* is in close apposition to the posterior border of the spirals.



Zygospira erratica, *Hall*, sp.

Orthis? erratica, *Hall*. Pal. New York, vol. i, p. 288, pl. 79, fig. 5, 1847.

Shell marginally broadly rounded, or slightly broader than long, greatest breadth about the middle, hinge-line rather long and nearly straight. Ventral valve convex longitudinally, somewhat carinated or flattened along the middle; beak incurved, beak-ridges sharply defined, and leaving between them and the hinge-line a narrow flattened space or false area. Dorsal valve convex at the sides, depressed longitudinally along the middle, and presenting a concave line in front. Surface marked by fine, uniform, radiating, raised striæ, increasing here and there in number by the interpolations of shorter and smaller ribs.

Length 7, width $7\frac{1}{2}$, depth 4 lines.

In 1847 Prof. Hall figured and described this fossil as an *Orthis*, but with a note of interrogation. Dr. G. J. Hinde having sent a number of specimens to the Rev. N. Glass, the latter was enabled to examine its internal characters, and these he found to agree with those already described for *Z. Headi*. It is therefore a spiral-bearing species, and not an *Orthis*. *Z. erratica* also bears some resemblance to *Z. Headi* in its external form, especially as in both species there is a somewhat deep sinus in the dorsal valve.

We have not found this fossil in Great Britain. Prof. Hall states it to be abundant in the Hudson-River group, near Washingtonville, Oswego County, America. Dr. G. J. Hinde informs me that he got the fossil in the Cincinnati group, from Weston, near Toronto. It remains, however, to be determined whether *Z. erratica* can be specifically distinguished from *Z. Headi*.

18. Zygospira anticostiensis, *Billings*, sp. Dav., Sil. Mon., Pl. XXII, figs. 1—8.

Athyris (?) Headi, *var.* anticostiensis, and *var.* borealis, *Billings.* Geol. Survey of Canada; Pal. Fossils, vol. i, p. 147, figs. 126 and 127, 1865 (not *A. Headi*).

Atrypa Headii, *var.* Anglica, *Dav.?* Sil. Mon., pl. xxii, figs. 1—8, 1865.

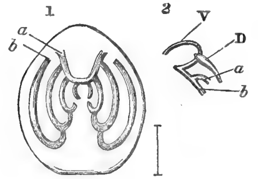
Shell circular or longitudinally oval, broadest about the middle; dorsal valve uniformly and strongly convex, especially at the umbo; no fold. Ventral slightly deeper than the dorsal valve, with a median depression or longitudinal groove commencing at the beak and extending to the front, dividing the valve into two equal halves; beak strongly incurved; lateral margins nearly straight, front line raised into a rounded wave or convex curve. Surface of valves covered with numerous radiating, fine, rounded, raised striæ or small riblets, closely crowded together, and nearly uniform in size. Two specimens measured respectively—

Length 7, width 6, depth $5\frac{1}{2}$ lines.
" 6, " 6, " 5 "

Obs.—In vol. i, p. 147, of the 'Geological Survey of Canada,' "Palæozoic Fossils," Mr. Billings figures this species as a variety of his *Athyris* (?) *Headi*, adding that it is "smaller than the typical form, more nearly circular, and with a more tumid umbo." He also describes and figures as a variety of *Headi*, and by the name of *borealis*, another shell, which he states to "differ from the typical form in being more elongated oval, and in having a more tumid umbo." Upon the examination of a large number of specimens of *Anticostiensis* and *borealis* Mr. Glass and myself have arrived at the opinion that they are only variations in shape of the same species, but specifically distinct from the *Zygospira* (*Athyris ?*) *Headi* of Billings.

In *Zygospira Headi* the shell is broadest posteriorly; in *Zygospira anticostiensis* at the middle of its length. *Headi* in medium-sized specimens is broader than long, big specimens as broad as long; in *Anticostiensis* the specimens are regular, oval or circular; but the most marked external characters consist in *Headi* having in the dorsal valve a somewhat deep longitudinal depression or sinus, while, on the contrary, *Anticostiensis* has the sinus in the ventral valve. This affects in both the form of the frontal line, which is concave in the one (*Headi*), convex in the other (*Anticostiensis*).

Dr. Hinde having kindly forwarded to Mr. Glass a number of specimens of *Z. Anticostiensis*, the latter was able to develop the spirals and their attachments in a most satisfactory manner. He found that the spirals were placed in the shell similarly to those of the other species of *Zygospira;* and he found that the loop resembled in shape that which is figured by Hall for *Z. Headi*, with this marked difference, that in *Z. Anticostensis* the upper part of the loop on either side, and the attachments to the hinge-plate, are bent backwards towards the ventral valve. This peculiarity will be seen in the accompanying figures.



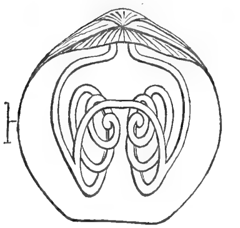
Zygospira Anticostiensis, Billings, sp.
Fig. 1, showing spirals and loop, *a*, *b* : in fig. 2 *a* and *b*, are continuations of the loop and primary lamella from *a*, *b*, in fig. 1 ; D, dorsal ; V, ventral valves. Cincinnati group, English Head, west end of Island of Anticosti, Canada. Developed by the Rev. N. Glass.

In Pl. XXII of my Silurian Monograph I figured, but did not describe, a variety of *Zygospira* by the name *Atrypa* (?) *Headi*, var. *Anglica*. Unfortunately our English and Irish specimens are not generally found in a good state of preservation, and consequently it was not possible to work out their internal arrangements. Mr. W. H. Baily has kindly again forwarded for my inspection some casts and impressions of the fossil in the possession of the Geological Survey of Ireland, which were collected from the Lower Silurian at Grangegeeth, County Meath. Externally they bear much resemblance to *Z. Anticostiensis;* and to this species, and not to *Z. Headi*, I would, at any rate provisionally, refer them. The specimens from the Caradoc of Moelydd, Shropshire, show the sinus in the ventral valve as in *Anticostiensis* ('Sil. Mon.,' Pl. XXII, fig. 8 *b* and *d*), and are exactly similar in shape to Billings' fig. 127.

Zygospira Anticostiensis and its variety *borealis* seem to be very common in a grey-coloured limestone in the Hudson-River formation, or what is more suitably termed the Cincinnati group, near English Head, west end of Anticosti; also on Lake St. John, on the River Saguenay, as well as in other places; and the Irish variety *Anglica* is equally common at Grangegeeth.

Genus—ANAZYGA, *Dav.*, 1882.

ἄνα, upwards, ζύγον, a connecting band. Type *Atrypa recurvirostra*, Hall.



Anazyga recurvirostra, dorsal aspect, showing spirals, attachment to the hinge-plate, and loop. Trenton limestone, Ontario, Canada. Developed by the Rev. N. Glass.

Shell small, longitudinally oval, and radiatedly striated. The position of the spiral cones in the type is the same as in *Zygospira*, the base of each spiral cone being obliquely inclined towards the bottom and sides of the ventral valve. There are about four coils in each spiral cone. The primary stems of the spirals are attached to the hinge-plate of the dorsal valve; and, after extending parallel to each other for a short distance, they bend at right angles abruptly towards the lateral portions of the beak, and form two large curves facing the lateral portions of the valve. Just before reaching their furthest extension in front they give off a semicircular band or loop, which is directed upwards towards the beak, and is exterior to the spiral cones on their dorsal side.

This genus has not been hitherto discovered in our British palæozoic rocks, but it will be desirable to give here a short description of the typical species.

Anazyga recurvirostra, *Hall*, sp.

Atrypa recurvirostris, *Hall.* Pal. New York, vol. i, p. 140, pl. xxxiii, fig. 5, 1847.
Rhynchonella — *Miller.* The American Palæozoic Fossils: A Catalogue of Genera and Species, &c., p. 127, 1877.

"Elliptical, somewhat ovoid, very symmetrical; breadth one fourth of an inch, length a little greater. Dorsal [our ventral] valve with the middle elevated, regularly convex on both sides; the beak extending and gracefully incurved over the beak of the ventral [our dorsal] valve, which is regularly convex with a slight longitudinal depression; surface of each valve marked by twenty-four simple longitudinal striæ, which continue entirely to the front" (Hall).

Length $3\frac{1}{2}$, width 3, depth $2\frac{1}{2}$ lines.

Obs.—The internal characters have been stated under the description of the genus, and our knowledge of them is due to the Rev. N. Glass, who was able to develop the spirals, attachments of principal lamellæ to the hinge-plate, and connections of the primary lamellæ in a number of specimens kindly forwarded to him by Dr. G. J. Hinde.

Anazyga recurvirostra is a common shell in the Trenton Limestone of Ontario, in Canada, and many of the specimens being filled with spar were peculiarly favorable for Mr. Glass's operations. Prof. Hall states that it occurs in considerable numbers in a compact greyish-blue bed of limestone near the centre of the Trenton Limestone near Martinsburgh, Lewis County.

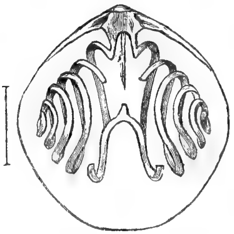
We have not discovered this shell in our British Silurian Rocks; and it is described in this place in order to show another link in the mode in which the primary lamellæ are connected in the *Atyrpidæ*.

Prof. Hall does not describe the spirals or their attachments in this small species; but, singularly, in one of his figures (fig. 1) of "*Zygospira modesta*" he represents the band or loop situated as it is in the shell under description.

Genus—Hindella, *Dav.*, 1882.

Type *Athyris umbonata*, Billings.

Shell elongate ovate; spiral cones have their apices directed towards the lateral margins of the shell. There are about six coils in each spiral. The two principal stems of the spiral cones are attached to the hinge-plate, and after extending a little way into the interior of the shell between the spirals they are suddenly bent backwards towards the hinge. They then form a broad rounded curve, facing the bottom of the dorsal valve; the curve being very gentle, so that the two primary lamellæ on the dorsal side seem almost like parallel lines. When the primary lamellæ reach the front they give off a semicircular band or loop having a projection or spike-like process at the top of it. This loop is directed upwards towards the beak, and is almost immediately behind the two primary lamellæ on the dorsal side of the spirals. The loop is therefore internal to the spirals, and the whole spiral arrangement places this genus under the group Nucleospiridæ.



Hindella umbonata, Bill., sp. Interior of dorsal valve, showing spirals, attachments to hinge-plate, and loop. A portion of the first coil of each spiral cone has been removed so as to show the loop between spiral cones. Anticosti group. Developed by the Rev. N. Glass.

I have named it after Dr. George J. Hinde, F.G.S., in recognition of the services he has rendered to the science of palæontology.

Hindella umbonata, *Billings*, sp.

Athyris umbonata, *Billings*. Geol. Survey of Canada; vol. i; Palæozoic Fossils, p. 144, fig. 121, 1865.

— — — List of the Brachiopoda from the Island of Anticosti; Bulletin of the Museum of Comparative Zoology, Cambridge, Massachusetts, p. 69, 1865.

Meristella — *Miller*. The American Palæozoic Fossils: A Catalogue of the Genera and Species, &c., p. 116, 1877.

Elongate ovate, longer than wide. Ventral valve strongly convex, with a slight longitudinal depression along the middle; beak much incurved. Dorsal valve very convex, and especially prominent at the umbo; a rounded longitudinal elevation extends from the umbo to the front, giving the valve a somewhat roof-shaped appearance. Surface of valves smooth, marked only by a few concentric lines of growth.

Length 9, width 7, depth 6 lines; but in some specimens the length and breadth are nearly equal.

Obs.—We have already given the characters of the spiral and of its attachments. It has not been hitherto found in our British Silurian Rocks, and is here briefly described on account of its being the type of the genus *Hindella*.

It is not a rare fossil at Junction Cliff, Anticosti; and the strata there are higher in the geological series than the Cincinnati group, and come between that and the Clinton strata.

Genus—Ambocœlia, *Hall*, 1860.

(Αμβων, umbo; and κοιλια, venter.) Type *Orthis umbonata*, Conrad.

In the 'Thirteenth Annual Report of the Regents on the State Cabinet,' 1860, Prof. Hall proposed a new genus, Ambocœlia, for a shell described by Conrad in the 'Journal of the Academy of Natural Sciences,' vol. viii, 1842, under the name of *Orthis umbonata*, and occurring in the Devonian or Hamilton group at Moscow, New York State, and in the same rocks at Seneca Lake on the shores of Lake Erie. He adds that *Spirifera unguiculus* of Sowerby may likewise be included in this genus.

Prof. Hall describes the external characters of his genus, and gives figures of the internal surface of both of its valves; but says nothing with respect to its spirals. These have been clearly worked out by the Rev. Norman Glass in two or three specimens; and he found them to be similar to those of *Spirifera* proper, each spiral cone being composed of five convolutions.

The external shape and characters of the type of this genus are peculiar. It is marginally somewhat subpentagonal; hinge-line nearly equals the greatest width of the shell. Dorsal valve is convex at the umbo, after which it becomes slightly concave to the margin with a narrow false area. The ventral valve is very convex, and divided longitudinally by a median groove; beak large, produced and incurved at its extremity; area large, divided by a triangular fissure; surface of valves smooth.

The species referred by Hall to his genus are small, the type measuring—

Length 6, breadth 5½, depth 4 lines.

In Great Britain the genus may be represented by the *Sp. Urei* (Carboniferous) = *Sp. unguiculus*, Sow. (Devonian), and = *Sp. clannyana*, King (Permian). All these shells partake of the same characters, and to my eye are specifically indistinguishable. They only differ from *Ambocœlia umbonata* by the presence of a longitudinal mesial groove in both valves. Prof. Hall mentions the existence of five known American species of his genus in the Devonian and Carboniferous Rocks of the United States.

Whether *Ambocœlia* is generically separable from *Spirifera* proper must remain a question for further consideration. The quadruple muscular impressions in the interior of the dorsal valve represented in Prof. Hall's figure would certainly constitute a good generic character, and I have never observed them so placed in any of the species of *Spirifera* that have come under my notice.

We must now append to the Table of the distribution of spiral-bearing Brachiopoda in time we have given in p. 85 the following genera.

Genera.	Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Liassic.
1. *Family*—SPIRIFERIDÆ, *King*, 1846.						
Ambocœlia, *Hall*, 1860		—	—			
2. *Family*—NUCLEOSPIRIDÆ, *Dav.*, 1881.						
Hindella, *Dav.*, 1882	—					
4. *Family*—ATRYPIDÆ, *Dall.*, 1877.						
Anazyga, *Dav.*, 1882	—					

What has been stated in the Devonian and Silurian Supplements in connection with the spiral-bearing genera and species has shown how absolutely necessary and important it is to become acquainted with the position and direction of the spiral coils, their attachments to the hinge-plate, and the shape of the lamellæ or loop by which the principal stems are connected, before we can assign to unworked forms their correct generic position.

In this last category, that of unworked forms, the following British species must be placed, and their interior arrangements sought for :

Genus—Meristella, *Hall*, 1860.

Meristella (?) angustifrons, *McCoy*, sp. Dav., Sil. Mon., Pl. X, figs. 21, 27.

Of this species the exterior characters have been fully described at p. 111 of my 'Silurian Monograph.' I was able to ascertain that the shell was possessed of spiral appendages, but I was not able to determine their attachments.

Hitherto we have not found any British species possessing the characters of the genus *Meristella,* and are unable to state to what genus the so-termed *M.* (?) *angustifrons* really belongs. The shell is not rare at Mulloch Hill, Dalquharren, and in other localities of the Girvan Valley, and therefore suitable specimens for internal examinations should be sought for and operated upon.

Meristella (?) Maclareni, *Haswell*, sp. Dav., Sil. Mon., p. 116, Pl. XII, fig. 20.

We know nothing of the internal arrangements of this species. In all probability it possessed spiral appendages, but they have not been hitherto discovered.

Meristella (?) crassa, *Sow.* Dav., Sil. Mon., Pl. XIII, figs. 1, 2, 3.

It has not been determined as yet whether or no this species was provided with spiral appendages, so that the genus to which it really belongs cannot be determined. It has, however, all the appearance of being a spiral-bearing Brachiopod.

Meristella (?) subundata, *McCoy*. Dav., Sil. Mon., Pl. XIII, fig. 4.

This species is no doubt a spiral-bearing Brachiopod, but neither its spirals nor attachments have been worked out.

Meristella (?) furcata, *Sow.*, sp. Dav., Sil. Mon., p. 119, Pl. XIII, figs. 7, 8, 9.

No spirals have been as yet discovered.

Atrypa (?) hemisphærica, *Sow.*, sp. Dav., Sil. Mon., Pl. XIII, figs. 23—30.

This belongs in all probability to Prof. Hall's genus *Leptocœlia,* but hitherto the internal characters of that genus have not been completely established. Consequently we cannot say positively whether or not it was provided with spiral appendages; but in all probability it had none. (See the description of the species at p. 136 of Silurian Monograph.

MERISTA (?) CYMBULA, *Dav.* Sil. Mon., p. 204, Pl. XXII, figs. 28, 29.

It would be very desirable that the spirals and their attachments in this species should be examined.

Genus—RHYNCHONELLA, *Fischer*, 1809.

ATRYPA (?) DEPRESSA, *Sow.* Dav., Sil. Mon., Pl. XII, figs. 11—15, and Pl. XIII, fig. 6.

This has been determined by Mr. Glass not to be a spiral-bearing species. It possesses the interior characters of a RHYNCHONELLA.

RHYNCHONELLA (?) PENTLANDICA, *Haswell.* Dav., Sil. Mon., Pl. XXII, figs. 9—19.

The exterior characters of this very interesting small species were fully described at p. 187 of my 'Silurian Monograph.' I was also able to give a complete description and figure of the interior surface of the dorsal and ventral valves, but was unable to ascertain whether the shell was or not possessed of spiral lamellæ for the support of the labial appendages. Unfortunately the species, although extremely abundant, occurs generally only in the state of internal casts or of impressions of its exterior, but it might also be possible to find examples in a suitable condition for working the interior. The muscular impressions bear much general resemblance with those observable in *Dayia navicula*, and in external shape the shell approaches much to that of *Zygospira anticostiensis*. It is provisionally left in *Rhynchonella*, or until its true characters can be determined.

None of these species can be classed in their proper genera until their internal characters shall have been worked out. There would be no difficulty in attaining that object if a sufficient number of specimens to be operated upon could be got together.

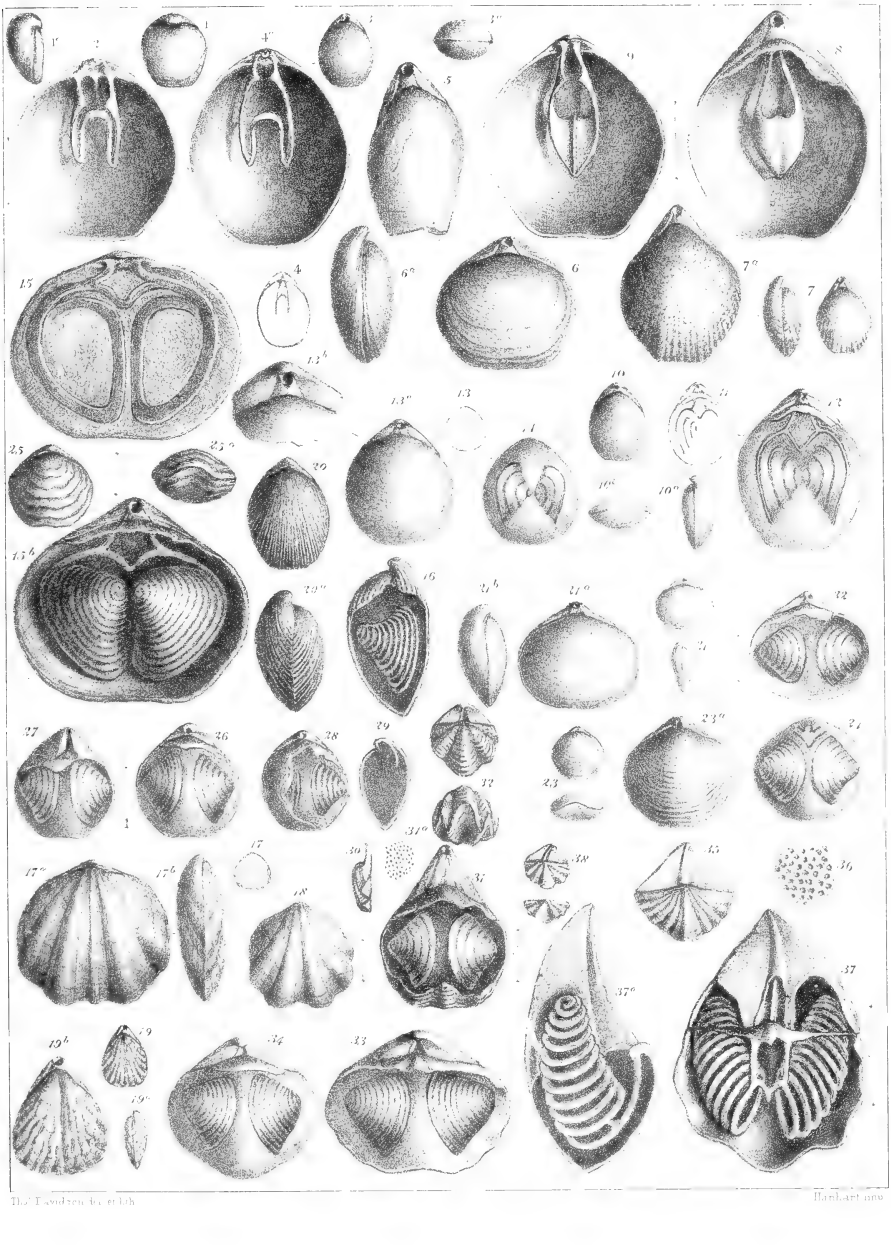
SUPPLEMENT, PLATE I.

DEVONIAN.

Spirals and loops developed by the Rev. N. Glass.

Fig.		
1, 1 *a*.	*Waldheimia* (or *Macandrevia*) *juvenis*, Sow.	Mid. Dev., Lummaton. (P. 13.)
2.	„ „ „	Dorsal valve enlarged, showing the loop.
3, 3 *a*.	„ (or *Macandrevia*) *Whidbornei*, Dav.	Exterior, nat. size. Mid. Dev., Lummaton.
4, 4 *a*.	„ „ „	4 *a*. Dorsal valve (enlarged) showing the loop. 4. Nat. size. (P. 12.)
5.	„ ? or *Terebratula*, sp.	Mid. Dev., Hope's Nose, near Torquay. (P. 13.)
6, 6 *a*.	*Terebratula ? Newtoniensis*, Dav.	Mid. Dev., Lummaton. Mus. Nat. Hist., Torquay. (P. 14.)
7, 7 *a*.	*Centronella virgo*, Phill., sp.	7. Nat. size. 7 *a*. Enlarged. Coll. of Mr. G. F. Whidborne.
8, 9.	„ „ „	8. Dorsal aspect or back of the loop facing the bottom of dorsal valve. 9. Ventral aspect or loop as attached to the dorsal valve. These figures are enlarged. (P. 14.)
10, 10 *a*, *b*.	*Glassia Whidbornei*, Dav.	Exterior nat. size. Mid. Dev., Lummaton. Coll. of Mr. Whidborne. (P. 38.)
11, 12.	„ „ „	11. Dorsal aspect, nat. size, showing attachments and one spiral. 12. A specimen complete, enlarged. (P. 38.)
13, 13 *a*, *b*.	„ „ „	13. Exterior, nat. size. 13 *a*, *b*. Enlarged. Lummaton. (P. 38.)
14.	„ „ „	Another specimen showing spirals. (P. 38.)
15, 15 *a*.	*Atrypa desquamata*, Sow.	Dorsal and ventral aspects showing spirals. Mid. Dev., Lummaton. (P. 39.)
16.	„ *reticularis*, Linné.	A weathered section, showing one of the vertical coils, Hope's Nose. Coll. of Mr. Whidborne. (P. 39.)
17, 18.	*Bifida ? Huntii*, Dav.	17. Nat. size. 17 *a*, *b*. Enlarged. 18. Back of ventral valve, enlarged. Mid. Dev., Lummaton. (P. 28.)
19, 19 *a*, *b*.	*Atrypa ? trigonella*, Dav.	Mid. Dev., Lummaton. 19, 19 *a*. Nat. size. 19 *b*. Enlarged. (P. 40.)
20, 20 *a*.	*Rensselæria ? striatissima*, Dav.	Mid. Dev., Hope's Nose. Coll. of Mr. Whidborne. (P. 19.)
21, 21 *a*, *b*.	*Athyris Glassii*, Dav.	21. Nat. size. 21 *a*, *b*. Enlarged. Mid. Dev., Lummaton. (P. 24.)
22.	„ „ „	Enlarged, showing the spirals.
23, 24.	„ *concentrica*, Buch.	23 *a*. Enlarged. Mid. Dev., Lummaton. 24. Spirals and attachments. (P. 25.)
25, 25 *a*.	„ *rugata*, Dav.	Mid. Dev., Lummaton. (P. 26.)
26—29.	*Merista plebeia*, Sow. = *scalprum*, Roemer.	26. Enlarged, showing spirals. 27. Spirals and shoe lifter process seen from back of ventral valve. 28. Weathered specimen, showing spiral. 29. Weathered section, showing shoe lifter process. Mid. Dev., Hope's Nose, Torquay. (P. 20.)
30, 30 *a*, 31.	*Retzia longirostris*, Kayser.	30. Nat. size, seen in profile. 30 *a*. Bit of punctate surface of shell enlarged. 31. Showing the spirals. Mid. Dev., Lummaton. (P. 29.)
32.	*Spiriferina insculpta*, Phill.	Mid. Dev., Lummaton. Coll. of Mr. Whidborne.
33.	*Spirifera undifera*, F. Roemer.	Spirals, Mid. Dev., Lummaton. (P. 33.)
34.	„ *curvata*, Schloth.	Spirals. (P. 32.)
35, 36.	*Cyrtina heteroclita*, Schloth.	Hope's Nose, near Torquay. 36. Bit of punctured shell enlarged. (P. 37.)
37, 37 *a*.	„ „ „	Spirals and attachments. (P. 37.)
38.	„ sp. ? „	Mid. Dev., Oarstone, near Torquay. Coll. of Mr. Whidborne. (P. 38.)

DEVONIAN



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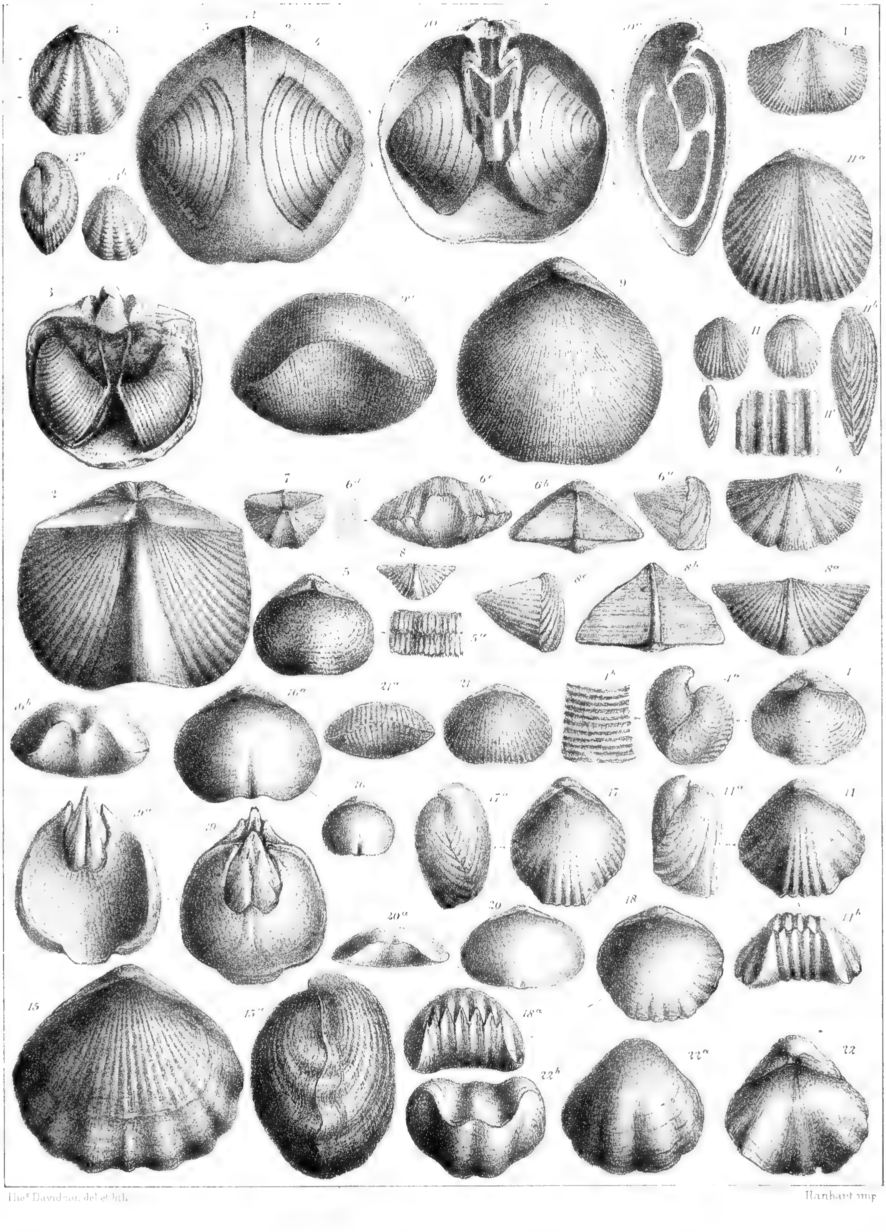
SUPPLEMENT, PLATE II.

Spirals and loops developed by the Rev. N. Glass.

DEVONIAN.

Fig.	
1.	*Spirifera Verneuilii?* Murch. Mid. Dev., Lummaton, near Torquay. Coll. of Mr. Whidborne. (P. 35.)
2.	,, *lævicosta*, Val. = *ostiolatus*, Schloth. Railway Cutting, Ashridge, near Totnes. Coll. of Mr. A. Champernowne. (P. 33.)
3.	,, ,, ,, Interior showing spirals. A German specimen after Quenstedt. (P. 34.)
4, 4 *a, b.*	,, *curvata*, Schloth. Mid. Dev., Lummaton. Coll. of Mr. Whidborne. 4 *b.* Portion of shell enlarged. (P. 32.)
5, 5 *a.*	,, *lineata*, Martin. 5 *a.* A portion of shell enlarged. Mid. Dev., Hope's Nose, near Torquay. (P. 32.)
6, 6 *a, b, c, d, e*, 7.	*Cyrtia* or *Cyrtina Whidbornei*, Dav. 6. A large example. Mid. Dev., Lummaton, near Torquay. Torquay Nat. Hist. Soc. Mus. 7 *a.* Small specimen same locality. Coll. of Mr. Whidborne. (P. 36.)
8, 8 *a, b, c.*	*Cyrtina heteroclita*, var. *multiplicata*, Dav. 8. Nat. size. 8 *a, b, c.* Enlarged variety with many ribs (perhaps a distinct species). Mid. Dev., Lummaton. Coll. of Mr. Whidborne. (P. 38.)
9, 9 *a.*	*Atrypa? latilinguis*, Schnur. Mid. Dev., near Newton Abbot? Coll. of Mr. W. Vicary. (P. 41.)
10, 10 *a.*	*Athyris concentrica*, Buch. 10. Dorsal valve enlarged, showing spirals, attachments to hinge-plate, and loop. 10 *a.* Profile view of the same specimen. Mid. Dev., Hope's Nose, near Torquay. (P. 25.)
11, 11 *a, b, c*, 12.	*Kayseria lens*, Phil., sp. 11. Nat. size. 11 *a, b.* Same enlarged. 11 *c.* Portion of shell much magnified. 12. Specimen showing the spiral coils arising from the hinge-plate and from the loop; also dorsal septum. Mid. Dev., Hope's Nose, near Torquay. (P. 21.)
13.	*Bifida lepida*, Goldf. Enlarged. Mid. Dev., Hope's Nose. Spirals and septum. (P. 27.)
14.	*Rhynchonella Phillipsii*, Dav. Mid. Dev., Lummaton. Coll. of Mr. Whidborne. (P. 43.)
15, 15*a.*	,, *Leei*, Dav. Lummaton. Coll. of Mr. Whidborne. (P. 47.)
16, 16 *a, b.*	,, *Ogwelliensis*, Dav. 16. Nat. size. 16 *a, b.* Enlarged. Lummaton. Coll. of Mr. Whidborne. (P. 44.)
17.	,, *protracta*, Phil. = *proboscidialis*, Phil. Lummaton. Coll. of Mr. A. Champernowne. (P. 44.)
18.	,, *cuboides*, Sow. Lummaton. Coll. of Mr. Whidborne. (P. 46.)
19, 19 *a.*	,, ,, ,, Internal casts of both valves. Mudstone Bay, near Torquay. Coll. of Mr. Champernowne. (P. 46.)
20.	,, *acuminata*, var. *platiloba*, Sow. Mid. Dev., Lummaton. (P. 47.)
21.	,, *triloba*, Sow. A young specimen. Lummaton. (P. 47.)
22.	*Pentamerus biplicatus*, Schnur. A large example. Mid. Dev., Lummaton. Coll. of Mr. Whidborne. (P. 42.)



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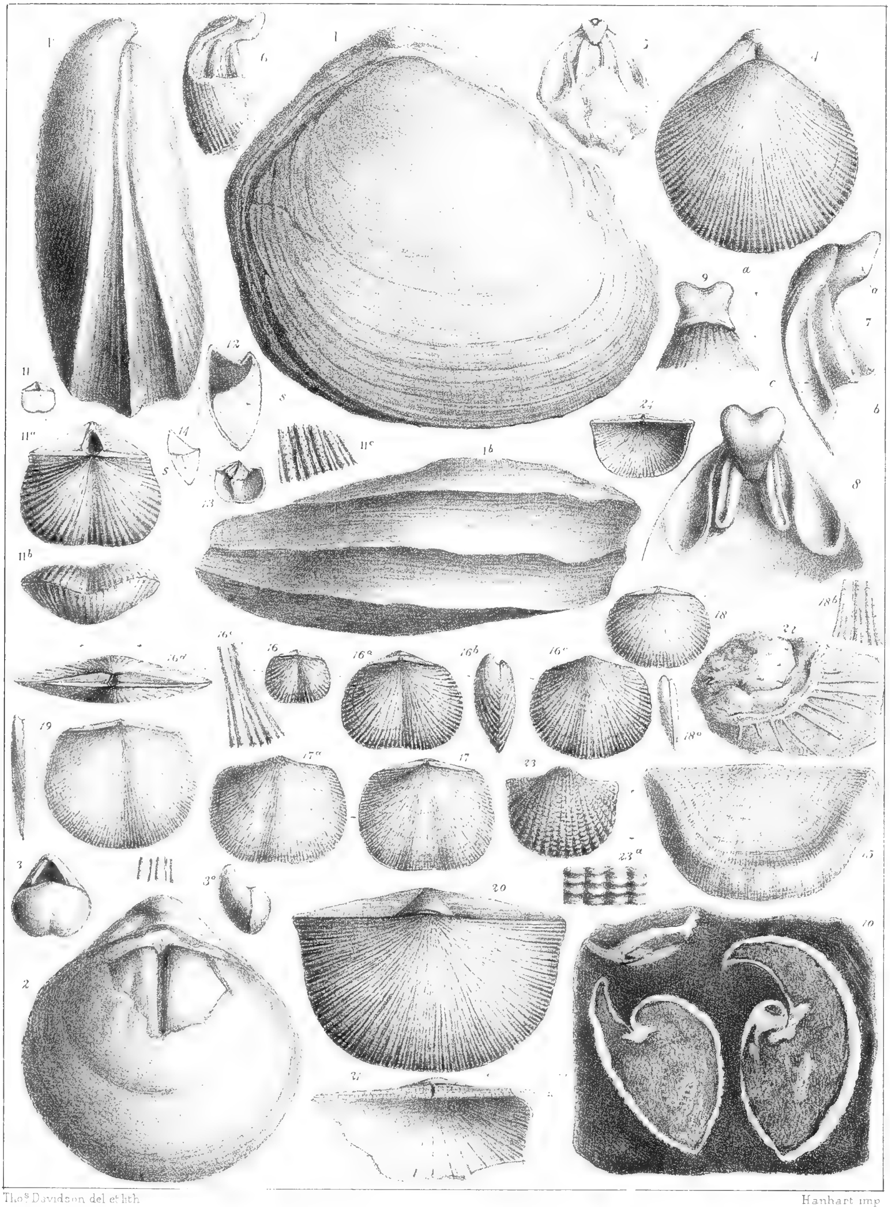
SUPPLEMENT, PLATE III.

DEVONIAN.

Fig.	
1, 1 *a*, *b*.	*Meganteris? Vicaryi*, Dav. Mid. Dev., Woolborough, near Newton Abbot. Coll. of Mr. W. Vicary. (P. 20.)
2, 3.	*Stringocephalus Burtini*, Def. Mid. Dev., Lummaton. Coll. of Mr. Lee. 3. A young specimen. Mid. Dev., Orchard Quarry, near Dartington. Coll. of Mr. A. Champernowne. (P. 19.)
4.	*Uncites gryphus*, Def. A perfect specimen showing no lateral pouches. Mid. Dev., Orchard Quarry, Dartington. Coll. of Mr. A. Champernowne. (P. 30.)
5—10.	,, ,, ,, 5, 6. A fragment of dorsal valve showing cardinal process, pouch-shaped cavities, and two grooved ridges. From Orchard Quarry, Dartington. Albert Memorial Museum, Exeter. 7, 8, 9. Enlarged. 7, 8. Profile view; *a*, cardinal process; *b*, two grooved elongated ridges; *c*, lateral pouches. 9. Back of ventral valve showing cardinal process (*a*). 10. Sections in a boulder of black marble. Found at Petit Tor Beach, near Torquay. Museum of the Torquay Natural History Society. (P. 30.)
11, 11 *a*, *b*, *c*, 12.	*Skenidium areola*, Quenstedt, sp. (*Mystrophora areola*, Kayser). 11. Nat. size. 11 *a*, *b*. Enlarged. 11 *c*. Portion of shell magnified. 12. Longitudinal section enlarged to show dorsal septum (*s*). (P .49.)
13, 14.	,, ,, ,, An Eifel specimen, after Kayser. 13. Interior of dorsal valve, showing large semicircular hinge-plate and septum. 14. Section of dorsal valve to show septum. (P. 49)
15.	*Strophomena rhomboidales*, var. *nodulosa*, Phillips. Mid. Dev., Lummaton. Coll. of Mr. Whidborne. (P. 52)
16, 16 *a*, *b*, *c*, *d*, *e*.	*Orthis Eifliensis*, de Vern. 16. Nat. size. Mid. Dev., Lummaton. 16 *a*, *b*, *c*. Enlarged. 16 *d*. Seen from the beaks to show area. 16 *e*. Portion of shell enlarged. (P. 50.)
17, 17*a*.	,, *tetragona*, de Vern. Mid. Dev., Ashridge, near Totnes. Coll. of Mr. A. Champernowne. (P. 51.)
18.	,, *? Champernownei*, Dav. Calcareous shales, Meadfoot, near Torquay. Coll. of Mr. Champernowne. (P. 52.)
19.	? ,, *Pengelliana*, Dav. Meadfoot, near Torquay. (P. 51.)
20.	*Streptorhynchus umbraculum*, Schloth. Mid. Dev., Hope's Nose. Coll. of Mr. Whidborne.
21.	*Leptæna interstrialis*, Phil. Mid. Dev., Lummaton. Enlarged. Coll. of Mr. Whidborne.
22.	*Productus subaculeatus*, Murch. A fragment of ventral valve, showing spines half an inch in length. Mid. Dev., Hope's Nose. Coll. of Mr. Whidborne. (P. 54.)
23, 23 *a*.	*Chonetes? Phillipsii*, Dav. 23. Ventral valve enlarged. 23 *a*. Portion of shell magnified. Mid. Dev., Lummaton. Coll. of Mr. Whidborne. (P. 54.)
24.	,, *Hardrensis*, Phil. From Mid. Dev., Hope's Nose. Coll. of Mr. Whidborne. (P. 54.)



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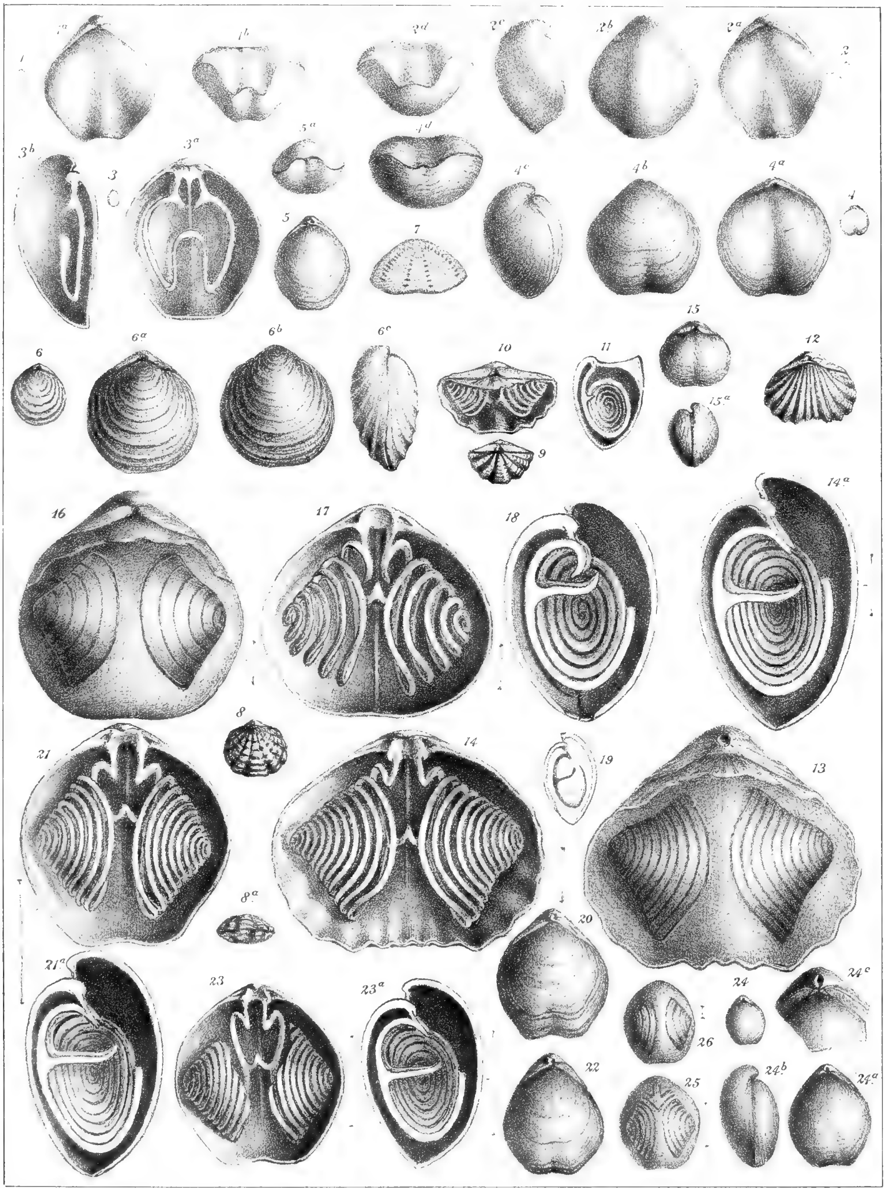
SUPPLEMENT, PLATE IV.

SILURIAN.

Spirals and loops developed by the Rev. N. GLASS.

FIG.		
1, 2, 3.	*Waldheimia* (or *Macandrevia*) *Mawii*, Dav.	1, 2. Nat. size. 1 *a*, *b*, 2 *a*, *b*, *c*, *d*. Enlarged. 3. Nat. size. 3 *a*. Interior of dorsal valve enlarged, showing the loop. 3 *b*. Profile view of loop. Wenlock shales, Shropshire. (P. 76.)
4, 4 *a*, *b*, *c*, *d*.	,, ,, *Glassii*, Dav.	4. Nat. size. 4 *a*, *b*, *c*, *d*. Enlarged. Lower Wenlock shale, Shropshire. (P. 77.)
5, 5 *a*.	*Merista ? Circe*, Barrande ?	Wenlock shale, Shropshire. (P. 105.)
6, 6 *a*, *b*, *c*.	*Atrypa ? Mawii*, Dav.	6. Nat. size. 6 *a*, *b*, *c*. Enlarged. Wenlock limestone, Benthall Edge, Shropshire. (P. 116.)
7.	,, *imbricata*, Sow.	Wenlock limestone, Benthall Edge. A transverse section to show the vertical spirals. (P. 115.)
8, 8 *a*.	,, *asperula*, Dav.	Wenlock limestone, Benthall Edge. (P. 112.)
9, 10.	*Spirifera crispa*, Linné.	9. Exterior, nat. size. 10. Enlarged, showing spiral coils and the lamellæ from the primary coils, which form in Spirifera the imperfect loop. Wenlock shales, under Benthall Edge. (P. 80.)
11.	*Cyrtia exporrecta*, Wahl.	Longitudinal section, showing one of the spirals and lamella from the primary coil which forms part of the imperfect loop as in Spirifera. (P. 81.)
12, 13, 14.	*Retzia Salteri*, Dav.	12. A large example. Wenlock shale, Benthall Edge. 13. Dorsal aspect enlarged, showing spirals. 14. Ventral aspect enlarged, showing spiral coils, attachment of primary lamellæ to the hinge-plate and loop. 14 *a*. Profile view, showing one of the spirals, the primary lamella of the other spiral attachments to the hinge-plate, and simple loop. Wenlock shales, Shropshire. (P. 92.)
15—18.	*Nucleospira pisum*, Sow.	15, 15 *a*. A large specimen. 16. Dorsal aspect enlarged, showing spirals. 17. Ventral aspect, showing spirals, attachments to the hinge-plate, and loop. 18. Profile view, showing the hook-shaped attachments to the hinge-plate. (P. 91.)
19.	*Retzia* (= *Rhynchospira*) *evax*, Hall.	Niagara group. Waldron, Indiana. Longitudinal section, showing attachment of the principal lamella to hinge-plate, and loop. Given here for comparison. (P. 93.)
20—21.	*Meristina nitida*, Hall.	20. Exterior, nat. size. 21. Interior of dorsal valve, showing spirals, attachments to hinge-plate, and loop, enlarged. 21 *a*. A profile view, showing one spiral, the primary lamella of the other spiral, attachments to hinge-plate, and loop. Niagara group, Waldron, Indiana. Given here for comparison with *M. didyma*, of which it is properly a synonym. (P. 94.)
22—23 *a*.	, *didyma*, Dal.	22. Exterior, nat. size. 23. Interior of dorsal valve, showing spirals, attachments to hinge-plate, and loop. 23 *a*. Profile view, showing one spiral, the primary lamella of the other spiral, attachments to hinge-plate, and loop. Wenlock shale, Shropshire. (P. 94.)
24—26.	*Athyris læviuscula*, Sow.	24. Nat. size. 24 *a*, *b*. Enlarged. 24 *c*. Beak enlarged to show the apical foramen. 25. Enlarged specimen, showing spirals, accessory lamellæ, and hook-shaped attachments to the hinge-plate. 26. Another specimen, showing spirals. Wenlock limestone, Benthall Edge (P. 101.



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SUPPLEMENT, PLATE V.

SILURIAN AND CARBONIFEROUS.

Spirals and loops developed by the Rev. N. GLASS.

FIG.

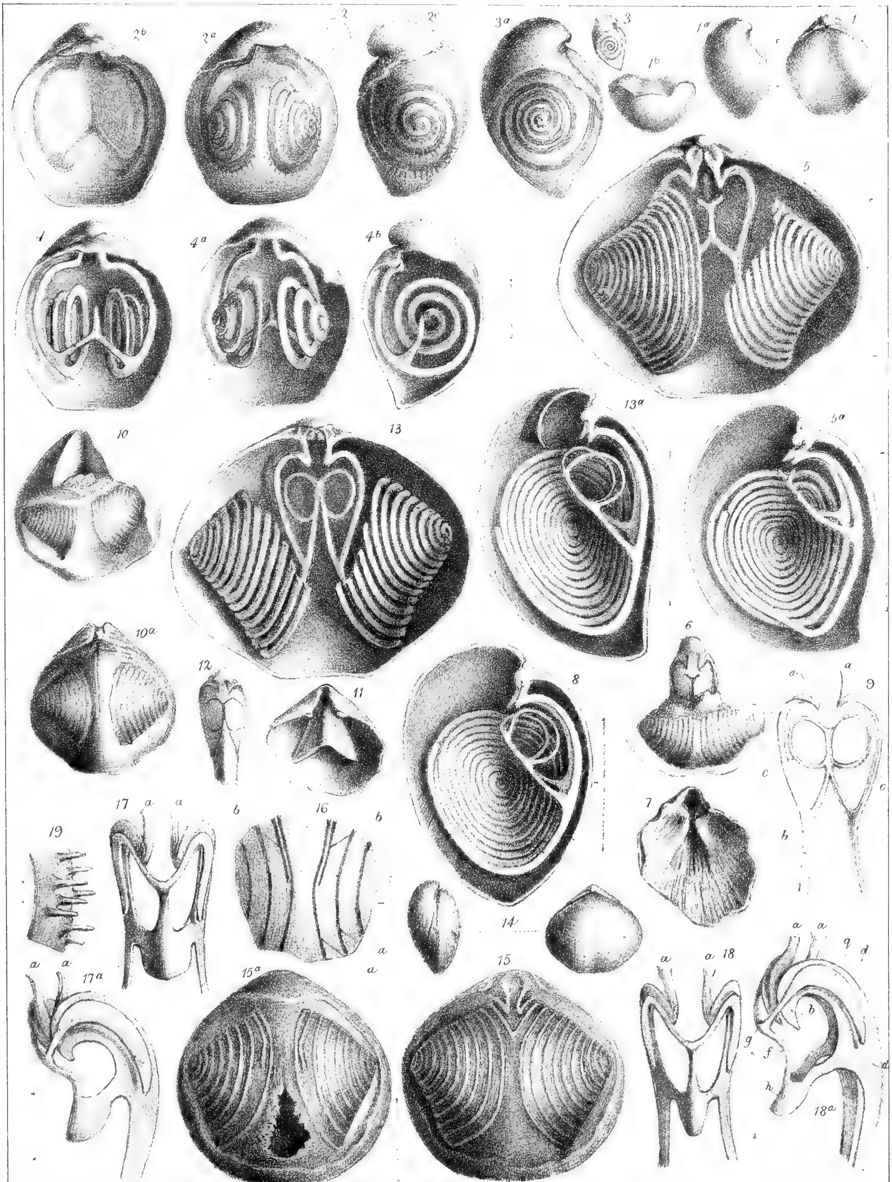
1—4. *Dayia navicula*, Sow., sp. 1 *a, b*. Exterior, enlarged. 2. Lateral aspect, nat. size. 2 *a, b, c*. Enlarged, showing ventral, dorsal, and lateral aspects of spirals, loop, and attachments to hinge-plate. 3. Large specimen, lateral aspect, nat. size. 3 *a*. The same enlarged. 4, 4 *a, b*. The same as 2 *a, b, c*, as they would appear if free from matrix. Ludlow shales, Shropshire. (P. 96.)

5, 6. *Whitfieldia tumida*, Dal., sp. 5. Interior of dorsal valve, enlarged, showing spirals, attachments to the hinge-plate, and forked loop. 5 *a*. Profile of the same, enlarged, showing one of the spirals, the primary lamella of the other spiral, attachments of primary lamellæ to hinge-plate, and forked loop. 6. *Meristina Maria*, Hall, an American specimen, to show that it is the same genus and species as *W. tumida*, Dal. Developed by Mr. Glass from a typical specimen of Prof. Hall's species forwarded by him. (P. 107.)

7, 8, 9. *Meristella arcuata*, Hall. Given here for comparison with *Whitfieldia* and *Merista*. 7. Interior of ventral valve to show there is no shoe-lifter process. 8. Profile section enlarged, to show one of the spirals, the primary lamella of the other spiral, the attachments of primary lamellæ to hinge-plate, and the loop with its rings. Developed from an American specimen sent to Mr. Glass by Mr. Whitfield. 9. Primary lamellæ and loop, much enlarged; *a, b*, primary lamellæ; *c*, ring and loop. (P. 106.)

10—13. *Merista Herculea*, Barrande, sp. Given here for comparison with *Whitfieldia* and *Meristella*. 10. Back of ventral valve, showing the cavity left by the shoe-lifter process, and showing the spirals. 10 *a*. Showing the spirals from the dorsal side. 11. Interior of a portion of ventral valve, showing the beak and shoe-lifter process. 12. Specimen as developed by Mr. Glass, showing primary lamellæ, attachments to hinge-plate, loop, and rings. 13. Interior of the dorsal valve, much enlarged, showing spirals, primary lamellæ, loop, rings, and attachments to the hinge-plate. 13 *a*. A profile section to show position of loop and rings. The shoe-lifter process, as shown by subsequent investigations, should be represented in the figure as being nearer to the attachments of the spirals to the hinge-plate. The above specimens were developed by the Rev. N. Glass from examples of *Merista Herculea*, forwarded by Mr. Barrande. (P. 103.)

14—19. *Athyris plano-sulcata*, Phillips. Carboniferous, given for comparison. 14. Exterior, nat. size. 15, 15 *a*. Ventral and dorsal aspects, enlarged, the shell having been removed so as to expose the spirals, the accessory lamellæ, and attachments. 16. Part of dorsal aspect of spirals enlarged, showing, *a*, first and second ordinary spiral coils; *b*, the accessory lamellæ. 17, 17 *a*. Front and profile view, showing the primary lamellæ and their hook-shaped attachments to the hinge-plate (*a*), also showing the loop and the accessory lamellæ. 18, 18 *a*. From another example: *a*, attachments to hinge-plate; *b*, hook-shaped prolongations from attachments to hinge-plate; *d*, primary lamellæ; *h*, roof-shaped process of loop; *f*, single curved lamella; *g*, bifurcation of the lamella; *q*, accessory lamella. 19. Portion of one of the spiral coils with projecting spines, enlarged. All the above examples were developed by the Rev. N. Glass from specimens sent to him by Mr. John Tym from the Carboniferous limestone of Castleton, Derbyshire. (P. 98.)



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SUPPLEMENT, PLATE VI.

SILURIAN.

Spirals and loops developed by the Rev. N. Glass.

Fig.

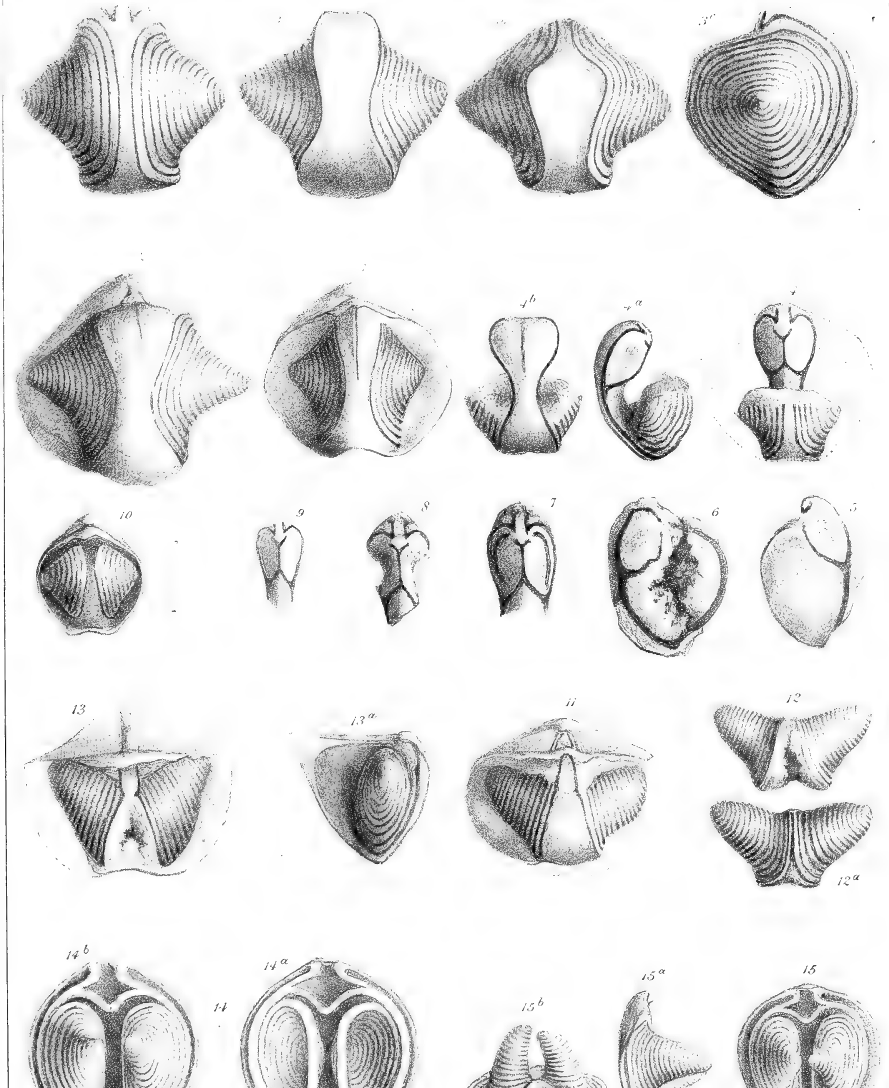
1—9. *Whitfieldia tumida*, Dalman, sp. 1 and 2. The dorsal valves removed to show the spirals. 3, 3 *a*, *b*, *c*. The spirals entirely removed from the interior of the shell, so as to show them in different aspects. 4, 4 *a*, 4 *b*. A specimen seen in different aspects, and worked by Mr. Glass, so as to show the primary lamellæ, their attachments to the hinge-plate, and the forked loop. 5 to 9. Other similar preparations to show that the characters are constant and the same. All these specimens worked by Mr. Glass were procured by him from a railway cutting near Walsall, and are from Wenlock shales. (P. 107.)

10. *Meristina didyma*, Dal., sp. Worked by Mr. Glass, and now in the collection of Mr. Hollier. (P. 94.)

11, 12. *Spirifera plicatella*, var. *radiata*, Sow. Specimens developed by Mr. Glass to show spirals. 12 and 12 *a*. Spirals entirely removed from interior of shell. Wenlock limestone, Walsall. (P. 87.)

13, 13 *a*. *Cyrtia exporrecta*, Wahl. To show the spirals. Wenlock limestone, Walsall.

14—15. *Atrypa reticularis*, Linné. Specimens developed by Mr. Glass to show the spirals in different aspects. Wenlock limestone, Walsall. (P. 109.)



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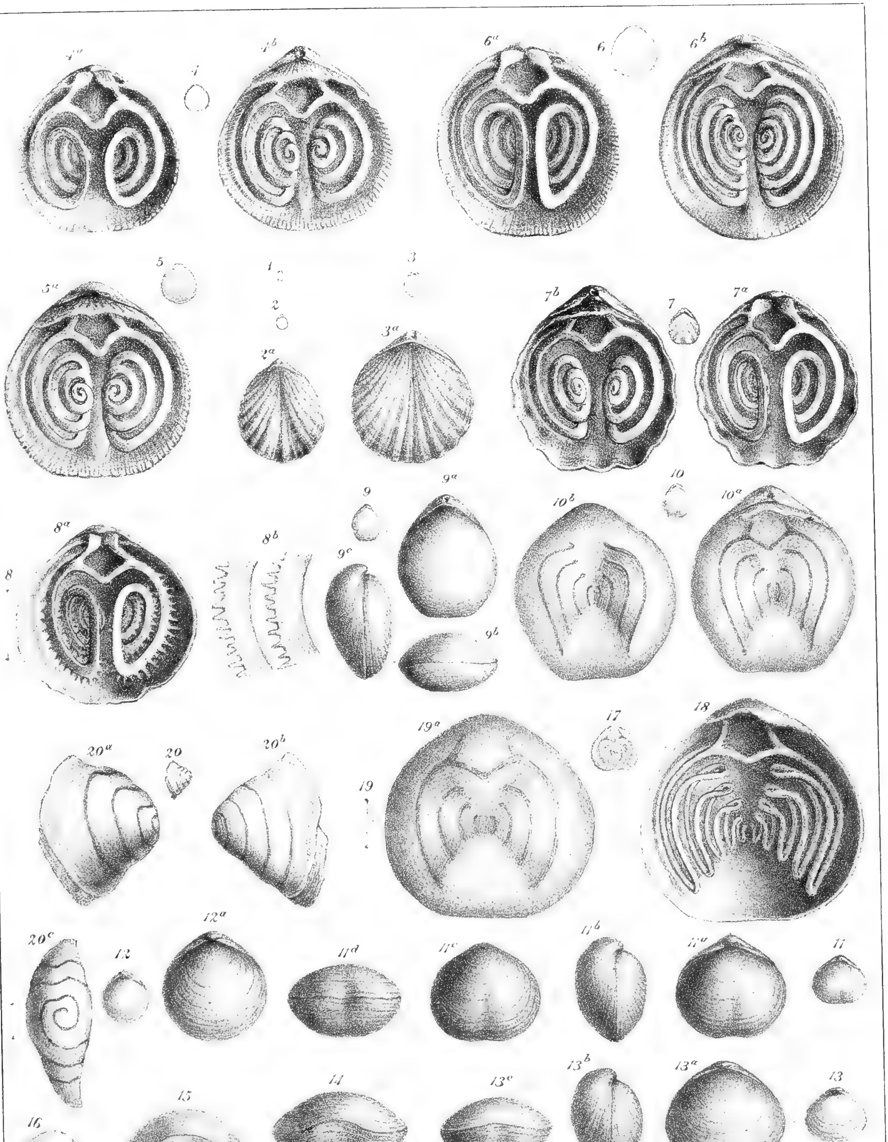
SUPPLEMENT, PLATE VII.

SILURIAN.

Spirals and loops developed by the Rev. N. Glass.

Fig.		
1, 2, 3.	*Atrypa reticularis*, Linné.	Young shells from Wenlock shales, Shropshire.
4 to 6.	,, ,, ,,	Young specimens of different sizes, developed by Mr. Glass to show the growth of the spirals and enlarged. Wenlock shales, Shropshire. (P. 109.)
7, 7 *a, b.*	,, *Barrandei*, Dav.	7. Exterior, nat. size. 7 *a, b.* Interior enlarged, to show spiral attachments to the hinge-plate and loop. Wenlock shales, Shropshire. (P. 114.)
8, 8 *a b.*	,, *marginalis*, Dal.	8 *a.* Interior developed to show spirals with their spiny projections, attachments to hinge-plate, and loop, enlarged. 8 *b.* Portion of one of the spiral lamellæ, much enlarged to show spiny projections. Wenlock limestone, Benthall Edge. (P. 113.)
9, 10.	*Glassia elongata*, Dav.	9. Exterior, nat. size. 9 *a, b, c.* Enlarged. 10. Nat. size. 10 *a, b.* Dorsal and ventral aspects of spires, as developed by Rev. N. Glass and seen as a transparency. Wenlock shales, Shropshire. (P. 119.)
11 to 20.	,, *obovata*, Sow., sp.	11, 12, 13, and 16. Nat. size. 11 *a, b, c, d,* 12 *a,* 13 *a, b, c,* 14 and 15. Enlarged. Wenlock shales, Shropshire. 17. Ventral aspect of the spirals and attachments, nat. size. 18. The same enlarged, and as it would appear entirely free from matrix. 19 *a.* Dorsal aspect of the spirals and attachments, enlarged. 20. Spiral entirely removed from the shell. 20 *a, b, c.* the same enlarged and shown in different aspects. (P. 116.)



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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1882.

LONDON:

MDCCCLXXXII.

THIRD SUPPLEMENT

TO THE

CRAG MOLLUSCA,

COMPRISING

TESTACEA FROM THE UPPER TERTIARIES OF THE EAST OF ENGLAND.

BY THE LATE

SEARLES V. WOOD, F.G.S.

EDITED BY HIS SON SEARLES V. WOOD, F.G.S.

PREFACE; PAGES 1—24; PLATE I.

UNIVALVES AND BIVALVES.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1882.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

PREFACE BY THE EDITOR.

My late father had at the time of his death (which took place on Oct. 26th, 1880 collected some materials and written the text for a further short Supplement to his original work on the "Crag Mollusca." These materials and text consisted of the descriptions here given, and also of those of the remains of certain vermiform mollusca which he had got together from the Coralline and Red Crag beds. The latter, however, were not left by him in such a form as would allow me to give his views without risk of misrepresentation; and as I know, moreover, that in respect of one at least of these forms he was in great doubt to the last, whether it belonged to the Molluscous subkingdom at all, I have thought it best to suppress that portion of his notes, and to give only the portion which relates to the Gasteropoda and Bivalvia; as to which I well know what his ideas were. This part forms but an insignificant addition to the preceding portions of his work, and comprises for the most part only shells that have got into the Red Crag beds by derivation from older formations; but as all such shells must be considered, and eliminated from the evidence which is obtainable to show of what the molluscan Fauna of that part of the North Sea which washed the shore of East Anglia at the time of the Red Crag really consisted, their description and representation by figure, as my father intended, appear to me to form a proper sequel to his work.

The text which is not comprised by brackets is that left by my father. The text within brackets (with the exception of the description of *Margarita crassi-striata*, and of the bed at Boyton from which that shell was obtained, which is by Mr. Robert Bell, is by myself.

THIRD SUPPLEMENT TO THE CRAG MOLLUSCA.

GASTEROPODA.

ROSTELLARIA? GRACILENTA, *S. Wood.* 3rd Sup., Tab. I, fig. 1.

Axis, 1 inch.

Locality. Red Crag, Felixstowe.

Many years ago I found a few specimens in the Red Crag at Sutton, to which I gave the provisional name of *Rostellaria plurimacosta* in my original Catalogue in 'Mag. Nat. Hist.,' September, 1842, p. 543. Not finding any of the like form and character in better preservation I, in the first supplement (1872) to my work on the 'Crag Mollusca' (p. 5, Tab. II, fig. 14), gave a figure with the best information I possessed respecting the few specimens in my own cabinet, and referred them (doubtfully) to a well-known Eocene species *R. lucida*, J. Sow.

In my recent researches at Felixstowe I have obtained three or four more specimens of this shell, though in a more mutilated condition. With these I have found some other mutilated specimens, the best of which I have here had figured. This resembles in its ornamentation the Eocene species *lucida*, which is from the upper part of the London Clay ('Min. Con.,' Tab. 91), but it differs in other respects, as it is much more slender, more elongated, and possesses larger and fewer costulæ. Unfortunately the mouth or aperture is imperfect so that the genus cannot with certainty be determined. I, however, propose for it provisionally the name above. It is undoubtedly an immature specimen, with its outer lip sharp as it would naturally be in a young and growing shell.

In the Ipswich Museum there is a mass of material, nearly two feet across and about three inches in thickness, found in the nodule bed at the base of the Red Crag at Waldringfield, and on the upper surface are a large number of specimens of a vermiform shell identical with what has been figured in 'Min. Conch.,' Tab. 596, figs. 1—3, as *Vermetus Bognoriensis*, and with them are several specimens, but in a mutilated condition, of what may be referred to *Rostellaria lucida*, as also some specimens resembling my present shell in a similar condition to my own above figured. There can therefore, I think, be little doubt but that the shell now figured is like the true *lucida*, a London Clay species, and has got into the Crag by derivation from that formation; for the shell figured by Sowerby in Dixon's 'Geology of Sussex,' Tab. V, fig. 21, from the Bracklesham beds as *R. lucida,* differs from that originally figured by him under this name in 'Min. Con.' (and which was from the London Clay of Highgate), and, in my opinion, is specifically distinct from it, as it possesses more numerous and sharp ribs or costulæ, and is more regularly striated in a spiral direction, the striations covering the entire surface.

TROPHON ANTIQUUS, var. DESPECTUS. 3rd Sup., Tab. I, fig. 9.

MUREX DESPECTUS, *Linn.* Syst. Nat., edit. xii, p. 1222, 1766.
FUSUS — *Lam.* An. sans Vert., 2nd ed., tom. ix, p. 448, 1843.
— — *Fleming.* Brit. Anim., p. 349, 1828.
TRITONIUM DESPECTUM var. ANTIQUATA, *Middendorf.* Malkop., p. 135, 1849.

Locality. Red Crag, Sutton.

In the first portion of my work I have given many of the extreme forms of this variable species, but there is no figure representing the front or opening of the present variety; and as the above name of *despectus* has been several times given as a distinct species from the Red Crag I have thought it necessary to represent a shell here which resembles the recent form of that name. This was introduced as a distinct Crag species by the late Sir Chas. Lyell in a list accompanying a paper by him, and published in the 'Mag. Nat. Hist.' in 1839, p. 329; by the late Edward Forbes, also, in his Memoir in the 'Geol. Survey,' 1846, p. 426, and in the list by Professor Prestwich in 'Quart. Journ. Geol. Soc.,' vol. xxvii, p. 488. I think it therefore incumbent on me to give the accompanying figure of this variety, for such only do I conceive it to be. I will, therefore, refer to Plate V of my first volume, and assign the figures therein as the following varieties of this species according to my view, viz. *Fusus decemcostatus,* Gould, 'Invert. Massach.,' is represented in it by fig. 1 *a; Fusus carinatus,* Lam., by fig. 1 *b; Fusus striatus*, Sow., by fig. 1 *c*; *Fusus contrarius,* Phil. and Nyst, by figs. 1 *d—k.*

There are some other varieties, I believe, in the Crag of which I have not been able to obtain specimens for representation. *Fusus tornatus,* Gould, is, I believe, only a variety of *T. antiquus,* and the shell figured in the 'Ency. Method.' with wavy ridges, pl. 426, fig. 4, is another variety, and this I am told has been found in the Red Crag, but I have not been able to see a specimen or I would have had it figured. Brown, in his 'Illustr. Brit. Conch.,' pl. 47, figs. 10 and 13, has figured this shell with wavy ridges, and calls it *Fusus subantiquatus*, but says, "I have great doubts of this being a British shell." This undulation is produced by a sinuated form of the outer lip, and is probably a distortion, and if so the specimens are not likely to be very numerous.

TROPHON MURICATUS, *Mont.* Crag Moll., vol. i, p. 50, and 1st Sup., p. 28.

TROPHON MURICATUS var. EXOSSUS. 3rd Supplement, tab. i, fig. 3, 1882.

Locality. Red Crag, Felixstowe.

The specimen figured as above was recently found by me, and though in excellent preservation is quite destitute of the longitudinal ribs present in the ordinary form of this species. I have therefore distinguished it as a variety, under the name of *exossus.*

PLEUROTOMA TURRIS, *Lamarck,* 3rd Sup., Tab. I, fig. 8.

PLEUROTOMA TURRIS, *Lam.* An. sans Vert., tom. vii, p. 97, 1822.
— — — Ibid., 2nd ed., tom. ix, p. 367, 1843.
— — — Ency. Method., p. 795, t. 441, fig. 7, 1832.
— — *Nyst.* Coq. foss. de Belg., p. 525, 1843.
MUREX INTERRUPTUS, *Brocchi.* Conch. foss. Subap., p. 433, pl. ix, fig. 21, 1814.

Spec. Char. "*T. fusiformi-turrita, transversim sulcato-rugosa; striis longitudinalibus tenuissimis in areis planulatis per undulatis; anfractibus, infra medium ungulatis, ultra angulum plano-concavis, prope suturas marginatis.*"

Axis, $1\frac{1}{2}$ inch.

Locality. Red Crag, Felixstowe.

There is some confusion respecting the name of this species. Lamarck described two species as *interruptus,* one a recent and very distinct shell, the other a fossil for which he adopted the specific name of (*Murex*) *interruptus,* referring it to the *Murex interruptus* figured and described by Brocchi in 1814; but a shell named *Murex interruptus* had been described by Pilkington in 'Trans. Linn. Soc.,' for 1804, vol. vii, T. 11, f. 5 (and also figured in 'Min. Conch.,' T. 304), which takes precedence and is entitled to that specific name. I have therefore adopted the above specific name of *turris* for the fossil from the Red Crag, Pilkington's species being a British Lower Tertiary form, and quite distinct from our present shell which is a Bolderberg and Italian species.

Bellardi has represented two shells under the name of *Pleurotoma interrupta,* considering them only as varieties of the same species, and the specimen from the Red Crag at Waldringfield, figured in my first Supplement, T. V., f. 1, seems to correspond with his variety C, given in fig. 11 of Tab. I of his work, while the present shell corresponds with his fig. 16 of the same plate. [Our specimen therefore seems to have got into the Red Crag from some bed corresponding to those of the Bolderberg.—Ed.]

I found also among my siftings in the Red Crag at Felixstowe a considerable portion of a specimen of a species belonging to this genus with very distinct ornamental ridges or costæ which appears to correspond or at least to approach nearer to *Pleurotoma abnormis* of F. Edwards, 'Eocene Mollusca,' p. 294, Tab. XXX, fig. 14, *a. b.*, than to any other species I have compared it with. This being a London Clay species it may have come into the Red Crag with the *Rostellariæ* which I have figured. I also obtained a fragment of what seems to be *Pleurotoma Gastaldi*, Bellardi, Tab. II, fig. 19, but neither of them being in a condition to allow of correct determination I have not thought it worth while to have them figured.

Fig. 5 of Tab. I, represents one of two small specimens kindly sent to me by Dr. Reed with the name of *Pleurotoma gracilior*, A. Bell, from the Red Crag of Walton Naze affixed to it. These appear to have lost their outer coating, but are the same as the shell represented in fig. 12 of Tab. VII of vol. i of 'Crag. Moll.,' under the name *lævigata*, Phil., and which at p. 41 of my first Supp., is referred to *P. tenuistriata*, A. Bell. One of them has the upper whorls destroyed, but the other has all the whorls perfect and so peculiar that I have had it represented. It shows not only an obtuse apical region, but the first volutions are wholly different from the more cylindrical volutions of the rest of the shell.

Pleurotoma nebula, *Mont.* 3rd Supp., Tab. I, fig. 7.

Fusus ? nebula,	*S. Wood*	Catal. Mag. Nat. Hist., p. 541, 1842.
Clavatula —	—	Crag Moll., vol. i, p. 60, tab. vii, fig. 10, 1848.
Pleurotoma —	—	1st Supplement, p. 45, tab. vii, fig. 7, 1872.
Mangelia —	*Forb. & Hanl.*	Brit. Moll., vol. iii, p. 476, pl. 114, figs. 7—9, 1853.

Although I have already given two figures of the Crag shell under the above specific name, they neither of them show a satisfactory representation of this long known species, and I have therefore determined to give another of a specimen in a more perfect condition from the cabinet of Mr. Robert Bell, which has retained some of its spiral striæ.

Pleurotoma harpula, *Brocchi*. 3rd Suppt., Tab. 1, fig. 4.

Murex harpula, *Brocchi*. Conch. foss. Subap., p. 421, tab. viii, fig. 12, 1814.
Pleurotoma — *Phil.* En. Moll. Sic., vol. ii, p. 173, 1844.
Fusus — *Risso.* Hist. Nat. Europe Mérid., vol. iv, p. 208, 1826.
Raphitoma — *Bellardi.* Monog. de Pleurot., p. 101, No. 22, 1847.

Axis, $\frac{9}{20}$ of an inch.

Locality.—Boyton.

A single specimen has been sent to me for examination and illustration by Mr. Robt. Bell, with Brocchi's specific name attached, and in this assignment I quite coincide. It appears in shape to be intermediate between *Fusus* and *Pleurotoma*, but probably only doubtfully to be entitled to the above generic position, as it seems quite destitute of the "side slit" of that genus. Our shell may be described in the words of Brocchi, viz.: "Testa turrita, longitudinaliter costata costis (8—9) tenuis, spiraliter striatis, interstitiis lævigatis, anfractibus convexiusculis, apertura ovata; cauda brevissima aperta.

Raphitoma submarginata, *Bellardi*. 3rd Suppt., Tab. 1, fig. 2.

Pleurotoma sub-marginata, *Bonelli*. Cat. Mus., *fide* Bellardi.
Rhaphitoma — *Bellardi*. Monog. Pleurot. foss., p. 95, tab. iv, fig. 20, 1847.

Axis, $\frac{6}{10}$ of an inch.

Locality.—Red Crag, Felixstowe.

A single specimen, but unfortunately not quite in perfection, has been found in my siftings of the Red Crag material at Felixstowe, and I have referred it as above, but my dependence for so doing has been upon the description and figure by Bellardi, not having a specimen of the Italian fossil for comparison. My shell appears to be somewhat intermediate between this and *R. plicatella*, but I have no doubt that it is one of the very large group of fossil shells varying in some trifling degree only which connect the genus *Pleurotoma* and *Fusus*, and for which I believe nearly twenty generic divisions have been proposed. My shell is not far removed from *Murex vulpeculus*, Brocchi, and *Pleurotoma Maggiori*, Phil., forms. which, I think, might without any impropriety be specifically united. My shell measures six-tenths of an inch in length, and two-tenths in its diameter, without any ridges or folds upon the columella, or any denticulations on the inside of the outer lip; but this may be from its not having arrived at maturity. There are traces of spiral striæ, but the specimen has had its surface much eroded, and when perfect it was probably fully covered. It has about a dozen costulæ or riblets on the last volution. [The specimen appears to me to be a derivative.—Ed.]

COLUMBELLA ERYTHROSTOMA? *Bonanni.* 3rd Suppt., Tab. 1, fig. 10 *a*, *b*.

COLUMBELLA ERYTHROSTOMA, *Bon.* *Fide* Bellardi Monog. delle Columbelle foss. del Piedmonte, p. 9, fig. 4, 1848.

Spec, char.—"*Testa turrito-elongata, turgidula, anfractibus lævibus, convexiusculis; ultimo magno: apertura dilatato-elongata, labro subarcuato, subvaricoso; columella adnata, regulariter et numerose rugosa; rugis brevibus externis.*"—Bellardi.

Locality. Red Crag, Butley.

The above figures represent specimens found by myself some years ago, in the Red Crag of Butley, which I have hitherto left unnoticed, regarding them merely as specimens of *C. sulcata,* Sowerby, derived from an older part of the Red Crag, and worn smooth in consequence, that species being abundant at Walton, and variable in length; one figured in Supplement to Crag Moll., p. 9, Tab. 11, f. 16, measuring one inch and five-eighths, while another is less than three-quarters of an inch, both of them being full-grown, and belonging, I believe, to the same species.

The specimens now figured are quite smooth, a character agreeing with that which Bellardi has given for the Italian fossil *erythrostoma,* which is described as "*anfractibus lævibus;*" but if my specimens have been derived from an anterior Red Crag bed, they may have lost the spiral striæ from either decortication or abrasion, and so be, as I originally supposed them to be, merely worn specimens of *C. sulcata.* Mr. A. Bell gives three specimens of this genus from what he terms the Middle and Upper Crag, viz. *C. sulcata, C. abbreviata,* and *C. Borsoni;* and another is added in Prof. Prestwich's catalogue of mollusca from the Red Crag, viz. *C. scripta.* In my original work, and in the supplements thereto, I have figured several different forms of what appear all to be *C. sulcata;* and as two specimens, which had been furnished him by Mr. A. Bell, under the name of *Columbella abbreviata,* have been kindly sent to me by Dr. Reed, I have figured one of them (Tab. 1, fig. 6), in order that a representation of the shell, on the strength of which this name of *abbreviata* has been introduced into the list of Red Crag Mollusca, may appear. The shorter of the two specimens which I have figured under the name of *erythrostoma* (fig. 10A), agrees with this *abbreviata,* but is smooth.

Lacuna (Medoria) terebellata, *Nyst.*

Melania terebellata, *Nyst.* Coq. foss. de Belge, p. 413, pl. xxxviii, fig. 12, 1843.
Paludestrina — *S. Wood.* Crag Moll., vol. i, p. 109, tab. xii, fig. 7, 1848.
Eulimene — — 1st Supplement, p. 65, 1872.

This shell was figured by myself in the 'Crag Moll.' under the generic name of *Paludestrina.* In my first Supplement I, in my perplexity, grouped it in a new genus, in which I proposed to embrace another crag shell, viz., *Eulimene.* It is not, I think, either a freshwater or an estuarine shell, neither does it belong either to *Paludina* or to *Littorina.*

In the Red Crag at Felixstowe I have lately obtained more than a hundred specimens, varying in the length of axis from an eighth of an inch to upwards of five eighths, every one of which is in a mutilated condition, but all belonging to this species (whatever it may be); and every one has, more or less, its umbilicus (lacuna), covered over, by apparently, an extension of the left lip of the shell. This extremely mutilated condition evidently indicates that the specimens have been introduced into the Red Crag both at Walton and elsewhere from some older bed, but I have not been able to trace whence. They are very thick and strong shells, more so than any freshwater species in this country.

[The shell is described by M. Nyst, in his 'Coq. foss. de Belge,' as occurring at Antwerp and Calloo, and as being rare, but he does not there specify in what division of the Upper Tertiaries at these places the shell is found. In his 'Listes des Fossiles des divers Etages,' p. 424, however, he gives it from the Crag jaune (or uppermost crag) only. I do not find it in any of the lists given by M. Vanden Broeck, in his 'Esquisse Geologique,' for the different horizons which he seeks to establish of the beds at, and in the neighbourhood of Antwerp.—Ed.]

In the 'Crag Moll.,' vol. i, p. 108, Tab. XI, fig. 2 *a, b,* is figured and described a shell from Bramerton, under the name of *Paludestrina subumbilicata,* which may, I now think, be regarded as the ancestor of the living *ventrosa,* and it is there stated that in my cabinet was one specimen from the Cor. Crag, the identity of which was given as doubtful in consequence of the Bramerton shell (*subumbilicata* or *ventrosa*) being generally considered a freshwater or estuarine inhabitant. This species, however, as well as *ulvæ,* is capable of living where the water is not quite fresh, and I have lately found in the purely marine Red Crag of Felixstowe a few specimens which appear to me undistinguishable either from the Bramerton shell, or from the living species, called by the British Conchologists *Hydrobia ventrosa.* If we may depend upon figures and descriptions, there are several continental shells with different names (both generic and specific) which cannot be separated from the Crag and recent shell above referred to, but of these some are given as fossils from deposits that are said to be purely of freshwater origin, while others are given as from beds of purely marine origin. This species so closely resembles some of those of *Rissoa*, that I do not know any character in the testaceous part by which it can be separated from that genus.

NODOSTOMA ORNATA, *S. Wood.* 'Crag Moll.,' vol. i, p. 87, Tab. IX, fig. 6, as *Odostomia simillima;* 1st Sup., p. 64, as *O. ornata;* 3rd Sup., Tab. I, fig. 13.

Locality.—Cor. Crag, Sutton.

This pretty little shell was figured and described in the 'Crag Moll.," under the name of *Odostomia simillima*, and was assigned to Montagu's species *simillimus*, which I now consider was erroneous; and in my first Supplement I assigned it as distinct, and gave it the name *ornata.* The obscure tooth, stated in my first volume (p. 87) as present upon the columella, is, I find, only a fragment of sand adhering to the columella, while the aperture is more elongately ovate than in *Odostomia*, and of quite a different form from that in *Chemnitzia.* My specimens were very few and somewhat variable, but the species, I think, cannot be placed in the genus *Odostomia*, being apparently intermediate between that genus and *Eulima.* I therefore propose to call it *Nodostoma*[1] from its evident relationship with *Odostomia*, but separated from it by its toothless character.

The shell described by Montague is considered by the authors of 'Brit. Moll.,' as well as by the author of 'Brit. Conch.,' to have been "a bleached and worn specimen" of *Chemnitzia rufa*, Phil., and doubtfully British. The present figure is taken from a single specimen that I have recently found, the shell being extremely rare.

NODOSTOMA EULIMELLOIDES, *S. Wood.* 3rd Sup., Tab. I, fig. 14.

Locality.—Cor. Crag, Sutton.

[Of the specimen figured as above, a sketch was made by my father for his intended plate under this name; and he appears to have intended to give it as a second species of his new genus, *Nodostoma*, but he has left no other MS. respecting it beyond the above specific name of *eulimelloides.* I have compared it with all the species of *Eulima* described by him from the Crag, and it agrees with none satisfactorily. It comes nearest to *Eulima glabella*, but the form of the mouth differs, the whorls are more cylindrical,

[1] Νωδος, toothless, and στομα, mouth.

and the suture is deeper or more marked. The surface is smooth and without any ornament. Though imperfect by the loss of the upper whorls, the specimen is otherwise in good preservation, and shows these distinguishing characters clearly.—Ed.]

Menestho ? Suttonensis, *S. Wood.* 3rd. Sup., Tab. I, fig. 11.

Locality.—Cor. Crag, Sutton.

The above figure represents a small shell found by myself some years ago and retained until now in the hope of obtaining a better specimen. I have referred it to the genus *Menestho,* as to which I have made some remark at p. 56 of my first Supplement.

My shell is unfortunately not quite perfect, the outer lip being slightly broken, but it much resembles the opening of *Rissoa* or *Odostomia.* The specimen is covered with four rather coarse spiral lines and depressions on the lower whorl, and three on the next above this, but probably it may not be a full-grown shell. The nearest figure to which I have been at all able to refer it (approximately) is a very small shell, described by Isaac Lea in his contributions to 'Geology,' pl. iv, fig. 84, under the name of *Pasithea sulcata,* but, judging from this figure, my shell is distinct. Lea gives no less than nine species under that generic name, several of them differing materially in characters that it would be difficult to collect into one genus, and he does not specify which of these he regards as the type of his genus *Pasithea,* so that I am unable to adopt that genus for my present species.

Odostomia Reevei, *S. Wood,* 3rd Supp., Tab. I, fig. 12.

Locality. Fluvio-marine Crag, Bramerton.

The above figure represents a specimen of the above-named genus sent to me by Mr. Jas. Reeve, of the Norwich museum and found by him at Bramerton in the bed which yielded the specimens of *Cerithium derivatum* and *Odostomia derivata* described in the 'Second Supplement to the Crag Moll.' (pp. 39—40). The nearest species to which I can compare it is *O. dubia,* Jeff., but it differs sufficiently, I think, to be considered distinct, at least as much so as several of our so-called British species. The shell is somewhat thick and free from striæ of any kind, the aperture measures half the length of the entire shell, and is of a very ovate form, the base of it being contracted more than usual in any species of this genus. The shell is rather larger than any of my specimens from the Cor. Crag, with the exception of *O. conoidea* and *O. turrita,* which have eleven volutions while the present shell has not more than four, or perhaps five.

In the 'British Mollusca," and in the 'British Conchology,' there are more than twenty *Odostomiæ* described as distinct species, each with very slight differences of character; but whether they are all specifically distinct is perhaps questionable. The Authors of 'British Mollusca,' vol. iii, p. 260, justly say: "The species are difficult to distinguish and very critical." I have figured several so-called species under this generic name and I have in most cases assigned them from the figures and descriptions of these Authors, and of the Author of 'British Conchology,' as they had better means for determination than I have had.

[The specimen figured is probably one which has been carried into the fluvio-marine Crag from the same bed as that which supplied *Cerithium derivatum* and *Odostomia derivata.*—Ed.].

[The following description of a new species and some remarks as to the bed at Boyton, in which it occurred, have been kindly supplied by Mr. Robert Bell.—Ed.]

[Margarita crassi-striata, *Robt. Bell.* 3rd Sup., Tab. 1, fig. 15.

Locality. Boyton.

Shell small, very solid, somewhat conical; whorls five; suture deep, each volution having four or five thick revolving ridges with traces of fine intermediate ridges. These are crossed by prominent lines of growth, giving them a slightly crenulated appearance. The base is, like the whorls, rounded and strongly ridged, with a very small umbilicus. Mouth rounded, with an obscure tooth or fold near the base of the columellar lip.

The species which seems nearest to it is *Margarita cinerea,* Couthuoy, but it differs in having much stronger ridges, especially at the base, and a smaller umbilicus. The upper whorls also do not seem to have that lattice-like appearance which is present in well-preserved specimens of *M. cinerea.*

It is difficult to indicate which formation this shell belongs to. The section of Crag worked at Boyton can seldom be seen, being an excavation close to the Butley River, and mostly from three to six feet under water, the coprolite diggers standing in the water when at work, and scooping up the sand from the bottom of the trench; but from what I have been able to observe, and from an examination of a large number of species found there, the formation seems to range from the fossiliferous beds of the Coralline (Zone d. of Prestwich's section in his paper on the "Crag Beds of Suffolk and Norfolk," 'Quart. Journ. Geol. Soc.,' vol. xxvii, p. 121,) up to the middle portion of the Red Crag. Probably some of the beds have been reconstructed from the wearing away of the Upper Coralline strata on the other side of the river, although a bed of the larger bivalves

Astarte, Cardita, &c.) was seen some few years ago *in sitû* at the base of the excavation, in a part now filled in, and I have obtained many double shells from there exactly answering to those found in the pits at Broom Hill, Sudbourn, and at Sutton. There seems also to be an admixture of shells from some formation with which we are unacquainted in England (most probably the Belgian Crag) as several species have been found here that have not been detected in any other Crag bed (*Fusus Waelii, Murex Reedii,* &c.). The Red Crag element is, however, sufficiently prevalent, and such shells as *Trophon scalariformis, T. muricatus,* and especially *Nassa reticosa,* are particularly abundant.[1] The specimen of *Amaura candida* mentioned in the column of remarks in the list of Mollusca given in the first 'Supplement to the Crag Mollusca,' as found at Boyton, came, I believe, from Butley, *i. e.* from the same locality as the specimen figured in Tab. I, fig. 3, of that Supplement. Robt. Bell.]

BIVALVIA.

SILIQUARIA PARVA, *Speyer.* 3rd Sup., Tab. I, figs. 16 *a—b.*

SILIQUARIA PARVA, *Speyer.* Ober.-Oligoc. Tertiar. Detmold., p. 33, tab. iv, fig. 2 *a, b,* Palæontographica, Band xvi, 1869.

Spec. Char. "*Testa parva tenuissima, oblonga, antice brevis, postice producta, utrinque æqualiter rotundata, lævigata, nitida; cardo subumbone parvulo fossula plana instructus, dente unico munitus. Nymphæ breves angustæ.*" Speyer.

Locality. Bramerton.

Two fragmentary specimens of a small bivalve were sent to me by Mr. Jas. Reeve (as mentioned in my second Supplement, p. 40), which I thought were too small and imperfect to be represented, but as they appear to be indicative of the presence in Norfolk of an older formation than the one in which they have been found, I think it desirable to figure them, imperfect as they are. The hinge has a prominent fulcrum for the support of its external connector, the central tooth large, prominent, and obtuse, being immediately before it and under the umbo; and there is a depression in the corresponding valve for its reception[2] similar to the hinge furniture of *Saxicava,* which it much resembles, as it does also the shells of *Sphenia,* but there appears, I think, sufficient difference to

[1] [See also footnote to p. 3 of Second Supplement as to this Boyton bed, the information quoted there having been obtained from Mr. Alfred Bell. From that it would appear that the bed containing *Astarte* and *Cardita* was part of the lowest portion of the Coralline Crag, and was overlain by some Red Crag; the shells of both formations becoming thus intermingled in the working.

[2] The engraver has not been successful in delineating the character of the hinge in either valve. The generic name *Siliquaria* is used here from Speyer, but it is that also of a vermiform shell.—ED.]

justify a generic distinction. The hinge more resembles that of the latter shell, but that species (*Sphenia*) has an internal connector. The name of *Siliquaria* (of Schumacher), as given to the Oligocene shell by Dr. Speyer, is, I think, sufficient to guide us in our future determination, for although I have many hundreds of specimens of *Saxicava* of small size from the Coralline Crag, I have nothing that will fairly correspond with the present shell.

[The specimens have probably got into the Fluvio-marine Crag of Norfolk from the same formation there which supplied those of *Cerithium derivatum, Odostomia derivata,* and *Odostomia Reevii.*—Ed.]

Cardium echinatum, *Linn.* Crag Moll., vol. ii, p. 152.

As stated at p. 152 of my second volume this species has very rarely occurred in the Crag, but a specimen has lately been found at Felixstowe by Mr. W. E. Hardy, of Park Crescent, Stockwell, which was sent to me for verification, and it is similar to the one (now in the British Museum) figured in the 'Crag Moll.,' vol. ii, p. 152, Tab. XIV, fig. 3. It belongs probably to the variety called *ovata* by Dr. Jeffreys in 'Brit. Conch.,' vol. ii, p. 271, and described by him as having the "ribs sharp." The Crag shell has triangular ribs (unlike the common recent species, on which the ribs are quadrate), with spines in a slight depression down the centre of these. The species is very rare in my collection, I having found no other specimen than the one I gave to the British Museum. This specimen is in good preservation with the exception of having lost all its spines. I have a shell from the Sicilian beds which it more resembles, with sharp angular ribs covered with broad spatulate imbricated spines, but Mr. Hardy's specimen, though well preserved otherwise, has lost all. I do not know whether this Sicilian fossil has ever been figured.

Pecten disparatus, *S. Wood.* 3rd Suppt., Tab. I, fig. 17.

Locality. Red Crag, Waldringfield.

The shell as above represented has been sent to me by Mr. R. Bell, but without a name, and I know not to what published species it can be justly referred. I thought at first that it might be one of the many varieties of that variable shell *P. Danicus* (*septem radiatus*), but I have not been able to find one precisely similar in character; and although there is much resemblance to two or three other species, I have not been able to assign it satisfactorily to any one. I have therefore given to it provisionally the above name. It is somewhat similar to *P. multicarinatus*, Lam., figured and described by the late Dr. Deshayes, 'Descr. de Coq. foss. des Env. de Par.,' p. 307, Pl. XLII, figs. 17, 18, 19, but that is not quite so large a shell, and is said to be from Parnes, in the upper portion of the Paris Eocene. It differs essentially from *P. duplicatus*, on which the ribs are nearly uniform in size. Our shell is nearly orbicular, covered with ten or twelve large and slightly prominent convex rays, upon which, and also between them are three smaller rays, and between each of these is an alternate smaller one, so that between each of the most prominent there are seven smaller. All of these are ornamented with sharp imbrications, and the shell has unequal auricles, which in our specimen are not quite perfect; but there are indications of these being of large size in the perfect shell. In the interior of this valve, which is the right one, there are eight or nine furrows corresponding to the elevation of the prominences of the larger ribs. The muscle mark is not very distinct. This specimen, is, in all probability, a derivative from an older formation.

OBSERVATIONS AS TO THE SUCCESSIVE FORMATION OF THE BEDS FORMING THE APPARENTLY HOMOGENEOUS AND SYNCHRONOUS MASS OF "RED CRAG," AND THE ILLUSORY CHARACTER OF THE EVIDENCE AFFORDED BY PART OF THE ORGANIC REMAINS IN THEM.

Having in a previous portion of my work on the Crag Mollusca expressed my opinion of the distinctive character of the beds at Walton Naze from the main portion of the Red Crag, and of their older age, I took the opportunity of a few months' stay at Felixstowe in 1879-80 to thoroughly sift and search a large quantity of the Red Crag there, to ascertain not merely what species of Mollusca could be detected in it, but also the general condition in which the remains of these were preserved, so as to compare them with those at the Walton Naze locality, with which, from many visits to that place in the earlier years of my study of the subject, I was very familiar.

The following list is the result of that investigation; and in it I have affixed to those species which appear to me to have come into the Red Crag of Felixstowe only by derivation from beds older than the Red Crag (including those of the Coralline Crag,) the letter D, while to those which appear to me to have come only by derivation from earlier beds of Red Crag age, such as that at Walton Naze, I have affixed the letter W, the exclusively fragmentary condition of some species being indicated by the letter F.

Remains of Mollusca[1] found in the Crag of Felixstowe.

Gasteropoda.

Cypræa Europea, *Mont.*
— avellana, *J. Sow.*, W.
Voluta Lamberti, *J. Sow.*, F, D, W.
Terebra inversa, *Nyst*, F, D.
— canalis, *S. Wood*, F, D.
Columbella sulcata, *J. Sow.*, F, W.
Cassidaria bicatenata, *J. Sow.*, F, D.
Nassa granulata, *J. Sow.*
— incrassata, *Müll.*
— consociata, *S. Wood*, F, D.
— propinqua, *J. Sow.*
— pygmœa, *Lam.*
— labiosa, *J. Sow.*, F, D.
— reticosa, *J. Sow.*, W. and mostly F. or imperfect.
Rostellaria lucida, *J. Sow.*, F, D.
gracilenta, *S. Wood*, F, D.
Buccinum Dalei, *J. Sow.*
— undatum, *Linn.*
Purpura lapillus, *Linn.*
— incrassata, *J. Sow.*
— tetragona, *J. Sow.*, F, W.
Murex tortuosus, *J. Sow.*, F, D.
Trophon antiquus, *Linn.*
— — id. *var.* contrarius.
— alveolatus, *J. Sow.*, F, D.
— costifer, *Nyst*, F, W.
— altus, *S. Wood.*
— gracilis, *Dacosta.*
— muricatus, *Mont.*
— — id. *var.* exossus.
— Olavii, *Beck.*
— scalariformis, *Gould.*
Pleurotoma interrupta, *Broc.*, F, D.
— turricula, *Mont.*
Pleurotoma Trevelyana, *Turt.*
— scalaris, *Möll* (one specimen full size and perfect).
— nebula, *Mont.*
— costata, *Dacosta.*
Cancellaria scalaroides, *S. Wood*, F, D.
— (Admete) viridula, *Fab* (one specimen broken).
Cerithium tricinctum, *Broc.*, F.
— variculosum, *Nyst* (one whirl only), F, W.
— granosum, *S. Wood ?* F, W.
Aporrhais pespelicani, *Linn.*, F, D. (very worn fragments).
Turritella incrassata, *J. Sow.*, F. and mostly D.
Scalaria funiculus, *S. Wood*, F, D.
— foliacea, *J. Sow.*, F, D.
Chemnitzia internodula, *S. Wood.*
Eulima intermedia, *Cant.*, D and W ?
Eulimene pendula, *S. Wood.*
Lacuna (Eulimene) terebellata, *Nyst.*, D.
Rissoa curticostata, *S. Wood.*
Littorina littorea, *Linn.*
Natica catena, *Da Costa.*
— catenoides ? *S. Wood.*
— clausa, *Brod.* and *Sow.*
— hemiclausa, *J. Sow.*
— multipunctata, *S. Wood.*
Vermetus intortus, *Lam.*, D ?
Trochus cinerarius, *Linn.*, W ? (the specimens are all slightly mutilated).
— Montacuti, *W. Wood.*
— tumidus, *Mont.*
— zizyphinus, *Linn.*, F, D.

[1] The absence of a capital letter after the name of a species means that that species is not derivative.

Fissurella Græca, *Linn.*
Emarginula fissura, *Linn.*
Calyptrœa Chinensis, *Linn.*
Capulus Ungaricus, *Linn.*
Tectura virginea, *Möll.*
Dentalium dentalis, *Linn.*, F, D.
— entalis, *Linn.*, D ? (worn).
Ringicula buccinea, *Broc.*, F, D.
Bulla cylindracea, *Penn.*, F.
Melampus pyramidalis, *J. Sow.*

Bivalvia.

Anomia, *sp.*
Ostrea, *sp.*
Pecten maximus, *Linn.*, F, D.
— opercularis, *Linn.*
— pusio, *Penn.*
Lima exilis, *S. Wood,* F, D, W ?
Mytilus edulis, *Linn.*, F.
Arca lactea, *Linn.*
Pectunculus glycimeris, *Linn.*
— subobliquus, *S. Wood,* W.
— pilosus, *Linn.*, D.
Nucula lævigata, *J. Sow.*
— Cobboldiæ, *J. Sow.*
— nucleus, *Linn.*
Leda oblongoides, *S. Wood.*
Lucina borealis, *Linn.*
Diplodonta astartea, *Nyst.*
Cardita senilis, *Lam.*, D.
— scalaris, *Leathes.*
— chamæformis, *Leathes,* D (worn).
— corbis, *Phil.*
Cardium angustatum, *J. Sow.*
— decorticatum, *S. Wood,* D.
— edule, *Linn.*
— echinatum, *Linn.*
— Parkinsoni, *J. Sow.*
— venustum ? *S. Wood.*
Astarte Basterotii, *de la Jonkaire,* F, D.
— Burtinii, *de la Jonkaire,* D.
— crebrilirata, *S. Wood.*
Astarte incrassata, *Broc.*, D.
— obliquata, *J. Sow.*
— Omalii, *de la Jonk.*, F, D.
— compressa ? *Mont.*
Woodia digitaria, *Linn.*
Cyprina islandica, *Linn.*, F.
Venus casina, *Linn.*, F, D.
— fasciata, *Da Costa.*
Cytherea chione, *Linn.*, F, D.
— rudis, *Poli.*
Artemis lentiformis, *J. Sow.*, F, W.
Tapes pullastra, *W. Wood,* F.
— virgineus ? *Linn.*, F.
Gastrana laminosa, *J. Sow.*, F, D.
Donax politus, *Poli,* F, D ?
Psammobia, *sp.*, F, D.
Tellina obliqua, *J. Sow.*
— prætenuis, *Leathes.*
Mactra arcuata, *J. Sow.*
— ovalis, *J. Sow.*
Solen siliqua, *Linn.*, F.
— ensis, *Linn.*, F.
Corbula striata, *Walk.*
Corbulomya complanata, *J. Sow.*, W ?
Saxicava arctica, *Linn.*
Panopea Faujasii, *Men de la Groye,* F, D.
Mya arenaria, *Linn.*, mostly F.
Pholas crispata. *Linn.*, F.
— cylindrica, *J. Sow.*, F, W ?
Gastrochæna dubia, *Penn,* F, D.

[Mr. Robert Bell, who has of late years very assiduously searched the Walton beds, as well as examined several collections made by others from that locality, has kindly furnished the following list of all the molluscan remains which he has been able to detect there, beyond those given in the column for that place in my father's lists in the first Supplement to his work. The species to which an asterisk is affixed are additions to the mollusca of the Upper Tertiaries of the east of England, given in the previous part of this work, and are inserted solely on the authority of Mr. Bell.

Gasteropoda.

Erato lævis, *Don.*
Nassa labiosa, *J. Sow.*
— propinqua, *J. Sow.*
Buccinum undatum, *Linn*
Trophon consocialis, *S. Wood* (one specimen only, much worn, and probably derivative).
— gracilis, *Da Costa.*
— scalariformis, *Gould.*
Pleurotoma linearis, *Mont.*
— turrifera, *Nyst.*
— nebula, *Mont.*
— rufa ? *Mont.*
Turritella planispira, *S. Wood.*
Chemnitzia communis,* ? *Risso.* (perhaps only a short form of *C. internodula.*)
Eulima subulata, *Don.*
Odostomia acuta, *Jeff.**
Natica catena, *Da Costa.*
— clausa, *Brod.* and *Sow.* (affinis. of *Gmel.*)
— varians, *Dujardin.*
Vermetus intortus, *Lam.*
Trochus formosus, *Forbes.*
— multigranus, *S. Wood.*
— Adansoni, *Payr.*
— tumidus, *Mont.*
— Kicksii, *Nyst.*
— Montacuti, *W. Wood.*
— zizyphinus, *Linn.*
Emarginula crassa, *J. Sow.*
Tectura virginea, *Müll.*
Dentalium dentalis, *Linn.*
— rectum, *Linn.*
Actæon subulatus, *S. Wood.*
— tornatilis, *Linn.*

Bivalvia.

Mytilus edulis, *Linn.*
Modiola phaseolina ? *Phil.*
Nucula nucleus, *Linn.*
— Cobboldiæ, *J. Sow.* ?[1]
Nucula tenuis ? *Mont.*
Cardita senilis, *Lam.*
Cardium fasciatum, *Mont.*
Cardium strigilliferum, *S. Wood.*

[1] My father collected extensively at Walton at intervals during forty years, and Mr. Robert Bell also very assiduously for many years past, without either of them having met there with the slightest trace of this shell, so common in the later part of the Red Crag; but Mr. Bell has lately met with a single worn valve in the collection made from Walton by Mr. Greenhill, of Vermont College, Clapton, on the authority of which the shell is inserted with a note of interrogation in the above list.

Cardium pinnatulum, *Con.* (nodosulum).
Astarte Galeotii, *Nyst.*
— Forbesii, *S. Wood.*
Circe minima, *Mont.*
Abra prismatica, *Mont.*
Mactra glauca, *Born.*
Tellina obliqua, *J. Sow.* (a fragment only by Mr. Bell, another fragment by Mr. Hy. Norton of Norwich, and a single valve by Mr. Greenhill.)
Mya arenaria, *Linn.*

The contrast thus shown by the Crag of Felixstowe to that at Walton Naze (seven miles distant from it) is very striking. At the former place such species as *Trophon costifer*, and *Nassa reticosa,* among Gasteropods, which abound at Walton, and are there preserved in the most perfect condition, are, though abundant, scarcely to be found unmutilated; and such very few examples of them as do occur but little broken are all more or less worn. Among the Bivalvia one of the most abundant shells at Walton, *Artemis lentiformis,* and which at that place is almost always perfect (though generally with valves detached), is, though very abundant, *invariably* in fragments at Felixstowe. That this fragmentary condition at Felixstowe can only arise from the presence of the shell in the Crag there being due to derivation from the destruction of anterior accumulations, is shown by the fact that while *A. lentiformis,* which is thus in fragments is a strong shell, the thin and fragile shell, *Tellina prætenuis* (a species unknown from the Walton bed but in tolerable abundance at Felixstowe) occurs almost always perfect. It is, in my opinion, abundantly clear that during the time which elapsed between the accumulation of the Walton beds of Red Crag and their destruction and re-accumulation to form the Red Crag of Felixstowe, such shells as *Trophon costifer, Nassa reticosa,* and *Artemis lentiformis,* as well perhaps as some others had ceased to live in the Red Crag sea; and that other shells such as the dextral form of *Trophon antiquus, Leda oblongoides, Tellina prætenuis,* to which might have been added *Nucula Cobboldiæ,* but for the solitary and somewhat uncertain occurrence mentioned in the footnote on p. 16, (all of these being species which endured into the early Glacial sea,) and probably some others which might be mentioned, had been introduced into it. Moreover, the extremely profuse shell of all the rest of the Red Crag and of the Lower Glacial sands, *Tellina obliqua,* but which had lived in the Coralline Crag sea, was during the Walton accumulation so scarce in the Red Crag sea that only a single valve of it and two fragments (by three separate collectors) have been detected there.

In the Red Crag of Butley the change becomes further marked, both by the greater frequency of these later introductions, and by the presence of arctic species, which have not yet been detected in the Crag of Essex or of the more southern part of Suffolk, the Upper Beds of the Red Crag having either been removed from, or else having never been formed in, that part of Suffolk.

The changes which led to the peculiar and exceptionally perplexing features thus presented by the beds of the Red Crag of England, with their large admixture of false evidence afforded by derivations from beds anterior to that Crag, to a smaller extent also by derivations from earlier beds of Red Crag age, appear briefly to have been these.

At the incoming of marine conditions over part of England after the long interval of terrestrial conditions which had endured since the elevation and denudation of the Oligocene sea-bed, and when several of the tropical genera of Mollusca characteristic of the older tertiary time still lived in the sea of our latitudes, the older Pliocene submergence seems to have extended from the north of Belgium, over the south-east of England, and in that way formed a strait, connecting the North Sea with an arm from the Atlantic which extended over Touraine.[1] The evidences of the oldest accumulations of this strait which remain in England are probably some sands on the Chalk Downs between Maidstone and Dover, and (I think it likely) also an outspread of shingle along the strait's northern shore, of which patches remain on the Lower Bagshot outliers of South Essex, and of the Isle of Sheppy,[2] and sweep over the edges of some of these on to the uppermost beds of the London Clay there, as well as of a patch of the same shingle crowning the middle part of the London Clay on Shooters Hill, in north-west Kent, and possibly some others on the chalk of North Surrey, near Caterham. Changes took place in the distribution of the land and water of this strait, and the Coralline Crag ensued. Except over a part of Belgium, and (deeply buried under more recent beds) probably a part of Holland also, the oldest beds of this Pliocene Strait have been almost entirely removed by the later action of the sea, and numerous remains of the marine animals, both vertebrate and invertebrate, which were entombed in them have, in consequence, got into the Red Crag, particularly the nodule bed at its base. Remnants of the Coralline Crag, however, remain near each extremity of this Strait, viz. in Normandy near the one, and in Suffolk near the other end, besides a more general

[1] The French geologists still apply the term "Miocene" to the Faluns of Maine et Loire and of Touraine, although these Faluns appear to be coeval with beds in Belgium to which several of the geologists of that country apply the term "Pliocene," insisting that the "Miocene," *i. e.* the marine equivalent for the terrestrial interval between the "Oligocene" and the oldest "Pliocene," is not represented by any marine deposits there. To avoid as much as possible adding to this confusion, especially as the oldest part of the English Crag—the Coralline—is clearly "Pliocene," I have avoided in the text the use of the word "Miocene." The beds of Maine et Loire and of Touraine not only contain many shells of the Coralline Crag which do not appear to be survivors from the older Tertiary seas of England and France, but also living British shells, such as *Murex erinaceus*, which do not appear to have entered British seas until the time of the Red Crag, or, such as *Nassa reticulata*, even until the Glacial submergence.

[2] See 'Quart. Journ. Geol. Soc.,' vol. 24, p. 464, and bed No. viii, of the plate in vol. 36, p. 457. Prof. Prestwich, in a paper "On the Extension into Essex, Middlesex, and other inland counties, of the Mundesley and Westleton Beds," read before the Brit. Assoc. in 1881, appears to refer the shingle mentioned in the text as occurring on the Lower Bagshot outliers to the Lower Glacial pebbly sand (No. 6 of the beds described in the "Introduction" to the first Supplement to the Crag Mollusca); from which view, as well as from others in the same paper, I differ. My own view of the events which took place during the Newer Pliocene period in England is given in a memoir of which the first part is published in the 36th volume of the 'Quarterly Journal of the Geol. Soc.,' p. 457.

outspread in Belgium. By the gradual emergence of this strait the sea in Belgium and East Anglia, at the time represented by the Red Crag, *i.e.* the commencement of the Newer Pliocene period, had become separated by land from that in Normandy, but the molluscan remains which it has left in the latter country closely agree with those of the older portions of the Red Crag of East Anglia.[1] One of the results of this separation seems to have been to cause, on the English Coast of the North Sea, a great rise and fall of the tide over a very shallow and flat bottom. As this tide surged round the low island of Coralline Crag at Sutton, and also round the peninsula of the same Crag formed by the parishes of Sudbourn, Orford, and Aldboro' (the rest of the Coralline Crag, with some small exception, having been destroyed either during emergence by the sea which deposited it or by the inroad of the Red Crag water), it carried from that Crag a large quantity of its Molluscan remains which thus became mixed with the remains of the Mollusca then living in this sea, so that the banks of Red Crag, which were then accumulating in South Suffolk, became full of such derivatives, while the bed at Walton, being more distant from that island and peninsula, was left almost entirely destitute of organisms of this extraneous origin.

Formed under these conditions, and accumulated as banks or foreshores between high and low-water mark, as their peculiarly continuous highly oblique bedding attests, the marine beds of the Red Crag (with the exception of the latest or Chillesford beds of that formation, which accumulated during a slight depression of the area at the close of the Crag,) were continuously undergoing destruction and reaccumulation; and successive accumulations of them, formed between tide marks, may be seen in some sections laid up at the foreshore angle of bedding, one upon another. Thus the changes in the molluscan life of the North Sea, which from the approach of the glacial period were taking place during the Red Crag, have become obscured by the circumstance that the remains of mollusca which had died out (in that sea at least) were, in consequence of the destruction of these older banks, and the reaccumulation of the material of them in new banks of the same character and mode of deposit, mixed up with those of the mollusca still surviving there, and of some new forms which the change of climate, and probably distant geographical changes also, were bringing in; this mixed accumulation being further complicated by the introduction of molluscan remains from the Coralline Crag and still older formations.

[1] See 'Étude Geologique sur les Terrains Crétaces et Tertiares du Cotentin,' par. MM. Viellard and Dollfus, Caen, 1875, pp. 148—163. The material of these beds of the Cotentin referable to the Coralline Crag (*Conglomérat à térébratules*), of which Mr. Harmer brought me some from St. Georges de Bohon, near Carentan, appears undistinguishable, both in mineral character and included organisms, from the Upper Beds of the Coralline Crag, at Sudbourn.

I take this opportunity of correcting the representations given by Mr. Harmer and myself of the beds of the Crag district in the map, and sections which accompany the "Introduction" to the first Supplement to the Crag Mollusca in the volume of the Society for 1871, so far as subsequent observations have rendered necessary, as follows:

Owing to the obscurity existing where sand rests on sand, the Lower Glacial sand, No. 6 of the map, is not shown further south than the neighbourhood of Dunwich; and in the section (A) through the Red Crag area it is omitted altogether, and the Middle Glacial (No. 8) represented as resting throughout on the Red Crag. Residence in the district since 1873 has afforded me the means of a closer examination and comparison of pit sections there, and convinced me that this representation (which was mine only) was erroneous, and that the sand No. 6 is not only present, but is the principal formation in this area; for though it is mostly underlain by Red Crag, it in many places takes the place of this, and rests direct on the London Clay. Over the Red Crag, however, there is in some excavations a reddish-brown sand, soft, loamy, and destitute of the smallest fragment of shell, but in which sometimes masses of shelly crag are enveloped, and in which, in some rare instances, bands of ironstone containing casts of Red Crag shells also occur. This sand is merely the Red Crag from which the calcareous constituents have been carried away by dissolution in water, while the argillaceous and ferruginous constituents have been either left unaffected, or else redeposited in the undisturbed sandy mass. The difficulty, therefore, is to distinguish between this and the sand No. 6; for in South Suffolk the latter loses the shingly or pebbly character which enables it to be easily recognised in North East Suffolk and in Norfolk. Over the Red Crag area the sand No. 6 passes upwards by the mere substitution of argillaceous for arenaceous sediment into stratified brickearth, just as it does on the Cromer Coast and generally in North Norfolk, though from its geographical position in South Suffolk this brickearth has not there received that copious intermixture of chalk *débris* and chalk silt which along the Cromer Coast (where it is represented by the "Contorted Drift," bed No. 7 of the Map, &c.) forms its preponderating constituent, in proportion to the diminution in its distance from the Lincolnshire Chalkwold, from the degradation of which by the land ice during the earlier part of the Glacial period, when England was undergoing its great submergence, this *débris* and silt were derived; but thin layers of this *débris* are sometimes present in it in South Suffolk, as *e.g.* at Kesgrave. Neither has it been so disturbed by the action of grounding bergs as in North Norfolk, where the result of this action has obtained for it the name of "Contorted Drift;" nevertheless, it is sometimes contorted in Suffolk, as I observed in an excavation of it beneath the chalky clay on the Hasketon side of Woodbridge in 1874. Over the Red Crag area this bed has suffered so generally and extensively from the wash of the sea during the emergence of the country, when the Middle Glacial gravel (No. 8) was in course of accumulation, and the land ice, of which the chalky clay was the moraine, was extending from the Wold to follow the retiring sea, that only patches of it remain there. One of these patches, that at Kesgrave, is shown in the map, but another occurs at California-by-Ipswich, another at Kirton, and another at Rookery Farm, Eyke, none of which are shown in it. All of these appear to be of considerable thickness (40 to 50 feet), and the first and last of them have a little of the Middle Glacial gravel over them in places. Another patch, on the Hasketon side of Woodbridge, is overlain by the chalky clay; and at Tuddenham, near Ipswich, the base of this brickearth is exposed passing down into the sand No. 6, of which about twenty feet underlies it, and rests on the London Clay; and there also the denudation of this brickearth, which took place prior to the deposit on it of the Middle Glacial gravel, is well shown by the irregular way in which that gravel lies upon it. Remnants occur also in other parts of South Suffolk, but they are beyond the limit of the map.[1] In the Section (A) drawn through the Red Crag area, the Middle Glacial is therefore erroneously represented as resting generally on the Red Crag, whereas this is exceptional, and the Lower Glacial sands should have been shown in most parts (*i.e.* in those where they have not taken the place of the Crag altogether) as intervening, and the thickness of the Middle Glacial been there proportionately reduced. The correct position of all the beds of this sequence is shown in fig. 1 of the plate which accompanies my memoir on the "Newer Pliocene Period in England," in the thirty-sixth volume of the 'Quarterly Journal of the Geological Society,' the line of which is drawn through three of these remnants of the brickearth; and in it the Middle Glacial gravel is shown on the plateaux as very thin, and in places absent altogether, but as thickening towards the brows of the valleys, which, when they were in the condition of troughs excavated in the rising sea bottom of the sand No. 6, had been filled by it; the gravel in the central parts of these troughs having been cut out as these were deepened by the shrinkage into them of the ice of the chalky clay, or by the action of the sea, as emergence went on. A well which I sunk to a depth of eighty-four feet subsequently to the publication of that figure, but on the exact line of it, and on the eastern edge of the plateau from which the valley of the Deben is cut down, showed this gravel to be there seventy feet thick beneath six feet of the chalky clay (the upper thirty feet being full of the chalk *débris* of that clay), and that the sands No. 6 had been almost all removed to give place for it. It is this sand, or else that formed by the decalcification of the Crag, and not the Middle Glacial, which overlies the Crag shown in the cut on page xxi of the "Introduction" and in Sections XIX and XX.

The map thus requires to be corrected by the intercalation of a belt of the shade and colour representing the sand No. 6 between the Red Crag and the Middle Glacial; and it

[1] One of these, at Stowmarket, is in the footnote to p. 22 of the "Introduction," referred to as of post-glacial age, and another about six miles north of Ipswich, and three-quarters of a mile south-west of Hemingstone Church, is shown in the map by a dot of the wrong colour (that of bed No. 10). I am informed also by Mr. Dalton, of the Geological Survey, that he found an exposure of this brickearth under the chalky clay at Baddingham, just midway between the patch of it shown in the map at Bloxhall, in South-east Suffolk, and the exposure of it at Withersdale, on the Waveney, near Harleston, so that probably much of the chalky clay of High Suffolk is underlain by remnants of the same bed.

also requires the substitution of this colour for that of the Middle Glacial over most of the area east of the chalky clay, which stretches from Sizewell to the River Blyth, and to the cliffs of Easton Bavent and Covehithe; there being but very little, if any, of the Middle Glacial present over this area, which is occupied by the sand and shingle No. 6 in greater thickness than elsewhere.

The Section (R) of Dunwich Cliff, and that (S) of Easton Bavent and Covehithe Cliffs, also require correction, the bed shown in the latter as the Contorted Drift (No 7) being the same as the capping loam of Dunwich Cliff, which in Section R is shown under the number 10;[1] both of them being, as a late examination of them has enabled me to perceive, a morainic bed formed (in Dunwich and the southern part of Easton Cliffs, from a reconstruction of the pebbly sand No. 6 with some admixture of the material of the chalky clay, and in the northern part of Easton Cliff, from a reconstruction of these sands and the Chillesford clay together,) by the ice in its passage to the sea after this part of Suffolk had emerged towards the close of the chalky clay formation; and the gravel, shown by the number 10, as resting on this bed and on the Chillesford clay in this cliff, and shown also in Covehithe Cliff, is merely a part of this morainic bed, being pots of pebbles derived from No. 6. A bed of this morainic material cutting like a dyke through the sands No. 6 at the southern end of Easton Cliff (where this cliff is only six or seven feet high) requires to be added to Section S. Another such bed forms the northern extremity of Southwold Cliff, overlying the bed of derivative shells in the shingly sand No. 6, presently to be referred to. The section of Dunwich Cliff also requires correction by the omission of the Middle Glacial which is shown in it under the numbers 8'', 8''', and 8''''; all of this being part of the sand No. 6, to which the shingle under the ruins (shown in Section R by the figure 10) also belongs; and this shingle is still more largely present in that sand at the southern end of this cliff. The whole of Dunwich Cliff, from below the beach line up to the capping loam of morainic origin just mentioned, is thus formed of No. 6, the intercalation of clay shown in Section R by the figure 9 being probably a modification of the sandy formation, by the introduction of argillaceous material analogous to that which gave rise to the Cromer Till and Contorted Drift of North Norfolk; both of which are, in my view, merely modifications of the same shingly sand by the introduction of a different sediment.

Descending thus below the beach line, and forming (with the morainic loam already mentioned) the whole of the cliffs of Dunwich and Southwold, this sand there occupies a space from which the Chillesford clay and the upper part of the Crag beneath it had been removed, so as to form a channel in the Lower Glacial sea which divided two islands formed of Chillesford clay and Crag beds; of which islands the southern was comprised by the country extending from Butley and Chillesford to Sizewell, and the northern by the area of which the cliffs of Easton and Covehithe (Sect. S) furnish a section. The sands No. 6, which, as already mentioned, cover the Red Crag area, lie up to the

[1] See the footnote No. 5 to p. 29 of the "Introduction."

southern of these two islands, as well as extend over it, just as they do in the case of the northern, and so that, being bedded in the channel and up to the shore of this southern island, they lie much below the level of the Chillesford beds which cap it at Chillesford, Sudbourne, Iken, Oxford, and Aldboro', as well as below much of the Coralline and Red Crag on which those beds there rest, and of which that island is formed.[1] Occupying also the channel dividing these islands from each other, and in that way furnishing the section of Dunwich and Southwold Cliffs, these sands lie up to the shore of the northern island thus formed of beds of Crag age, as may be seen in the southern part of Easton Cliff when this is sufficiently free from talus. It is in this part that a bed of shells occurs in these sands, and it is the only one, so far as I am aware, that they yield in Suffolk. This shell bed is exposed at the northern end of Southwold Cliff, about the beach level, and immediately under the morainic loam already mentioned;[2] and I call attention to it because I believe that *all* the shells in it are derivatives from the Crag of which this Lower Glacial island was formed, before the progress of the submergence overwhelmed it, in a similar way to that in which so large a part of the shells in the Red Crag are derivatives from the island and peninsula of Coralline Crag which existed in the Red Crag sea. Not only is the characteristic species of these sands in Norfolk, *Tellina Balthica*, not present in this bed, but the shells that are in it, even the strongest, such as the Littorinæ, are for the most part fragmentary. The shells which I was able to detect in it during many repeated searches were the following, viz. *Nassa incrassata*, *Purpura lapillus*, *Cerithium tricinctum*, *Turritella*

[1] The southern of the two islands mentioned in the text may have been divided into three smaller, by channels now represented by the mouth of the Alde and by the Butley creek, in which these Lower Glacial sands may have been bedded and since removed; for at Iken Cliff, on the Alde, these sands are in section at the sea level, nearly fifty feet below the contiguous top of the Chillesford beds on this island. This southern island (or islands) was probably abutted on the south by another island formed of Red Crag, and now buried beneath the Lower Glacial sand (capped with more or less of the Middle Glacial gravel) of the heaths of Hollesley, Boyton, Sutton, and Alderton; for exposures of Red Crag along the edges of the small valleys penetrating this tract of country occur at as high or even higher level than the Chillesford beds just referred to. This, again, was probably divided by a channel now represented by the Deben from another island of Red Crag, represented by the tract between the Deben and Orwell estuaries, and this again by one represented by the tract between the Orwell and Stour estuaries; as from the way in which the Lower Glacial sands take the place of the Crag in many parts along the sides of the valleys of these estuaries, these latter may very likely have been channels during the earlier part of the Lower Glacial sea, and been once filled by its sands, which were removed by the action of the sea, followed up by the land ice as the land was emerging during the formation of the chalky clay. Whether the Chillesford clay ever was spread out over that part of the Red Crag which occupies the area between Butley and the Stour, and was afterwards removed, or whether this southern part of the Red Crag was land during the slight depression under which the Chillesford beds were spread out, there are no means of determining, though the Chillesford clay seems to have been deposited in north-east Essex (Walton), and up the Gipping valley at Needham.

[2] This bed was also found about half a mile inland in making the railway cutting near Southward station.

terebra, Littorina littorea, Natica clausa, Leda oblongoides, Lucina borealis, Cardium edule, Astarte compressa, Cyprina islandica, Tellina obliqua, Corbula striata, and *Mya arenaria;* all being species which occur in the adjacent Crag beds.

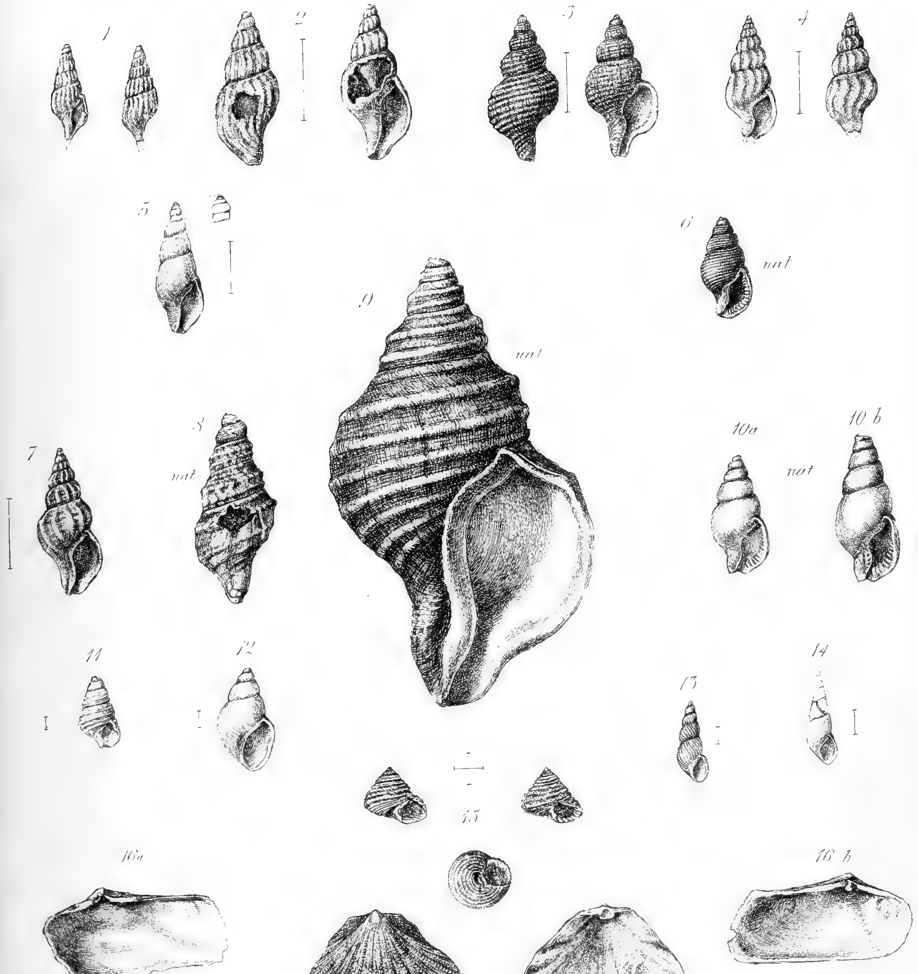
The fluvio-marine Crag from which the Chillesford beds have been removed to form this channel, and on which the sands No. 6 thus rest below the beach line, comes through the beach in two very small knobs about a quarter of a mile from the southern end of Dunwich Cliff, which are crowded with shells; and it yielded me also an equine tooth.

Lastly, I have in the memoir of the "Newer Pliocene Period" in England, already referred to, given my reasons for regarding the Bridlington bed from which the Mollusca given in the "Upper Glacial" column of the tabular list at the end of the first Supplement to the "Crag Mollusca" were obtained, and also the basement clay of Holderness with which that bed is associated, as being of Lower Glacial age, such clay being, in fact, the actual moraine of the ice from which proceeded the material interstratified in the Cromer Till (No. 6 *a* of the Map, &c.); and for regarding the molluscan remains given in the "Middle Glacial" column of the same tabular list, as being an admixture of remains from the bottom of some fiord which had been in process of accumulation from the commencement of the sands No. 6, and during the whole of the Glacial submergence, but which was ploughed out by the ice of the chalky clay during its advance as it followed the retreating sea during emergence; so that these remains became embedded by this derivative process in the upper part of the Middle Glacial (No. 8 of the Map and Sections), as that bed was emerging, and just before the chalky clay moraine was pushed over it.

I should add that though, to avoid confusion in this explanation, I have adhered to the term Middle Glacial, this formation is (in the view to which the continued study of the subject has brought me) merely the marine accumulation which was synchronous with the moraine of the land ice which is represented by the chalky clay; and the precise mode in which the two were accumulated, according to my view, is traced in detail in the memoir just referred to.]

PLATE I.

Fig.	*Names of the shells.*	Page	*Localities from which the specimens figured were obtained.*
1.	*Rostellaria? gracilenta* (nat. size)	1	Red Crag, Felixstowe (derived).
2.	*Raphitoma submarginata* (enlarged)	5	Red Crag, Felixstowe (derived).
3.	*Trophon muricatus*, var. *exossus* (enlarged)	3	Red Crag, Felixstowe.
4.	*Pleurotoma harpula* (enlarged)	5	? Crag, Boyton.
5.	— *gracilior* (enlarged)	4	Red Crag, Walton Naze.
6.	*Columbella abbreviata*	6	Red Crag, Foxhall.
7.	*Pleurotoma nebula* (enlarged).	4	Red Crag.
8.	— *turris* (nat. size)	3	Red Crag, Felixstowe (derived).
9.	*Trophon antiquus*, var. *despectus* (nat. size)	2	Red Crag, Sutton.
10, *a*.	*Columbella erythrostoma?* (nat. size)	6	Red Crag, Butley.
10, *b*.	— — ? (nat. size)	6	Red Crag, Butley.
11.	*Menestho Suttonensis* (enlarged)	9	Cor. Crag, Sutton.
12.	*Odostomia Reevei* (enlarged)	9	Fluvio-marine Crag, Bramerton (derived?)
13.	*Nodostoma ornata* (enlarged)	8	Cor. Crag, Sutton.
14.	— *eulimelloides* (enlarged)	8	Cor. Crag, Sutton.
15.	*Margarita crassi-striata* (enlarged)	10	? Crag, Boyton.
16, *a*.	*Siliquaria parva* (enlarged)	11	Fluvio-marine Crag, Bramerton (derived?)
16, *b*.	— — (enlarged)	11	
17.	*Pecten disparatus* (nat. size)	12	Red Crag.



G. B. Sowerby.

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MONOGRAPH

ON THE

LIAS AMMONITES

OF

THE BRITISH ISLANDS.

BY

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PART FIFTH—DESCRIPTION OF SPECIES.

PAGES 329—400; PLATES XLIX—LII, LIIA, LIII—LXIX.

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figures; the lines, which are certainly developed in the outer lamina of the shell, appear to resemble the punctated lines I have described in the shells of *Arietites obtusus* and *Ariet. stellaris*, and which also exist on *Aeg. planicosta*, to be described in the sequel. These beautiful and graceful falciform lines in the outer lamina of the shell form a new feature in the history of this species, and become a good diagnostic character between it and *Aeg. Charmassei*, to which it otherwise stands in close relationship. The falciform lines on the surface of the shell, and the tubercles on the sides of the siphonal area, serve to distinguish *Aeg. Boucaultianum* from other Lower-Lias congeneric forms. The largest specimen sent, was collected from the zone of *Aeg. Birchii* at Port-Royal, and the small specimen came from Ménetreux, near Semur (Côte-d'Or). One of the large specimens of this species, contained in the Semur Museum, has the entire shell most beautifully ornamented with the fine punctated lines which I have so imperfectly described from the weathered specimen now before me.

The group Angulati requires a more detailed study than has been given to it. The neglect has probably arisen from the difficulty experienced in assembling a sufficient number of examples of the different forms for critical comparison; figures, however good, will not suffice for this purpose, as nothing short of the fossils themselves can supply the structural evidence necessary to arrive at a definite conclusion. Dr. Oppel grouped *Am. angulatus*, Schloth., *colubratus*, Ziet., *catenatus*, Sow., *Moreanus*, d'Orb., *Charmassei*, d'Orb., *Leigneletii*, d'Orb., *angulatus depressus*, and *compressus*, Quenst., as varieties of *angulatus*, Schloth. A careful study of *Aeg. catenatum*, *angulatum*, *Charmassei*, however, has disclosed, as we have already seen, certain structural characters in each of these forms which appear to justify the separation proposed by d'Orbigny. This series of forms stands very distinct from those of the section Psilonoti, which preceded them in the Lias sea, and probably derived their parentage from *Aeg. incultum*, Beyr., and *Aeg. Palmai*, Mojs., in Trias time. I have not yet satisfied myself as to the true ancestry of *Aeg. angulatum*, which has a form so distinctly different from all the Psilonoti that it is impossible to confuse it with any form belonging to that series. Here we must range, likewise, *Aeg. catenatum*, Sow., *Charmassei*, d'Orb., *Boucaltianum*, d'Orb., and *lacunatum*, Buckm., all of which exhibit many characters in common, and many differences in detail of minute structure by which they are separated from each other.

Professor Hyatt, in his 'Genetic Relations of the Angulatidæ,'[1] remarks that they form a group precisely equivalent to Discoceratidæ, or to the whole of the Falciferi. So far as their involution and the general parallelism of their characteristics are concerned, they are simply a very highly accelerated series, in which there are as great differences between the extreme forms as there is between the extreme forms of the Discoceratidæ or of many other groups composed of more numerous forms with less abrupt modifications.

Aeg. catenatum at Semur occurs below *Aeg. Charmassei* and *Aeg. Leigneletii* in the Aeg. angulatum-bed, and in the Aeg. tuberculatum-bed is succeeded by *Aeg. Boucaultianum.*

[1] Proceedings of the Boston Soc. of Nat. Hist., vol. xvii, p. 15—33, May, 1874.

This regularity of succession, which the Semur Collection appears to prove, accords very well with what has been observed in other groups. Not only does the involution greatly increase in each succeeding species, but the septa become more complicated in outline, and the adult characteristics of the ribs and form are repeated at earlier and earlier stages in each species; the same law governs also the inheritance of the old-age characteristics of the individual. Thus, *Aeg. Boucaultianum*, which occurs latest in time, has the old-age characteristics sooner developed in its growth than any other form, showing that the acceleration or quicker reproduction of the characteristics extends to the whole life, affecting even the period at which old age begins.

AEGOCERAS LACUNATUM, *Buckman*. Pl. LVI, figs. 16, 17, 18.

AMMONITES LACUNATUS, *Buckman*. Geology of Cheltenham, 2nd ed., p. 105, pl. 11, figs. 4, 5, 1845.
— — *Quenstedt*. Cephalopoden, vol. i, p. 151, pl. xi, fig. 13, 1849.
— — *Quenstedt*. Der Jura, p. 98, pl. xii, figs. 4—6, 1858.
AMMONITES LACUNATUS, *Dumortier*. Dépôts Jurass. Bassin du Rhône, vol. ii, p. 120 pl. xxi, figs. 18—20, 1867.

Diagnosis.—Shell small, compressed, not carinated, composed of highly involute whorls, which are convex on the sides, of a uniform thickness throughout, and ornamented near the umbilicus with twenty-five to thirty short ribs, separated by deep valleys; the primary ribs soon divide into two or three branches; this division does not take place on all the ribs either regularly or at an equal distance from the umbilicus; often a second bifurcation takes place; the ribs are then strongly inflected towards the aperture, and form graceful curves on the sides of the shell, ending in from sixty to seventy costæ at the outer margin of a deep sulcus which occupies the middle of the siphonal area, and interrupts the passage of the costæ of the right towards that of the left side of the area; umbilicus very narrow.

Dimensions.—Diameter 30 millimètres; height of the last whorl 16 millimètres; width of the aperture 8 millimètres; amount of involution two thirds of the penultimate whorl.

Description.—This rare little Ammonite was first discovered by Professor Buckman near Cheltenham. It has been thought by some to be the brood of *Aeg. Charmassei*, and by others to be a young *Aeg. Boucaultianum*. It differs, however, specifically from both, and is an interesting form of the section Angulati.

The shell is small, compressed, and not carinated; the whorls, four or five in number, are inflated, convex on the sides, extremely involute, and embrace two thirds of a whorl (fig. 16); they are covered with numerous small ribs, separated by valleys of equal width; near the umbilical margin there are twenty-five to thirty short, stout ribs, which soon bifurcate into two or three branches, and about the middle of the whorl become strongly flexed towards the aperture, ending in from sixty to seventy costæ, thickened towards their termination at the side of the sulcus, which occupies the middle of the siphonal area (figs. 17 and 18). In young specimens the sulcus is sometimes converted into a knotted carina, which, by subsequent evolution, afterwards develops the central sulcus. The test is rarely preserved, and is very thick for so small a shell; nevertheless, the ornamentation of the shell is sharply preserved on the mould, and all the inequalities of the exterior are repeated in the cast thereof. When the shell is preserved the sulcus appears to be narrower and not so deep.

Affinities and Differences.—M. Dumortier,[1] who has had many specimens of this species through his hands, says that the ornamentation of *Aeg. lacunatum* approaches much to those of young individuals of *Aeg. Charmassei* of the lower zone. Nevertheless, *Aeg. lacunatum* is much more compressed, its ribs are smaller and much more bent towards the aperture, and the sulcus is narrower and shallower than in *Aeg. Charmassei.* It forms part of a group of small Ammonites of the zone *Ammonites Davidsoni;* but, whilst the others appear to be limited to this zone, *Aeg. lacunatum* has a wider distribution in time than either of its other zonal associates. It is rarely found below the zone of *Arietites stellaris.* It is a very abundant species in many regions of the basin of the Rhone; the best specimens have been collected from the quarries of Noylay. It forms in France one of the most important Ammonites of the *Amal. oxynotus* zone. It is rare to find good specimens entire, still the fragments are abundant, and easily recognised.

Locality and Stratigraphical Position.—The Gloucestershire specimens were collected out of the Lower Lias Shales and Limestone near the Midland Railway-cutting at Lansdown New Road, about the horizon of *Amaltheus oxynotus*, and this is the only locality in the county from which I have a record of this Ammonite. It occurs in the *Amal. oxynotus* zone at Robin Hood's Bay, Yorkshire coast, for the specimen of *Arietites Collenotii* = *denotatus*, figured in Pl. VI, from the zone *Amaltheus oxynotus* in Robin Hood's Bay, contains in its body-chamber a quantity of the matrix of the rock from which it was extracted, and in this limestone are several fragments of *Aeg. lacunatum*, showing both the ribbing on the sides of the whorls and siphonal area, with its deep central sulcus.

[1] 'Dépôts Jurassiques du Bassin du Rhône,' ii, p. 121.

Third Section.—Armati.

Aegoceras Birchii, *Sowerby.* Pl. XXIII; Pl. XXXII, figs. 5—8.

Ammonites Birchi, *Sowerby.* Mineral Conchology, vol. iii, p. 121, pl. 267, 1820.
Planites — *Haan.* Ammon. und Goniatit., p. 82, No. 2, 1825.
Ammonites — *Quenstedt.* Petrefactenkunde; Cephalopoden, p. 86, 1849.
— — *d'Orbigny.* Pal. Française; Terr. Jurass., p. 287, pl. 86, 1842.
— — *Oppel.* Die Juraformation, p. 84, 1856.
Aegoceras — *Neumayr.* Zeitschrift der Deutsch. geol. Gesellschaft, B. xxvii, p. 906, 1875.
— Birchii, *Tate and Blake.* Yorkshire Lias, p. 274, 1876.

Diagnosis.—Shell discoidal, compressed; whorls eight, narrow, sub-rotund, and slightly involute; sides compressed with numerous thick, blunt, straight ribs; on each of these two sharp tubercles are developed, which are all visible in the wide, open umbilicus; the tubercles are very sharp in young, and blunt in old shells; aperture sub-quadrate, with lateral points only slightly grooved by the turn of the spine.

Dimensions—Large specimen.—Pl. XXIII. Diameter 160 millimètres; width of the umbilicus 95 millimètres; height of the last whorl 35 millimètres; width of ditto 35 millimètres.

Small specimen.—Pl. XXXII, figs. 5—8. Diameter 80 millimètres; width of the umbilicus 50 millimètres; height of last whorl 15 millimètres; width of ditto 15 millimètres.

Description.—This very distinct and characteristic Ammonite of the Lower Lias is readily distinguished by the round siphonal area with its numerous bi-tuberculated ribs.

The whorls increase so slowly in diameter, that in a large specimen before me, eight inches in diameter, there are only seven volutions of the shell; the sides of the whorls are convex and slightly flattened in the middle, they have from thirty-two to thirty-four thick, straight, lateral ribs, with two tubercles developed on each; the outer tubercle is the largest, and in some specimens becomes spinous; the inner is smaller and more obtuse, and the ribs disappear near the inner border.

The siphonal area (Pl. XXIII, fig. 2) is round, and in some specimens three or four fine transverse bands extend across the area from one outer tubercle to the other, and fine transverse lines of growth are seen on the shell figured in Pl. XXIII.

The spire is formed of very narrow whorls, which are slightly involute, and all are fully exposed.

The aperture is round above, flattened on the sides, and very little diminished by the turn of the spire (Pl. XXIII, fig. 2).

The septa are symmetrical, and have an extremely complicated arrangement of lobes and saddles; of these I am only able to figure a portion (Pl. XXXII, fig. 7). The siphonal lobe is nearly as long as the principal lateral (fig. 7), it is deeply bifid, and on each side thereof are six or seven long narrow digitations. The principal and inferior lateral lobes have an exceedingly complex arrangement in the distribution of their side branches; this will be much better understood from the excellent figure given of them than by any verbal description. The saddles consist of numerous slender foliations.

This species preserves its specific form through life, and undergoes few morphological changes, with only a very limited variation; the young shells (Pl. XXXII, fig. 8), up to 13 millimètres in diameter, are smooth; the outer tubercles are first developed, and the inner ones soon follow, so that when the shell attains 25 millimètres in diameter it exhibits the distinguishing characters of the species, which are closely preserved in the largest specimen, 200 millimètres in diameter.

Affinities and Differences.—This Ammonite is very distinct from all its congeners in the Lower Lias, and is easily identified by its round siphonal area, slow increase in the diameter of the whorls, the bi-tuberculated character of its numerous ribs, and complex ramification of the lobe-line; by these characters it is easily distinguished from them.

Aeg. Valdani, d'Orb., of the Middle Lias, has likewise bi-tuberculate costæ, but the flatness of this shell and the elevated median ridge on its back, with the simpler character of its lobes, and the great size of its saddles, serve to distinguish it from *Aeg. Birchii*.

Locality and Stratigraphical Position.—The finest specimens of this shell are found near Charmouth and Lyme Regis, in the zone of *Arietites obtusus*, associated with *Arietites Brookii* on the same slab, and with the large Saurians, *Ichthyosaurus platyodon* and *Ichthyosaurus intermedius*. It is rare in Gloucestershire, although I have several specimens which were collected from the railway-cutting near Bredon; one of these specimens showed the arrangement of the septa figured at Pl. XXXII, fig. 7.

AEGOCERAS BIFERUM, *Quenstedt*. Pl. XXVI, figs. 1—4.

AMMONITES BIFER,	*Quenstedt.*	Flözgebirge Würtembergs, p. 160, 1843.
— —	—	Cephalopoden, p. 83, tab. iv, fig. 14, 1849.
— —	—	Petrefaktenkunde, p. 356, tab. xxvii, fig. 20, 1852.
TURRILITES VALDANI,	*d'Orbigny.*	Pal. Française; Ter. Jurassiques, t. i, p. 179, pl. xlii, figs. 1—3, 1842.
AMMONITES BIFER,	*Quenstedt.*	Der Jura, p. 103, tab. xiii, figs. 11—13, 1858.
— —	*Emerson.*	Die Liasmulde von Markoldendorf; Zeitsch. Deutsch. geol. Gesell., p. 327, pl. x, fig. 1, 1870.
AEGOCERAS BIFERUM,	*Neumayr.*	Die Ammoniten; Zeitsch. der Deutsch. geologisch. Gesellschaft, p. 906, 1875.

Diagnosis.—In youth shell smooth; at about the fourth whorl short, straight, blunt ribs are developed with spines and processes; when it attains a diameter of 18 millimètres the ribs project, become thin, and winged, and the thin expansion terminates in two points; and when the shell has reached 35 millimètres in diameter, the lateral bifurcated expansions of the ribs impart marked features to the lateral figure of the shell.

Dimensions.—Transverse diameter 24 millimètres; width of umbilicus 12 millimètres; height of aperture 5 millimètres; transverse width 5 millimètres.

Description.—Professor Quenstedt first recognised this very interesting Ammonite in the Lower Lias of Balingen and Ofterdingen, Würtemberg. It presents an assemblage of characters at different stages of growth which renders it a most interesting morphological study. In the first four whorls, and when the diameter of the tube does not exceed that of a crow's quill, the shell is smooth and without ribs; and in this phase of growth it has a circular mouth-opening, and only fine striæ, scarcely visible without a lens, are seen in the siphonal area covering the smooth shell and bent towards the aperture. In the next stage of growth it develops fifteen short, stout, lateral ribs, which disappear from the siphonal area; and after another whorl or so of growth the ribs extend outwards in thin, sharp folds, which shoot forth two spinous processes. The shell has now attained the size of a florin, and in this phase of growth the sides are ornamented with eighteen thin, sharp, compressed ribs, each terminating in a spinous process (Pl. XXVI, fig, 4), of which the outer spine is the largest; in this stage of growth the aperture is much wider in its lateral than in its vertical diameter. The shell is nearly evolute, and in consequence the winding of the spire it is sometimes excentral, and then assumes the obliquity of a Turrilite; from Captain Valdan finding some specimens in this condition in the Lower Lias of Augy-sur-Aubois, near St. Amand (Cher), with a spiral dextral shell, d'Orbigny regarded them as Turrilites, and figured them as such in the 'Paléontologie Française' (pl. 42, figs. 1—3), an error which is repeated in another evolute shell, the *Aegoceras Coynarti*. Both species were collected from the marls of the Lower Lias with *Gryphæa arcuata*. A similar error has been committed in mistaking the evolute *Arietites raricostatus* for a Turrilite, and figuring it as *Turrilites Boblayi*. The lobe-line is simple and is very well seen in one of my young specimens; the siphonal lobe is the longest and terminates in projecting processes (fig. 2); the siphonal saddle is wide, with rounded denticles; the lateral lobes are both about the same size and figure, and the lateral saddles are larger than the lobes; the auxiliary lobes and corresponding saddles are too much concealed to admit of accurate description, the type, however, of the entire lobe-line is that of the character of a Capricorn Aegoceras in all its essential details.

Affinities and Differences.—*Aegoceras biferum* in early youth resembles the young of *Arietites semicostatus*, being like it smooth and destitute of ribs. In its second or ribbed phase it resembles a young form of *Aeg. Capricornus* with lateral ribs and a smooth siphonal area; in its third stage, when it has acquired its winged ribs with compressed bi-spinous terminations, it presents a form unique amongst the group to which it belongs.

Locality and Stratigraphical Position.—This is a very rare Ammonite. I have never seen any other examples in England except the few specimens I collected from the Great-Western Railway cutting in the Lower Lias Beds of Lansdown Road, near Cheltenham, in a ferruginous marl, belonging to the *Amaltheus oxynotus*-zone, and from beds of the same horizon at Gloucester, obtained during the excavations made for the new docks. It certainly is not found at Lyme Regis, and is unknown in Yorkshire. Professor Quenstedt's original specimens were collected from the upper region of Lias β at Balingen, Ofterdingen, Betzingen, Würtemberg. There this Ammonite is associated with *Belemnites acutus*, Mill; *Leda Romani*, Opp.; *Mytilus minimus*, Sow.; *Plicatula ventricosa*, Goldf.; *Gryphæa obliqua*, Sow.; *Rhynchonella oxynota*, Quenst.; according to Dr. Oppel ('Juraformation,' p. 54).

AEGOCERAS PLANICOSTA, *Sowerby*. Pl. XXIV, figs. 1—8; Pl. XXV, figs. 1—3.

AMMONITES PLANICOSTA, *Sowerby*. Mineral Conchology, vol. i, p. 167, tab. 73, figs. 1—5, 1814.
— LAXICOSTATA, *Lamarck*. Anim. sans Vertèbres, t. vii, p. 638, 1822.
— PLANICOSTA, *Young and Bird*. Yorkshire Coast, p. 248, pl. 13, fig. 6, 1822.
PLANITES PLANICOSTATUS, *De Haan*. Monogr. Ammonit. et Goniatit., p. 92, No. 26, 1825.
AMMONITES — *Young and Bird*. Yorkshire Coast, p. 259, 1828.
— ZIPHUS, *Zieten*. Versteinerungen Württembergs, p. 6, tab. 5, fig. 2, 1830.
— PLANICOSTA, *Voltz*. Jahrbuch f. Min. Geol., p. 272, 1830.
— CAPRICORNUS, *Zieten*. Versteinerungen Württembergs, p. 6, tab. 4, fig. 8, 1830.
— — *Von Buch*. Ueber Ammoniten; Abh. Berlin Acad. d. Wissensch., pl. iv, fig. 4 (1830), 1832.
— CAPRICORNUS, *Roemer*. Versteiner. Nord-Deutsch. Oolithen-Gebirges, p. 192, 1836.
— PLANICOSTA, *Bronn*. Lethæa Geognostica, p. 440, pl. xxiii, fig. 1, 1837.
TURRILITES COYNARTI, *d'Orbigny*. Paléontol. Française; Ter. Jurassiques, p. 181, pl. 42, figs. 4—7, 1842.
AMMONITES CAPRICORNUS, *Quenstedt*. Flözgebirge Würtembergs, p. 158, 1843.
— DUDRESSIERI, *d'Orbigny*. Pal. Française; Terr. Jurassiques, p. 325, pl. 103, 1844.
— CAPRICORNUS NUDUS, *Quenstedt*. Cephalopoden, p. 81, tab. iii, figs. 6 *a*, *b*, 1849.
— — — — Der Jura, p. 96, tab. 12, fig. 3, 1858.
AEGOCERAS PLANICOSTA, *Neumayr*. Zeitschrift der Deutsch. geol. Gesellschaft, p. 906, 1875.

Description.—This is one of the Ammonites about which much confusion exists, arising from the fact that in youth it very much resembles the young form of another Ammonite, so that when of about the same age specimens of both species are frequently mistaken for each other, whilst the morphological changes in form and structure with advancing life show how widely dissimilar the two forms are before they reach their mature condition. The one form, *Aegoceras planicosta,* Sow., appertains to the Lower Lias, and the other form, *Aegoceras capricornus,* Schloth., belongs to the Middle Lias.

The true position of *Aegoceras planicosta* was well defined by the slab containing this species, which Sowerby figured in 1812. Here we see it associated with *Arietites obtusus* in a mass of Marston stone found at Marston Magna, near Ilchester. Near Yeovil, in Somerset, also, large slabs of a similar rock full of this Ammonite are raised with their nacreous shells well preserved in clusters, some of the slabs are big enough to form the tops of small-sized sideboards and other pieces of furniture. The beauty of the marble depends upon the number of the Ammonites clustered together; the white pearly layer of their shells is most admirably preserved, whilst the chambers are filled in with fine brown crystallised carbonate of iron or carbonate of lime, which adds much to the colour and richness of the dark grey ground of the Lias Marble.

In the "Yorkshire Coast" the Rev. George Young early noted the specific character of this Ammonite, in alluding to Bird's very bad figure (pl. xiii, fig. 6); he says, p. 259 (2nd edit., 1828), "It is from the lowest shale at Robin Hood's Bay [zone of *Arietites obtusus*]; it is a small and handsome Ammonite, similar to *Ammonites maculatus,* having ribs that are sharp on the sides but flattened on the back. But the flat part in this Ammonite bears a much greater proportion to the rest of the rib, and it is therefore named *A. planicostatus,* Sowerby, Tab. 73 and 406. It is generally found in a pyritous state. In the older specimens a slight knob is sometimes found at each end of the flat part of the back."

Professor Quenstedt also noted that the variety with the broad ribs on the back was found only associated with *Ammonites Turneri* (= *obtusus*), from whence also the specimen figured in Zieten's "Württemberg" came and not from Gammelshausen as stated, where hardly any Lias is found. The figures given in the "Cephalopoden," Tab. iv, fig. 6 *a*, *b*, are representations of one form of this Ammonite which I collected from the *Stellaris*-bed at Lyme Regis, and which are drawn in Pl. XXIV, figs. 1 and 2, of this work, clearly proving the identity of the English and Würtemberg shells.

The *Ammonites ziphus,* Hehl, figured in Zieten, and which was determined by Mr. Hehl, is distinguished principally by its elevated blunt spines placed at some distance apart. This fragment was regarded by its author as a distinct species; it was found in the Lias Sandstone near Boll. When we compare Zieten's figures with the forms I have figured from Lyme Regis, which are there associated with younger and older forms of the same species, one cannot doubt their identity (Pl. XXIV, figs. 4—7).

The next change in this species is characterised by the shortening of the ribs, which terminate in small tubercles developed near the lateral boundary of the siphonal area, and by the rounding of the abdominal surface of this region of the shell. A comparison of d'Orbigny's Pl. 103, figs. 1 and 2, with our Pl. XXIV, fig. 5, will convince the student of the identity of the French and English forms.

In describing this species it will contribute to a more correct knowledge of its forms if we trace them through the four stages over which they pass, and which I shall call—1st, the *planicostal*, 2nd, the *ziphus*, 3rd, the *Dudressieri*, and 4th, the *adult* condition. The *planicostal* stage extends to five whorls; the two first whorls are smooth and slowly acquire ribs which, in the other three, are slender and prominent, and as they bend over the siphonal area they become much flattened and are separated by concave spaces as wide as the flat portion of the ribs. All the whorls are fully exposed, and the umbilicus is widely open through the slight involution of the encircling whorls.

The *ziphus* stage commences with the sixth whorl, fig. 1. The ribs are now more prominent, and before they bend over the siphonal area a sharp prominent tubercle is developed on the termination of the rib, which gives a considerable extension to the area, and leaves the prominence of the large transverse elevations in the direction of the ribs, on the surface of which are ornate lines of delicate sculpture (see Pl. XXIV, figs. 4, 6, 7).

In the *Dudressieri* stage (fig. 5) the shell is discoidal, thick, and compressed, with a wide open umbilicus and very evolute spire exposing the entire whorls to view. Here we count seven volutions which, when carefully examined, show the different characters already pointed out in the description of the morphology of this species, and which are very well shown in figs. 1 and 5 of Pl. XXIV.

The adult state is not often seen; most of the large shells of this species I have examined had come to grief, partly in consequence of the slender involution of the spire. Fortunately, however, I found a nearly perfect example in the Jermyn Street Museum (School of Mines), obtained from Lyme Regis, which afforded a rare opportunity for studying the adult condition of *Aeg. planicosta*. No person could be expected to believe the specimen was this species unless he had followed the changes of shape through which this fine Ammonite passed. The fossil afforded not only a good example of a generalised form of a remarkable species, but at the same time showed how persistent and well-defined the different morphological changes were, which allied species of Ammonites endured amongst the various transition forms through which they were destined to pass between youth, adolescence, and old age. Here we discover no confusion with allied species, each holds its own predestined course during the varied evolutionary stages through which it has to pass, so that amongst Ammonites we fail to detect any transmutation of specific forms one into another: on the contrary, each obeys its own law of successive change between the ovum and maturity. Pl. XXV shows *Aegoceras planicosta*, Sow., of its natural size and in its adult condition, and represents a large *Ammonites Dudressieri*, d'Orbigny. The sides are ornamented with forty ribs, which are straight, regular, and prominent, with equal sulcations between; the penultimate has the terminal tubercles on the ribs as in *Dudressieri*, but in the last whorl we observe the disappearance of the tubercles, and the appearance of a number of transverse lines of sculpture. In fig. 2 is represented a portion of the outer lamina of the shell showing lines and perforations highly magnified; in fig. 3 parallel lines formed by a finely-punctated surface are shown.

The siphonal area is large, convex, and wrinkled transversely in the adult; the spire is composed of whorls, which are about as wide as they are high, slightly flattened on the sides and only slightly involute. The aperture is nearly quadrate, mucronated on each side at the siphonal area, and gently grooved by the return of the spire. The septa, according to d'Orbigny—I have not seen the lobe-line—are divided into three lobes, of which the two external are formed of pairs of parts. The siphonal lobe is as long and wide as the principal lateral, and ornamented laterally with three branches, of which the inferior is bifurcated. The siphonal saddle, as large as the principal lateral lobe, is divided into three folioles of which the median has three festoons. The principal lateral lobe is divided into two large, nearly equal terminal branches, and four lateral digitations. The lateral saddle is formed of two parts almost equally bi-lobed; the inferior lateral lobe is oblique, and terminates in two unequal branches, of which the internal is the largest. The accessory lobe is provided with two small unequal points, a radial central line in parting from the extremity of the siphonal lobe touches the points of the principal lateral and passes well above the others.

Affinities and Differences.—In early age this species resembles *Aeg. capricornus*, whilst in its middle-age and adult conditions it is entirely different; this fact will be demonstrated when the shell-structure and morphology of that species is under discussion.

Locality and Stratigraphical Position.—This species is found in the *Arietites obtusus*-zone at Lyme Regis, in the same horizon near Yeovil, at Marston Magna near Ilchester, in Robin Hood's Bay, Yorkshire, and the Midland Railway cutting, at Breden, and in other exposures of the same zone in other parts of the Vale of Glo'ster.

AEGOCERAS SUBMUTICUM, *Oppel*. Pl. XXVII, figs. 1 and 2.

AMMONITES NATRIX OBLONGUS, *Quenstedt*. Cephalopoden, p. 85, pl. 4, figs. 16 *a—d*, 1849.

— — — *Oppel*. Mittlere Lias Schwabens, Jahreshefte Württemberg, p. 73, pl. 1, fig. 5, 1853.

— SUBMUTICUS, *Oppel*. Die Juraformation, p. 158, 1856.

— — *Dumortier*. Dépôts Jurassiques du Bassin du Rhône, tom. iii, p. 63, pl. xii, figs. 1, 2; pl. xliv, figs. 2—4, 1869.

— SUBMUTICUM, *Neumayr*. Systematik der Ammonitiden, Zeitschrift der Deutsch. geol. Gesellschaft, p. 906, 1875.

Diagnosis.—Shell large, flattened on the sides, and slightly involute, umbilicus widely open; spire formed of eight whorls which have a convex margin and are slightly compressed on the sides, the last whorl has thirty-eight slender principal ribs, which are only slight elevations, and terminate in sharp prominent tubercles near the outer border of the siphonal area; the ribs are very feebly marked on the inner volutions; on the last whorl they first bend backwards, then incline forwards, and again bend back and terminate in tubercles. The siphonal area is broad and slightly convex; from the lateral tubercles transverse folds extend across the area, with several smaller elevations between; aperture subquadrate, wide and convex above, flattened on the sides, contracted and grooved below by the turn of the spire; shell extremely thin and well preserved in several parts.

Dimensions.—Transverse diameter 140 millimètres; width of the umbilicus 60 millimètres; height of the aperture 50 millimètres; greatest width above 50 millimètres; below, over the spire, 35 millimètres.

Description.—This is a rare form, and closely resembles the *Am. natrix oblongus*, Quenst., of the 'Cephalopoden,' and is one of the most elegant species of the ARMATI group.

The shell attains a considerable size, is gently compressed on the sides, and has a very wide umbilicus; it is, therefore, extremely evolute and fully exposes all the inner turns of the spire, which is formed of eight volutions that are round and slightly compressed and covered with delicate ribs; the last whorl has thirty-eight principal ribs, which are slightly elevated and directed forwards, and they all terminate in small tubercles near the outer border of the siphonal area. The ribs on the inner whorls are very slight elevations, whilst on the outer whorl they describe with sigmoidal curves, smaller intermediate secondary folds lying between them. The siphonal area is wide, convex, and without a trace of keel; large transverse folds pass across the area from one tubercle to another, with one or two smaller intermediate bands between the larger folds. The shell of this Ammonite is extremely thin, and very well preserved on some parts of the figured specimen, and shows that the tubercles were hollow cones filled in with the matrix in which the mollusc was embedded (fig. 1). These form prominences on the mould, which are all embraced and covered over by the turns of the spire. The aperture has a subquadrate figure, much higher than wide, and expanded at the outer side, where it acquires an increased extension by the hollow spines. Fig. 2 shows the size and form of the aperture, the squareness of the same, and the numerous ridges that cross the area between the larger folds.

Dumortier has figured a large fragment of this species, which exhibits its specific characters extremely well, including the structure of the tubercles as here described from my specimen.

The lobe-line is not visible either on the French or English specimens.

Affinities and Differences.—This species resembles *Aegoceras armatum*, Sow., in its general figure, but differs from that form in having larger whorls; more numerous and smaller tubercles; and a more quadrate aperture.

Locality and Stratigraphical Position.—The figured specimen was collected at Lyme Regis; it is embedded in a grey Lias Limestone which occurs about the base of the Middle Lias. I had no other specimen from the same bed to check my diagnosis, but it is apparently the base of the *Aegoceras Jamesoni*-zone. I have not seen another specimen in any of the collections I have consulted.

Aegoceras armatum, *Sowerby*. Pl. XXVIII, figs. 1—6; Pl. XXIX.

Ammonites armatus, *Sowerby*. Mineral Conchology, vol. i, tab. 95, p. 215, 1815.
— — *Young and Bird*. Yorks. Coast., p. 249, pl. xiii, fig. 9, 1822.
— hastatus, *Young and Bird*. Ibid., pl. xiv, fig. 2, 1822.
Planites fibulatus, *Haan*. Amm. et Goniat., p. 84, No. 8, 1825.
Ammonites armatus, *d'Orbigny*. Paléontol. Française; Ter. Jurass., p. 270, pl. 78, 1842.
— — *Quenstedt*. Flözgebirge Würtembergs, p. 157, 1843.
— — *Simpson*. Monograph on York. Lias Ammon., p. 26, 1843.
— — *Quenstedt*. Cephalopoden, p. 82, 1849.
— — *Oppel*. Juraformation, p. 155, 1856.
— — *Simpson*. Fossils of York. Lias, p. 64, 1855.
— miles, *Simpson*. Ibid., p. 65, 1855.
— armatus, *Schlönbach*. Mittleren Lias, Zeitschrift Deutsch. geol. Gesellschaft, p. 511, Jahr 1863.
— — *Dumortier*. Dépôts Jurass. du Bassin du Rhône, vol. iii, p. 59, pl. viii, figs. 1, 2, 1869.
— — *Emerson*. Die Liasmulde von Markoldendorf, Zeitschrift Deutsch. geol. Gesell., p. 330, pl. x, fig. 4, 1870.
Aegoceras armatum, *Tate and Blake*. Yorkshire Lias, p. 277, 1876.

Diagnosis.—Shell large, compressed; whorls slightly involute, umbilicus wide, and inner whorls all exposed; spire formed of from six to eight volutions; the outer whorl, according to age, with from eighteen to twenty ribs, which arise from small striæ at the umbilical suture, and enlarge as they advance towards the margin of the siphonal area, where they terminate in long, stony, tubular spines; between the principal ribs, and on the spines themselves, are other smaller transverse striæ; siphonal area wide, flattened, slightly convex, and ornamented transversely with a continuation of the same striæ that adorn the sides; spire composed of rounded or subquadrate whorls somewhat depressed and inclined towards the umbilicus; aperture subquadrate, the transverse exceeding the vertical in diameter.

Dimensions.—Transverse diameter 115 millimètres; width of umbilicus 55 millimètres; height of the aperture 30 millimètres; width 36 millimètres.

Description.—Much confusion appears to have existed among the local palæontologists of Yorkshire, where this Ammonite was first discovered, regarding the figure and description by Sowerby, who states[1] that "numerous varieties of this species are found in the great Alum-clay formations at Whitby, where this large-sized specimen was gathered by Mr. Strangewayes. We have here also the advantage of many specimens, the middle being a small plain one, which, indeed, might have been considered a different species; the next circle might, by the same rule, form a second species with larger radii; and, again, the third with the flat disks and fewer striæ than the outer circles. It is worthy of remark that the spines have the appearance of having been stuck on, probably owing to their being attached to part of the outer shell which is worn away at their bases, the spines sometimes being gone also." In the Rev. George Young's[2] 'Geological Survey of the Yorkshire Coast,' this author says "We have met with no shell corresponding exactly with Mr. Sowerby's *A. armatus*, which he states to exist in our Alum-shale in numerous varieties. We have several distinct species of knobbed Ammonites, but have seen none with striated knobs stuck on like Barnacles or small Patellæ, as in the outer whorl of Mr. Sowerby's shell. We must therefore suppose that the latter is so rare, that it could not be found among all the thousands of specimens which we have examined; or that Mr. Sowerby has been misinformed as to its locality; or, which seems most likely that he has made out his figure by combining two specimens together, of which the outer one has not belonged to our Alum-shale, and the inner one has had some of its knobs altered to connect it with the other." It appears from this passage that Mr. Young had not seen a true *A. armatus* when he penned it, inasmuch as he figures in his pl. xiii, fig. 9, one of the varieties of *A. fibulatus*, described as "the inside of Sowerby's *A. armatus* with a little variation in the knobs, which are not striated but plain and rather sharp. The specimen appears to be nearly entire, and we have no reason to think that it has had another whorl like that in Sowerby's figure. Yet in tracing the spire in its several volutions, we see, as in his shell, a succession of different markings. Towards the mouth the ribs are alternately knobbed and plain, and the knobbed rib parts into three at the back, immediately beyond the knob, while the plain rib goes round the back single."[3] This confusion appears to have arisen from an error in Mr. Strangewayes' statement to Sowerby that his specimen was gathered from the Alum-clay formation or Upper Lias, whereas it was doubtless obtained from the lowest beds of the Middle Lias near the village in Robin Hood's Bay, strata, by-the-by, which appear to have been very little known when Young wrote his work, and so, failing to find *A. armatus* in the Alum-shale, which he knew so well, he selected and figured as *A. armatus* a good spinous variety of *A. fibulatus*, a very characteristic Ammonite of the Alum-shale. This form he supposed must have been the one Sowerby had before him when he very accurately figured but imperfectly described an Ammonite which Young had not met with in the Alum-shale, because it does not exist in that formation. Young does not appear to have

[1] 'Mineral Conchology,' vol. i, tab. 95, p. 215, 1812.

[2] 'Geological Survey of the Yorkshire Coast,' 1st edit., p. 248, 1822.

[3] Ibid., p. 249.

known that it was to be found in older beds in Robin Hood's Bay. Mr. Simpson[1] says "I have now got a fair specimen of Sowerby's *A. armatus* which has caused so much trouble to naturalists, the very central whorls are imperfect, but there is sufficient to show that they are plain or nearly so; the succeeding whorls have the characters exhibited in Sowerby's figure. Where the spines have been knocked off there remain the oval disks. It would seem that when Mr. Strangewayes visited Whitby this species was plentiful; but the specimen I have now described is the only one I have seen, and the one I formerly took to be *A. armatus*, Sow., I believe to be a different species, which I have named *A. miles*."

Like other species of the Armati section of the genus *Aegoceras*, *Aeg. armatum* exhibits different forms characteristic of the morphological phases of its growth. In early life the shell is smooth, and about the second whorl ribs commence to show themselves as transverse elevations, and on the fourth whorl small tubercles begin to make their appearance on their sides, and on the sixth whorl they have grown into large, thick, stout spines (Pl. XXVIII, fig. 3). The magnificent specimens figured in Pl. XXVIII, figs. 1, 2, 3, 4, and 5, represent the form this beautiful Ammonite assumes in middle age, when its ornamentation appears to have attained its most perfect state. Now we find the whorls are very slightly involute, a little rounded, and provided with thick ribs, which terminate on the outer side of the siphonal area in twenty strong prominent spines; these, when broken near their base, leave large disc-like marks on the mould; between the ribs are several (four or five) transverse striæ which pass between the ribs, extend across the area (figs. 2, 4, 5), and ornament this region; other smaller striæ creep over the spines themselves (fig. 3), so that the whorls in well-preserved specimens are finely sculptured with graceful lines. Through increasing age the spines are developed wider apart, the body-chamber grows very wide, and enormous recurved spines project from the sides of the siphonal area. I have figured a very fine example of one of these aged specimens of the natural size (Pl. XXIX), showing giant spines on the body-chamber and the comparative smallness of those on the inner whorls. This specimen was collected at Lyme Regis many years ago, and long adorned the cabinet of a local collector. It was purchased for the Museum of the Royal School of Mines and now forms part of their fine collection; it is figured for the first time.

Professor Quenstedt collected this Ammonite in Swabia, where the species is much smaller than our English specimens, but is well defined by the delicate folded striæ or fine concentric ribs which extend along the sides and across the area, among which, near the margin, large thick spines project on both sides, fewer, however, in number than in our specimens.

There are several varieties of this species which have received separate specific names from different authors. One of these, *A. miles*, Simpson, deserves more than a passing notice; the spire in this shell consists of six highly evolute whorls, which are round, slender, and all exposed in the umbilicus; the ribs, about sixteen in the last whorl, are wider apart, and each rib terminates near the siphonal margin in a long pointed spine; the lateral

[1] 'Fossils of the Yorkshire Lias,' p. 64, 1855.

striæ are fine, numerous, undulating, and annular; and the aperture has a roundish form. This is a much more smooth and elegant form than the typical *Aeg. armatum*, still it may be specifically identical with it. The smaller diameter of the whorls, and the greater distance the ribs are apart from each other, greatly diminish the number of the lateral spines, which are longer and more slender than in the typical specimens of *Aeg. armatum ;* the lobe-line is likewise less complicated, and the septa are also more distant from each other than in fig. 6; the inner whorls are striated without ribs or spines. This is a most interesting form of the group Armati; and probably the discovery of other specimens may disclose some features in its form that may justify the distinction Simpson assigned to it.

In *Aegoceras armatum* (the typical form figured in Pl. XXVIII, figs. 1 and 3), in the middle period of life, the septal chambers are shallow and the lobe-line extremely convoluted, so that it is very difficult to follow its contouring. Professor d'Orbigny sketched a generalised diagram of this line from the specimen he possessed, whilst I have had the lobe-line traced on one of my specimens, and an enlarged drawing made therefrom (fig. 6), which shows that the true ramification of the lobe-line is much more complicated than d'Orbigny's figure led us to suppose. The siphonal lobe is as wide and almost as long as the principal lateral, and has on each side four lateral branches. The siphonal saddle is much wider and longer than the principal lateral lobe, and is divided into two unequal portions, the external of which is the largest and terminates in many folioles; and the internal portion has a similar termination. The principal lateral lobe is highly ornate, and from the wide base two large branches proceed from each side of the stem, which terminate in a long terminal foliated portion. The lateral saddle is small and narrow, and terminates in three folioles. The inferior lateral lobe is small and narrow, about one fourth the size of the principal, it develops three lateral and one long terminal branch; the accessory lobes are oblique and much ramified, and the whole lobe-line forms a most highly complicated contouring of foliations.

Affinities and Differences.—I have separated the *Armatum*- from the *Jamesoni*-zone because it constitutes an excellent Ammonite horizon, with an interesting series of elegant forms which range themselves around the original Sowerbyan type as a centre, and which commenced and terminated their existence with the dawn of the Middle Lias; they had, therefore, it would appear, a very limited life in time.

A great family likeness runs throughout the group, which requires accurate observation and a critical judgment to discover and define; all the species have the whorls more or less armed with spines, and with ribs and striæ extending across the siphonal area; in most of the species only one row of spines is developed along the margin of this area, whilst in others there are two distinct series of spines, as in *Aeg. densinodum*, Quenst., and *Aeg. brevispinum*, Sowerby; the septal chambers in all are very shallow, and the lobe-line is likewise highly convoluted.

Locality and Stratigraphical Position.—The fine specimens figured in Pls. XXVIII and XXIX were obtained from the *Aegoceras armatum*-zone at Lyme Regis, and very fine specimens have likewise been collected from similar beds at Robin Hood's Bay, Yorkshire, where Sowerby's type was found. I have found fragments of this species in the same zone in some exposures of the *Aeg. Jamesoni*-beds near Cheltenham.

AEGOCERAS MILLERI, *Wright,* nov. sp. Pl. XXXVII, figs. 10, 11.

Diagnosis.—Ammonite large, depressed, flattened on the sides, and slightly involute; shell very thin, not thicker than fine cardboard; whorls broad, much flattened across the siphonal area, vertical height two thirds that of the transverse diameter, sides with slight undulations, terminating in short tubular blunt knobs on the margin; the siphonal area and sides of the tubercles sculptured with a series of longitudinal elevations and depressions, which impart an ornate character to this region of the shell, and form a good specific feature for the distinction of the species.

The size of this Ammonite is unknown, seeing that fragments only have been found, the whorls being so slightly involute that no disc will hold together.

This species resembles *Aeg. muticum* in the position, form, and size of the tubercles, and likewise in the small amount of its involution; it differs from *Aeg. muticum,* however, in the absence of longitudinal striæ on the siphonal area (see fig. 10). The lateral view of the whorl (fig. 11) shows the arrangement of the tubercles on the margin of the area.

Locality and Stratigraphical Position.—This fragment was collected by Professor Archibald Geikie, F.R.S., in Pabba, along with other fossils from the zone of *Aegoceras Jamesoni* sent by my friend to me to determine. Prof. Geikie at the same time requested that, should I meet with any new forms in the collection he had made, I should associate the name of Hugh Miller, of the Old Red Sandstone, with the Pabba beds as a memento of the valuable work he carried out by his researches among the Hebridean Lias beds in his cruise in the 'Betsey'; in compliance with my friend's request, and with very great pleasure in doing so, I dedicate this singular Ammonite to the memory of Hugh Miller.

AEGOCERAS LECKENBYI, *Wright,* nov. sp. Pl. XXX, figs. 1—7.

Diagnosis.—Shell discoidal, with rounded whorls, one third involute, and a wide open umbilicus; sides of the whorls ornamented with primary and secondary ribs; the primaries vary from twelve to twenty-four in number, they are larger in size, and each rib develops a blunt elongated tubercle near the siphonal area and sends several smaller branches therefrom across the area; and the secondaries consist of numerous smaller sigmoidal annular radii interposed between the primaries, encircling this region which is consequently ornamented with numerous close-set transverse folds, nearly uniform in thickness throughout. The lobe-line is extremely convoluted.

Dimensions.—Transverse diameter, 85 millimètres; diameter of umbilicus 35 millimètres; height of last whorl 30 millimètres; transverse diameter 30 millimètres; amount of involution one third the height of the whorl.

Description.—The rounded whorls with small ribs and blunt elongated tubercles, having the siphonal area crossed by numerous transverse folds, and corresponding valleys of about the same proportionate development throughout, form a group of characters which distinguish this species from its congeners. The number of primary lateral ribs varies in the two specimens here figured from fourteen to twenty-four; they arise near the spiral suture by a thickened fold, and, describing a sigmoidal flexure, develop near the margin of the siphonal area a blunt elongated tubercle, from which two or three smaller folds proceed across the area; the tubercles are neither large nor prominent (figs. 1, 2, 4, 6), and do not terminate in spines, at least in the specimens I have seen. The secondaries are smaller annular folds, which arise from the spiral suture, describe a sigmoidal flexure, and extend directly across the siphonal area, blending with their fellows from the opposite side, and covering the area with a series of elevations and depressions, which impart an ornate aspect to this region of the shell (figs. 2, 3, 6). The whorls are quite one-third concealed in the umbilicus by the involution of the spire (figs. 1, 4).

The lobe-line, as in all the other Armati group, is extremely convoluted (fig. 7); the siphonal lobe is long, and has one large lateral and three smaller terminal branches. The siphonal saddle presents three deeply ramified folioles; the principal lateral lobe is as large as the siphonal, and divides into two branches, which are both much digitated. The lateral saddle is small, narrow, and foliated, and the accessary lobes have a central stem with lateral digitations. The whole forms an oblique and most complicated line of suture, very difficult to trace through all its ramifications.

Affinities and Differences.—This species very much resembles *Aeg. armatum*, but differs from it in the following details of its anatomy. The whorls are rounder and more involute; the spines are shorter, elongate, and non-aculeate; the lobe-line is much less convoluted, and the transverse folds across the siphonal area are smaller and more numerous.

Locality and Stratigraphical Position.—This Ammonite was obtained in the Armatum-zone of the Middle Lias at Lyme Regis, associated with *Aeg. armatum* and *Aeg. miles*, and the other fossils of this bed. It must be a rare form as I have not seen any other specimens except those here figured, nor observed it in any of the collections examined for the purpose of acquiring all the different species of *Armati* for my work. This species is dedicated "*in memoriam*" to my old and much esteemed friend, the late Mr. John Leckenby, F.G.S., of Scarborough, who was always a ready and willing helper by the loan of his most beautiful specimens for figuring in my works on the Fossil Echinodermata and Ammonitidæ, published by the Palæontographical Society.

Aegoceras Davœi, *Sowerby*. Pl. XXXI, figs. 1, 2.

Ammonites Davœi, *Sowerby*. Min. Conch., vol. iv, p. 71, pl. 350, 1822.
Planites — *de Haan*. Ammonit. et Goniatit., p. 82, No. 3, 1825.
Ammonites — *Zieten*. Versteiner. Württembergs, p. 19, tab. xiv, fig. 2, 1830.
— — *Roemer*. Norddeutschen Oolithgebirg., p. 199, 1836.
— Davoei, *Bronn*. Lethæa geognost., p. 447, tab. xxiii, fig. 4, 1837.
— — *Collegno*. Bulletin Soc. géolog. de France, x, p. 247, 1839.
— — *Quenstedt*. Flözgebirge Würtembergs, 171, 1843.
— Davæi, *d'Orbigny*. Pal. Franç. Juras., tom. i, p. 276, pl. 81, 1842.
— — *Quenstedt*. Cephalopoden, p. 91, tab. 5, figs. 6, 1849.
— — *Savi and Meneghini*. Consid. Geologia Toscana, p. 115, 1851.
— — *Studer*. Geologie der Schweiz, t. ii, p. 31—35, 1853.
— — *Meneghini*. Nuovi Fossili Toscani, pp. 10, 31, 1853.
— Davöi, *Oppel*. Mittlere Lias Schwabens, Jahreshefte Württemberg, p. 80, 1853.
— — *Quenstedt*. Der Jura, p. 132, 1858.
— — *Von Hauer*. Die Cephalopoden aus dem Lias der Nord-Ost. Alpen, p. 54, pl. xvii, figs. 11, 12, 1856.
— — *Chapuis*. Terr. Sec. de Luxemb., p. 25, t. iv, fig. 5, t. v, fig. 1, 1858.
— — *Dumortier*. Dépôts Jurassiques du Bassin du Rhône, tom. iii, p. 94, pl. xi, figs. 4—6, 1869.
Aegoceras Davoei, *Neumayr*. Zeitschrift der Deutsch. geol. Gesellschaft, p. 906, 1875.

Diagnosis.—Shell discoidal, depressed; umbilicus wide; whorls round, slightly involute, covered on the sides and area with numerous simple, narrow, oblique ribs; on each revolution of the spire there are eight to ten round, obtuse tubercles developed near the middle of the whorl, and occupying the width of three ribs; siphonal area rounded, slightly depressed, and covered with numerous transverse close-set costæ; spire formed of eight whorls, which are round and slightly depressed on the outer margin; aperture roundish.

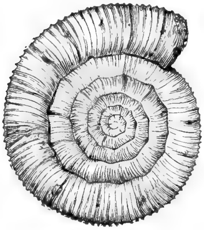


Fig. 188.—*Aegoceras Davœi*, Sow.

Dimensions.—The large figured specimen; transverse diameter 112 millimètres; width of umbilicus under aperture 65 millimètres; vertical height of whorl 26 millimètres; transverse diameter 30 millimètres. The specimens found in general are much smaller, two before me measure transverse diameter 90 millimètres; width of umbilicus under aperture 55 millimètres; vertical height of last whorl 22 millimètres; transverse diameters 23 millimètres.

Description.—This beautiful Ammonite is a very rare British fossil. The specimen here figured formerly belonged to my late friend, Mr. John Leckenby, F.G.S., who obtained it from Charmouth; it is one of the finest examples known, and is now in the Woodwardian Museum, Cambridge; the shell is discoidal and compressed, consisting of rounded whorls, which are only slightly involute, and closely clasp the penultimate volution; they are covered on the sides and area with a series of ribs and sulcations about equal in width throughout; on the sides the ribs are directed obliquely forwards, whilst across the siphonal area they are transverse and extremely regular. In typical shells each whorl develops from eight to twelve round blunt tubercles about the middle of the whorl, which occupy the space of two ribs and two sulcations; sometimes these tubercles have a thick envelope, and then they form spines; many specimens, however, are wanting in the tubercles, though in the figured specimen the projections are large and regular, and impart a very distinctive character to this Ammonite. The lobe-line is very complicated; the siphonal lobe, as long and wide as the principal lateral, is formed of three branches, two of which bifurcate. The siphonal saddle, as large as the principal lateral, is very irregularly divided into three folioles at the external side, and one at the internal. The principal lateral lobe divides into two large branches, the terminal one is very much ramified, and the external, nearly as large, is equally ramified. The lateral saddle is smaller than the principal lateral lobe, and terminates in four folioles. The lower lateral lobe is small, with five digitations, and the auxiliary lobe, still smaller, possesses three. The lobe-line has been extremely well figured by Quenstedt and d'Orbigny; none of the specimens which have passed through my hands show this structure so well, as they have all retained their shell (or portions thereof) which conceals the true septal suture.

Prof. d'Orbigny had the opportunity for studying the evolution of this Ammonite; he observes:[1]—"This species, more or less compressed, varies much according to age. Up to a diameter of 25 millimètres the whorls are much depressed, and ornamented with from thirteen to fifteen long, sharp-pointed spines; this depression of the whorls is often remarked up to a diameter of 50 millimètres; beyond this diameter there are in general from eight to twelve tubercles; the whorls become more or less thick and compressed. At the largest diameter known (120 millimètres) the ribs become more prominent, and more irregular, and the tubercles are less regularly placed. The spines appertaining to the shell leave a truncated tubercle on the mould."

Affinities and Differences.—This species resembles *Aeg. Leckenbyi* in its ribs and spines, but is distinguished from that form by its tubercles being set much wider apart, by its regular oblique narrow ribs and valleys on the sides, and by the finer sculpture across the area; the structure of the lobe-line likewise presents an important difference between the two species.

Locality and Stratigraphical Position.—This is a capital leading fossil for a certain horizon of the Middle Lias; the chief locality in England is the Green Ammonite-beds

[1] 'Paléontologie Française; Terr. Jurrassique,' t. i, p. 277.

near Charmouth, Dorset (see p. 89), where I have collected it associated with *Aeg. Bechei*, *Belemnites clavatus*, and *Monotis inæquivalvis*, all in the same slab. It is found in marls of the same horizon in Somersetshire and Gloucestershire.

Dumortier says:—"Of all the Ammonites of the Middle Lias *Am. Davœi* is the most important and most characteristic form; its ornamentation and size are more constant; and it presents itself always in the same horizon, that is to say, above the lowest beds of the Middle Lias, and in company with *Am. capricornus* and *Am. fimbriatus.* I do not know a bed at this level in which I have not found *Am. Davœi.*" It has been collected in many Departments of France, as at Mulhausen and Uhrwiler, Bas-Rhin; near Nancy, Meurthe; Amaye-sur-Orne, and Vieux-Pont, near Bayeux, Calvados; Saint-Rambert, Ain; near Lyon, Rhône; Pouilly-en-Auxois, Semur, Venarey, Côte-d'Or; Metz, Moselle.

In Germany, near Boll; at Bargau, near Gmünd and Aalen; at Füzen between Donaueschingen and Schaffhausen.

In Italy, in the Appenines; in Red Limestone at Monte Calvi; in Grey Limestone Monti di Cetona, near Lake Como.

In Switzerland, in the Bernese Alps; and at Coulat and Fondement, near Bex.

Aegoceras Taylori, *Sowerby*. Pl. XXXI, figs. 5—7.

Ammonites Taylori,		*Sowerby.* Mineral Conchology, vol. vi, p. 23, pl. 514, fig. 1, 1826.
— proboscidens,		*Zieten.* Versteinerungen Würtembergs, p. 9, pl. x, fig. 1, 1830.
— Taylori,		*Quenstedt.* Flözgebirge Würtembergs, p. 176, 1843.
— lamellosus,		*d'Orbigny.* Pal. Franç.; Terr. Jurass., pl. 84, 1842.
— Taylori,		*d'Orbigny.* Ibid., p. 323, pl. 102, figs. 3—5, 1844.
— —	costatus,	*Quenstedt.* Cephalopoden, p. 136, tab. ix, fig. 20, 1849.
— —	nodosus,	*Quenstedt.* Ibid., 136, tab. ix, fig. 21, 1849.
— —		*Giebel.* Fauna der Vorwelt, t. iii, p. 697, 1852.
— —		*Oppel.* Mittl. Lias Schwabens, Jahresh. Württ., p. 92, 1853.
— cornutus,		*Simpson.* Fossils of the Yorkshire Lias, p. 71, 1855.
— quadricornutus,		*Simpson.* Ibid.
— Taylori,		*Oppel.* Die Juraformation, p. 165, 1856.
— —		*Quenstedt.* Der Jura, p. 135, pl. 16, fig. 8, 1858.
— —		*Schlönbach.* Die Eisenstein d. Mittler Lias; Zeitschr. d. Deutsch. geolog. Gesellschaft, p. 527, 1863.
Aegoceras —		*Tate and Blake.* Yorkshire Lias, p. 279, 1876.
— —		*Neumayr.* Zeitschrift der Deutsch. geol. Gesellschaft, p. 906, Jahr 1875.

Diagnosis.—Shell discoidal; whorls rounded and externally compressed; sides with fourteen straight, elevated, upright ribs, with two large, blunt, lateral tubercles, one on the side and one on the siphonal area; the ribs separated by wide concave spaces. Siphonal area concave and bi-tuberculate; aperture rotund, two fifths the diameter of the shell.

Dimensions.—Transverse diameter 50 millimètres; width of umbilicus 20 millimètres; height of aperture 18 millimètres; transverse diameter 20 millimètres.

Description.—This beautiful Ammonite is a very rare British fossil, and was very well figured by Sowerby; it appears to be more common in Germany where it has been collected from its true horizon by Professor Quenstedt, who has given good figures of the two varieties of this species found by him. *Aeg. Taylori nodosus* is the typical form, and is the one I have collected at Lyme Regis, and figured in Pl. XXXI, fig. 5. This variety has four series of blunt, well-marked, prominent tubercles around the whorls; those on the sides appear like a thickened extension of the ribs (fig. 5), which contract above and unite themselves with the prominent nodules (figs. 6 and 7), developed around the lateral region of the siphonal area (fig. 6). When these tubercles were covered with shell they constituted very prominent processes and formed the *Am. lamellosus* of d'Orbigny (Ter. Jurass., Pl. 84). The specimen figured in Pl. XXXI, fig. 5, is simply a mould and conveys no idea of what this highly ornamented Ammonite was when it possessed its shell entire.

The second variety, *Aeg. Taylori costatus*, had in early life very sharp prominent ribs, on which the side tubercles were scarcely developed; those on the margin of the area appear as the termination of the ribs, rising high up on each side of the concave furrow, which the siphonal area forms between the two series of tubercles. This rare variety is very often mistaken for other forms. The ribs are separated by wide concave spaces covered with striæ, which describe the natural curve of the ribs; as they wind over the margin, and pass across the siphonal area, they become more and more developed (figs. 6 and 7).

The aperture is rotund, slightly grooved on the outer margin by the turn of the spire, and rather longer longitudinally than transversely, as is well shown in fig. 7.

The lobe-line is complicated; the siphonal lobe is formed of two branches of equal parts, composed of several lateral digitations with two terminal bifid digits. The siphonal saddle is large with several folioles at its termination; the principal lateral lobe as long as the siphonal, is narrow and elongated, with four bifid lateral digitations on each side, and a long terminal digit. The lateral saddle is also wide, terminating in two bifid and one trifid foliole; the lateral lobe is a small representative of the principal. The accessary lobes appear to be well developed, still their details are concealed in the turn of the spire.

Affinities and Differences.—This species resembles the young condition of *Aeg. striatum*, yet the central furrow along the siphonal area and the row of tubercles on the sides thereof form good diagnostic characters, by which it may be easily distinguished from that species. When it attains twenty millimètres in diameter it assumes its own typical distinctive shell characters.

Locality and Stratigraphical Position.—My figured specimen was collected in the zone of *Aeg. armatum,* near Charmouth; the same form is found at Robin Hood's Bay in beds of the same age; the two varieties mentioned by Quenstedt are likewise found there, and have been catalogued by Simpson as (*a*) *cornutus* = *costatus*, Quenst.; and (*b*) *quadricornutus* = *nodosus*, Quenst. These two forms certainly belong to one species.

The type specimen which Sowerby figured was found by Mr. Taylor, of Norwich, in a water-worn mass of indurated clay approaching ironstone and containing blende in Happisbury Cliff, Norfolk, where it was probably alluvial; it has likewise been found in the Middle Lias of Northamptonshire. A solitary specimen is catalogued by Professor Buckman, F.G.S., from Brickfields, Coltham-field, Hewletts Road, and Leckhampton, near Cheltenham, Gloucestershire. I have never seen a specimen from these beds.

In Germany, Professor Quenstedt collected it in the Middle Lias at Ofterdingen, Reutlingen, Jebenhausen near Goppingen; and Professor Oppel in the same horizon near Boll, Metzingen, and Hechingen, where it was common; in France it was collected by M. Engelhardt at Muhlhausen, Bas-Rhin, in a ferruginous matrix.

AEGOCERAS DENSINODUM, *Quenstedt.* Pl. XXXVIII, figs. 5, 6; Pl. XXXIX, figs. 6—10. Pl. L, fig. 11, 12.

AMMONITES ARMATUS DENSINODUS, *Quenstedt.* Cephalopoden, tab. iv, fig. 18, p. 82, 1849.

— — — *Oppel.* Mittl. Lias Schwabens, Jahresh. Württ., p. 71, 1853.

AEGOCERAS DENSINODUM, *Neumayr.* Zeitschrift der Deutsch. geol. Gesellschaft, p. 906, Jahr 1875.

Diagnosis.—Shell much depressed and flattened, whorls very slightly involute; umbilicus wide, with inner whorls all exposed; spire formed of from six to eight volutions outer whorl with twenty-four to thirty slender, oblique ribs directed backwards; each rib supports one small tubercle near its middle, and a large prominent knob at its termination near the margin; siphonal area very narrow and depressed, and ornamented with transverse striæ; body-chamber long, mouth enlarged with an oblong, trumpet-shaped aperture.

Dimensions—Large specimen.—Plate XXXVIII, figs. 5 and 6: transverse diameter 110 millimètres; diameter of umbilicus 60 millimètres; height of trumpet-shaped aperture, 40 millimètres; transverse width 27 millimètres.

Small specimen.—Plate XXXIX, figs. 6 and 7: transverse diameter 73 millimètres; diameter of umbilicus 40 millimètres; height of aperture 20 millimètres; transverse width 17 millimètres.

Description.—*Ammonites armatus,* according to Professor Quenstedt, presents two well-marked varieties: A, *Armatus sparsinodus,* and B, *Armatus densinodus.* After a careful study of the latter shell, which I have collected in different localities and in considerable numbers, I have erected it into a distinct species, as it exhibits characters which I have found to be specific and permanent.

The shell is discoidal, compressed and slightly involute, with a wide umbilicus, all the whorls being fully exposed in the medium-sized specimen (Pl. XXXIX, figs. 6 and 7). The flat sides are ornamented with twenty-five to thirty oblique ribs, which become visible above the spiral suture. Near the middle of their length they develop a small tubercle (fig. 8); beyond this the rib enlarges, and terminates at the margin of siphonal area in a round, blunt, prominent tubercle. In most of the specimens which have passed through my hands the ribs are inclined obliquely backwards, on which the double row of tubercles are very well developed (fig. 8). In other specimens, however, the marginal tubercles alone are developed, and the position of the inner series on the middle of the rib is indicated by a simple thickening of the lateral fold. The siphonal area is narrow, flat (figs. 7—9), and crossed by numerous transverse striæ; some of these pass from one large tubercle on one side of the area to those of the opposite side; in the intertubercular space three small striæ pass across, so that the area has a highly ornate appearance in well-preserved specimens, as in figs. 8 and 9.

In the large specimen, Pl. XXXVIII, figs. 5 and 6, and in a smaller individual of the same type, Pl. XXXIX, fig. 6, and Pl. L, figs. 11, 12, the medium row of tubercles is absent, and the ribs have the oblique backward inclined curve so characteristic of this species in the large specimen, which is exceptionally fine; and the termination of the body-chamber is greatly enlarged and forms a trumpet-mouthed expansion, which is likewise characteristic (Pl. XXXVIII, fig. 5); the body-chamber has a quadrate shape, the area is flat, and the whorl ornamented with thirty-eight ribs, the whole structure of the spire being exposed in the widely open umbilicus. The lobe-line is very complicated (Pl. XXXIX, fig. 10). The siphonal lobe is large and symmetrical, with three digitations on each side and two long terminal branches having serrated sides. The siphonal saddle is wide, and divided into three compartments, the internal and external being deep and terminating in folioles, and the central one narrow from the size of the partition. The principal lateral lobe is long, narrow, and branched; it has an irregular figure, the terminal portion ending in a long point. The lateral saddle is deep, terminating in two folioles like two oak leaves, with a narrow stem between them. The lateral lobe is long, narrow, and oblique, with a freely digitated margin. The auxiliary saddle is small and oblique, and ends in one foliole, and the auxiliary lobe is likewise small and oblique with lateral digitations.

The morphology of this species is very interesting. The facts I have noted were obtained from the study of a large assemblage of the brood of this species, collected from a thin bed in which they were entombed. In the first three volutions the young shell is quite smooth; in the fourth sharp ribs make their appearance with concave spaces between ; at about the sixth volution of the spire the ribs begin to exhibit tubercles at their termination by the margin of the area, and in the seventh volution the second series of tubercles show themselves. In old age the volutions become less ornamented by first losing the inner row of tubercles, and, secondly, by the outer row becoming smaller and more rudimentary. In all these morphological changes, however, I note several points of difference between the evolution of this species and that of *Aeg. armatum.*

Affinities and Differences.—This species is undoubtedly closely related to *Aeg. armatum,* but it has altogether a more slender compressed shell, with a second row of tubercles on the ribs, and is more quadrate in the *ensemble ;* it has likewise a narrower siphonal area, and a much less complicated lobe-line. Compare Pl. XXVIII, fig. 6, with Pl. XXXIX, fig. 10, and Pl. XXVIII, figs. 1, 2, with Pl. L, figs. 11, 12.

Locality and Stratigraphical Position.—I collected this species in the Armatus-bed at the base of the Aeg. Jamesoni-zone in St. Paul's district, Cheltenham, in the Middle Lias, whilst brick-earth was being dug for our town sewers. I have many beautiful examples from near Charmouth, Dorset, embedded in a hard ferruginous clay-ironstone, in fact, all the Armati from the Dorsetshire coast about this horizon are highly charged with ferric oxide. This Ammonite was found in the Jamesoni-beds of the Island of Pabba near Skye, and several specimens were collected for me from the lower beds of the Middle Lias at Ballintoy, Ireland. The specimens obtained from all these widely separated localities closely agree in their specific structure and petrological condition. Those from Ballintoy were embedded in a hard calcareous shale.

AEGOCERAS JAMESONI, *Sowerby.* Pl. XI, figs. 4—6 ; Pl. LI, figs. 1—6.

AMMONITES JAMESONI,	*Sowerby.*	Min. Conch., vol. vi, p. 105, pl. 555, fig. 1, 1827.
— BRONNII,	*Römer.*	Nord-deutschen Oolithen-Gebirge, p. 181, 1836.
— JAMESONI,	*Quenstedt.*	Flözgebirge Würtembergs, p. 31, 1843.
— REGNARDI,	*d'Orbigny.*	Paléontologie Française ; Terr. Jurass., pl. 72, tom. i, p. 257, 1842.
— JAMESONI ANGUSTUS,	*Quenstedt.*	Cephalopoden, tab. iv, fig. 8, 1849.
— — LATUS,	*Quenstedt.*	Ibid., tab. iv, fig. 1, 1849.
— —	*Oppel.*	Mittlere Lias Schwabens, Jab. Württ., p. 76, 1853.
— JAMESONI,	*Oppel.*	Jura-Formation, p. 159, 1856.
— —	*Von Hauer.*	Die Cephalopoden des Lias der Nordostlichen Alpen, pl. xix, figs. 1—3, 1856.
— — LATUS,	*Quenstedt.*	Der Jura, tab. xv, fig. 15, p. 125, 1858.

AMMONITES JAMESONI, *Wright*. Quart. Journ. Geol. Soc., vol. xiv, p. 27, 1858.
— — *Chapuis*. Terr. Sécond. Luxembourg, p. 32, tab. vi, fig. 1, 1858.
— — *Schlönbach*. Eisenstein d. Mittl. Lias; Zeitsch. d. Deutsch. geol. Gesellsch., p. 523, Jahr 1863.
— — *Dumortier*. Depôts Jurass. du Bassin du Rhône, vol. iii, p. 93, 1869.
— — *Emerson*. Lias von Markoldendorf, Zeit. Deut. geol. Gesell., p. 274, 1870.
ÆGOCERAS — *Tate and Blake*. Yorkshire Lias, p. 279, 1876.

Diagnosis.—Shell discoidal, more or less compressed; whorls one third involute, slightly depressed, and convex, ornamented with fifty-six slender, equal, simple ribs, with sigmoidal curve, often developing a tubercle near the margin, and forming an arch across the siphonal area and joining the ribs of the opposite side. Siphonal area narrow, convex, and depressed; aperture oblong, compressed, and elongated.

Dimensions.—Large figured specimen (Pl. LI, fig. 1) 160 millimètres; width of umbilicus 75 millimètres; height of aperture 50 millimètres; width 37 millimètres. Small Pabba fossil (Pl. LI, fig. 4)—transverse diameter 76 millimètres; width of umbilicus 37 millimètres.

Seldom found in a satisfactory condition in middle age.

Description.—This Ammonite, very rare in England and Scotland, is much more abundant in Würtemberg, whence my best specimens have been obtained (Pl. XI, fig. 4). Two very distinct varieties have there been described and figured by Professor Quenstedt; the first named—A, *Am. Jamesoni latus*, with thick ribs and a broad siphonal area, the normal form of Sowerby; the second—B, *Am. Jamesoni angustatus*, with more numerous and slender ribs, a narrow, convex, siphonal area, and the aperture compressed and elongated.

A good type shell of *Aeg. Jamesoni latum* is figured in Pl. LI, figs. 1 and 2, and a good type of *Jamesoni angustatum* in Pl. LI, fig. 4.

These figures show that there is a very considerable variation in the form and ribbing of this elegant Ammonite. Sowerby's type was a mere fragment obtained from the Lias of the Island of Mull; two of the specimens I possess were collected from the Middle Lias of the Island of Pabba near the Island of Skye, and one of these is figured in Pl. LI, fig. 4. In the Hebridean fossils we have the true Sowerbyan type; the shell is compressed in early and middle age, the sides are ornamented with simple equal-sized ribs, gradually increasing in length and thickness with the growth of the shell; they arise at a short distance from the spiral suture, and describe a slight sigmoidal flexure, the curve being inclined towards the aperture; near the margin the rib becomes thicker and forms an arch across the siphonal area, which in old large shells is thick, wide, and depressed, whilst in middle age it becomes convex, narrow, and prominent. In some specimens the thickened marginal portion of the rib develops a blunt tubercle, and a feeble carina extends along the middle of the siphonal area. The large specimen (Pl. LI, figs. 1, 2) from Mungar shows a very remarkable development of the ribs on the sides as well as on the siphonal area; these aged forms may, therefore, represent *Jamesoni latum*, Quenst. In the middle period the fossils figured in Pl. XI, figs. 4—6, and in Pl. LI, figs. 3, 4, may be taken as representing *Aeg. Jamesoni angustatum*, Quenst.; the sides of the whorls are convex and compressed, and the ribs slender and very numerous; in one specimen there are more than seventy ribs on the last whorl. Sometimes the ribs are fewer in number and stronger, as in the fig. 3, in which the forty-two ribs are sharp and prominent with wider intermediate valleys, presenting a strong contrast to fig. 4 on the same Pl. LI.

The Middle Lias in Robin Hood's Bay, Yorkshire, yields another variety of *Aeg. Jamesoni*, which has been described and figured as a new species by Professor Blake under the name of *Aeg. sagittarium*. I have long known this variety, which has roundish whorls nearly one-third involute, and large, sharp, sigmoidal ribs, about twenty-four in a whorl, with deep concave valleys between the ribs, which arch forward across the siphonal area. I have figured the young shell of this variety in Pl. LII, figs. 4, 5, and the large adult shell collected by the Rev. Mr. Cross, F.G.S., from the Jamesoni-Lias in Robin Hood's Bay. For further details consult the article on *Aegoceras sagittarium*.

The lobe-line is very well seen in several of my specimens. The siphonal lobe is shorter and wider than the principal lateral, and ornamented on each side with three ramified branches. The siphonal saddle, much wider than the principal lateral lobe, divides into two nearly equal-sized foliations. The principal lateral lobe is long and much complicated, and divides into three ramified branches. The lateral saddle divides into two unequal parts, of which the internal is the most developed. The lateral lobe is slender and narrow, and consists of a single stem with lateral digitations; and the auxiliary saddle is narrow with a few irregular folioles.

The morphology of *Aeg. Jamesoni* is extremely interesting. Although only fragments of large whorls have been collected, I have found many very perfect specimens of the brood of this species in the Middle Lias of Leckhampton. A good example is figured, Pl. LI, figs. 5, 6; in this stage it is *Ammonites Bronni*, Römer. The shell is ribbed on the sides in the second turn of the spire; and in the fourth turn the sharp ribs acquire small tubercles by the side of the area, fig. 5; and as they arch across that space a well marked carina is observed on the mesial line, fig. 6. With the growth of the shell the tubercles decrease in size, and finally disappear in middle age; the area, becoming narrow and convex, gradually assumes the form delineated in Pl. LI, figs. 3 and 4, as the typical forms of middle life.

Affinities and Differences.—I have long collected the young of this Ammonite in the Middle-Lias brick-yards near Cheltenham; in this state it is *Am. Bronni*, Römer; another form is *Am. Regnardi*, d'Orb., and another variety *Am. venustulus*, Dumortier. It is a very variable fossil, and has been a fertile field for species-mongers. I have specimens from Robin Hood's Bay identical with the Pabba examples; but the large, ribbed, figured specimen, with its undulated sides and waved area, is a very rare variety of this shell;

the finest examples known have been obtained from the Middle Lias at Hechingen, Würtemberg; these examples are identical with the Pabba types, one of which is figured on Pl. XI, figs. 4—6, and a second on Pl. LI, fig. 3. I have found only two fragments of a large shell in the Cheltenham beds, and both specimens belonged to the true Pabba type.

Locality and Stratigraphical Position.—*Aegoceras Jamesoni* is a leading fossil of the zone which it so well characterizes. It is found near Cheltenham, Gloucestershire; Fenny-Compton, Warwickshire; Munger, Somerset; Charmouth, Dorset; Robin Hood's Bay, Yorkshire; and in the islands of Mull and Pabba in the Hebrides.

Foreign Distribution.—In France it has been collected at Coutards and Bois-de-Trousse, near St. Amand, Cher; Sachi, Ardennes, Evrecy, Calvados; St. Rambert, Ain; near Lyons, Rhône.

In North-west Germany it has been found near Rottorf, Roklum, Hedeper, Harzburg, Liebenburg, Bodenstein, Kahlefeld, Willershausen, Oldershausen, Markoldendorf, Falkenhagen, and other localities. In South Germany it is found in Swabia in many localities, as at Pliensbach, near Boll, Soldelfingen, Hechingen, Balingen, &c.; in all the localities it occupies the same horizon, namely, at the base of the Middle Lias.

Aegoceras sagittarium, *Blake*. Pl. LII, figs. 1—5; Pl. LIIa, figs. 1—6.

Ammonites Jamesoni, *Simpson*. Foss. York. Lias, p. 48, 1855.
Aegoceras sagittarium, *Tate and Blake*. Yorkshire Lias, p. 276, pl. vii, fig. 2, 1876.

Diagnosis.—Shell discoidal, compressed; volutions five, uniformly rounded, and one-fourth involute; outer whorl one third the diameter in height with twenty-two to twenty-six slightly bent ribs moderately elevated, rounded, and disappearing near the margin of the siphonal area, which is in general smooth and convex, but sometimes has an elevated ridge which occupies the mesial line, and passes longitudinally round the shell; aperture oblong, narrower in the outer half.

Dimensions—Small specimens.—Pl. LII, fig. 4. Transverse diameter 56 millimètres; width of umbilicus 25 millimètres; height of last whorl 19 millimètres; height of aperture 18 millimètres; width 17 millimètres.

Large specimen.—Pl. LII, figs. 1, 2. Transverse diameter 240 millimètres; width of umbilicus 95 millimètres; height of last whorl 90 millimètres; width 50 millimètres.

Description.—This shell has been long known to me as a Yorkshire variety of *Aegoceras Jamesoni*, which I had separated from my Pabba types under a distinct diagnosis; now that Professor Blake has figured this form in his Yorkshire Lias under a specific name, priority of publication entitles him to precedence. I am indebted to the

Rev. J. E. Cross, F.G.S., for the loan of some large specimens of this Ammonite, one of these I have figured in Pl. LII, two-thirds the natural size, and I have another of much larger dimensions in my custody; it therefore attained a gigantic size, varying very little from the type figured.

The volutions are uniformly rounded, and about one-third or one-fourth of the width of a whorl is involute; the outer whorl in height is one-third the diameter of the shell, its sides are convex, and ornamented with twenty-five narrow, slightly bent ribs, which disappear in some shells near the margin of the area (Pl. LII, figs. 1—2), and in others extend across the space (Pl. LIIA, fig. 2). In such shells an elevated ridge is developed on the mesial line and runs longitudinally round the whorl, connecting the ribs with one another, as shown in Pl. LII, fig. 5, and Pl. LIIA, figs. 2, 4, and 6; and the ribs are separated by concave spaces three times the width of the ribs.

In most of the young shells which have passed through my hands, measuring from 50 to 60 millimètres in diameter, the ribs terminate in a thickened portion at the margin of the area, whilst the intervening space is smooth, as in Pl. LII, fig. 4 and fig. 5; in other specimens a central rudimentary carina distinctly shows itself, as in Pl. LIIA, fig. 2, and figs. 4 and 6. This is a true *Aeg. Jamesoni* character of early life. See Pl. LI, figs. 5 and 6, in which specimen it is very well seen. The shell is partially preserved in some of my smaller examples, which enables me to state that it is extremely thin.

The umbilicus is very open, and exposes all the inner whorls (Pl. LII, figs 1, 2, 4; Pl. LIIA, figs. 3, 5).

The aperture is oblong (Pl LII, fig. 2), it is widest at the inner side near the return of the spire, and tapers away at the outer side towards the siphonal area.

The lobe-line resembles the type of that of *Aeg. Jamesoni* (Pl. LII, fig. 3). The siphonal lobe is shorter and wider than the principal lateral. The siphonal saddle forms a regular arch, festooned with simple folioles on the sides, and at the termination. The principal lateral lobe is long and narrow; it has four lateral digits on each side, and one long terminal bifid process. The lateral saddle, much wider than siphonal, is festooned all round with bilobed leaves, the one side being almost the copy of the opposite. The lateral lobe is smaller than the principal, which it very much resembles in shape and digitations. The auxiliary saddle is nearly as large as the siphonal, which it much resembles in the style of its folioles; the accessory lobes are small oblique processes.

I consider the specimen figured in Pl. LII, figs. 1 and 2, as the best type of this form, as it differs very little from the specimens met with as *Am. Jamesoni* in most collections of Yorkshire Lias Ammonites. My old friend Mr. Leckenby, F.G.S., often pointed out from a type specimen he had, the points wherein he considered the Yorkshire shell to be different from the true *Am. Jamesoni*, Sow., of the Mineral Conchology.

The specimen figured in Pl. LIIA, figs. 1 and 2, was collected in Robin Hood's Bay, from the same rock whence the large specimen was obtained; in this example the whorls are not so high, the ribs are narrower, sharper, and more bent, and the intercostal valleys are much wider and more concave, the siphonal area is likewise much changed by the presence of a central carina which passes longitudinally between the ribs and connects them with each other. The inner whorls are absent; this body-chamber forms a striking contrast to the figure given in Pl. LII, figs. 1 and 2; the small specimens figured in both plates very much resemble each other in the thickness and roundness of the whorls and the sharpness of the ribs as shown in the mould.

Locality and Stratigraphical Position.—Professor Blake says that this Ammonite comes from a different horizon to that in which *Aeg. Jamesoni* lies, and assigns the base of the zone of *Amaltheus oxynotus* in Robin Hood's Bay as its true geological position. It was likewise from the same locality and horizon that the Rev. J. E. Cross obtained the large specimens he has so kindly communicated for this work.

AEGOCERAS VALDANI, *d'Orbigny*. Pl. XXXVIII, figs. 1, 2, 3, 4; Pl. LXIX, figs. 2, 3 and 4.

AMMONITES BIPUNCTATUS, *Römer*. Versteiner. des Nord-Deutsch. Oolithen-Gebirges, p. 193, 1836.
— BIRCHI, *Quenstedt*. Flözgebirge Würtembergs, p. 173, 1843.
— VALDANI, *d'Orbigny*. Paléontol. Française; Terr. Jurassique, tome i, p. 255, pl. 71, 1844.
— — *Quenstedt*. Cephalopoden, p. 90, tab. v, fig. 3, 1849.
— — *Giebel*. Fauna der Vorwelt, vol. iii, p. 683, 1852.
— — *Chapuis et Dewalque*. Terr. Sécond. Luxembourg, Mem. Cour. Acad. Belgique, t. xxv, p. 47, pl. vi, fig. 3, 1853.
— — *Oppel*. Mittlere Lias Schwabens, Jahreshefte Württemoerg, p. 78, tab. 2, fig. 2, 1853.
— — *Studer*. Geologie der Schweiz, ii, pp. 26, 32, 1853.
— — *Meneghini*. Nuovi Fossili Toscani, pp. 10, 32, 1853.
— — *Merian*. Verhand. Naturforsch. Gesellsch. Basel, vol. i, p. 79, 1854.
— — *Von Hauer*. Cephal. Lias N.-O. Alpen, Denk. Akad. Wissen., t. xvii, figs. 13, 15, p. 53, 1856.
— BIPUNCTATUS, *Oppel*. Die Juraformation, p. 160, 1856.
— VALDANI, *Quenstedt*. Der Jura, pl. xvi, figs. 2, 3, p. 131, 1858.
— BIPUNCTATUS, *Dumortier*. Dépôts Jurass. Bassin du Rhône, tom. iii, p. 70, 1869.

Diagnosis.—Shell discoidal, compressed, carinated; whorls flattened on the sides, with simple, straight ribs, which terminate in two rows of tubercles, one row situated at the margin of the siphonal area, the other at some distance from the spiral suture; siphonal area narrow, convex, carinated; aperture narrow, elongated, and flattened laterally.

Dimensions.—Transverse diameter 84 millimètres; width of the umbilicus 45 millimètres; height of aperture 20 millimètres; transverse width 15 millimètres.

Description.—This Ammonite is supposed to be the *bipunctatus* of Schlotheim—be that as it may, it certainly is the *bipunctatus* of Römer, who has very accurately described it in his 'Versteinerungen, &c.' The shell is discoidal, compressed, and flattened on the sides of the whorls, which support two rows of small blunt tubercles, the one row bound the margin of the siphonal area, the second row is developed at some distance from the spiral suture; and between the two tubercles a short, straight rib extends. The whorls are for nearly one-third their height involute, and the turn of the spire just covers and encloses the outer row of tubercles, whilst the inner row is visible on the whorls up to the earliest turns of the spire. The shell slopes very obliquely, at an angle of 30° from the inner row of tubercles to the foregoing whorl, so that the umbilicus has a stair-like aspect from the flat step or side of the whorl, and the inclined riser which leads to it. I know of no other Ammonite that has this feature so well shown, and which has been very well represented in fig. 1. The siphonal area is narrow and angular in consequence of the development of the carina. From the outer tubercles a continuation of the ribs extends obliquely forward towards the aperture, with other intermediate striæ having a like direction; so that good specimens with the shell preserved have the area ornate with fine oblique lines stretching forward from the marginal tubercles towards the central carina. The aperture is quadrate and elongated (Pl. XXXVIII, fig. 2), one third less in the transverse than the vertical diameter.

The lobe-line is extremely convoluted (fig. 4). The siphonal lobe is wider and shorter than the principal lateral, and ornamented on each side with three branches, of which the lowest is large and pyramidal. The siphonal saddle is wider than the principal lateral lobe, and formed of two very wide, much ramified, unequal parts, the largest being the innermost. The principal lateral lobe is formed on each side of three short single branches inferiorly, and the two lateral formed of two branches. The lateral saddle is narrower and deeper than the siphonal, and festooned into folioles which are unequally divided by a projecting process, the innermost being the larger of the two groups. The lateral lobe has three unequal branches, the terminal being sharply pointed. The auxiliary saddle is oblique, and formed of two unequal parts, the external being the larger.

I have found the Aptychus of this species in the body-chamber of a moderate-sized fragment (fig. 3); it has a central ridge, from which oblique lines contour the Aptychus, which was a thin structure with fine striations running in an opposite direction to the contouring lines of the lobe.

This Ammonite attains a considerable magnitude. I have collected many fragments, which indicated a shell at least 200 millimètres in diameter. The very small amount of the involution of this species accounts for the fragmentary condition in which it is found, seeing that the volutions have a very feeble support from the turns of the spine.

Affinities and Differences.—This species very much resembles *Aeg. Maugenesti*, found with it in the same bed. It is distinguished from that species by its more compressed shell and its carina, by its ribs limited to the middle of the whorl, and by the two tubercles between which the ribs are limited. These two Ammonites are certainly very nearly allied, although they are distinct.

Locality and Stratigraphical Position.—I have collected this species from the Middle Lias of Leckhampton, near Cheltenham, associated with *Aeg. Maugenesti*, *Aeg. Ibex*, and *Aeg. Loscombi*; and it is found in the same horizon in Somersetshire.

Foreign Distribution.—In the Middle Lias of France at Saint Amand, Cher; at Atys and at Maltol, near Caen, Calvados; Venarey, near Semur, Côte-d'Or; near Avallon, Yonne; Saint Fortunat, La Pointe d'Orchex, Rhône; Somme-Thonne, Luxembourg.

Germany, Middle Lias, Kahlefeld; in Swabia it is associated with *Aeg. Ibex* and *Aeg. Maugenesti*, as near Cheltenham. A beautiful specimen (Pl. LXIX, figs. 2, 3, 4) from the Middle Lias of Würtemberg is here figured.

Aegoceras Maugenesti, *d'Orbigny*. Pl. XXXVII, figs. 1, 2.

Ammonites Maugenesti, *d'Orbigny*. Pal. Franç.; Terr. Jurrass., t. i, p. 254, pl. 70, 1842.
— Maugenestii, *Quenstedt*. Cephalopod., p. 99, tab. v, fig. 1, 1849.
— Maugenesti, *Oppel*. Mittl. Lias Schwabens, p. 77, tab. 2, fig. 3, 1853.
— — *Oppel*. Jura-Formation, p. 160, 1856.
— — *Von Hauer*. Cephalopod. Lias N.-O. Alpen, Denk. Akad. Wissen., p. 53, tab. xvi, figs. 7—9, 1856.
— Maugenestii, *Quenstedt*. Der Jura, p. 132, tab. xvi, fig. 5, 1858.
— Maugenesti, *Dumortier*. Dépôts Jurass. du Rhône, vol. iii, p. 69, 1869.
— — *Seebach*. Hannov. Jura, p. 82, 1864.
— — *Emerson*. Lias von Markoldendorf, Zeit. Deut. geol., p. 311, 1870.

Diagnosis.—Shell discoidal, depressed, sub-carinate; whorls slightly involute, compressed, and flattened on the sides, which are ornamented with from twenty to twenty-four distant equal-sized ribs, straight, erect, and terminating in a row of tubercles at the outer margin of the siphonal area, which is wide, obtuse, and angulated.

Dimensions.—Transverse diameter 58 millimètres; width of umbilicus 28 millimètres; height of the aperture 20 millimètres; width of ditto 18 millimètres.

Description.—The shell of the species very much resembles that of *Aeg. Valdani*;

the whorls between are broader and not so high; like it, however, it is depressed, discoidal, and slightly carinated, without a distinct keel; the sides of the whorls are flattened, and transversely ornamented with from twenty to twenty-four ribs, according to the age of the shell. They commence at a short distance from the spiral suture, and ascend radially straight to the margin of the siphonal area, where they terminate in small prominent tubercles (fig. 1). The area is ridged in the middle, and declines on each side at a low angle. The row of tubercles from the termination of the ribs bounds this region, which is a clear, angulated, and well-defined area (fig. 2). The spire is composed of compressed whorls, flattened on the sides and angular externally, with a sloping riser internally. The aperture is quadrate, compressed on the sides, and arched in the line of the area; the height is greater than the breadth, and it is wider near the spiral suture than toward the outer margin.

The lobe-line is extremely complicated. The siphonal lobe is about the same size as the principal lateral, and ornamented on each side with simple digitations, and two branches, of which the last is the most highly ramified. The siphonal saddle, much wider than the principal lateral lobe, is formed of two unequal branches; the internal is the larger, and is formed of three foliations. The principal lateral lobe divides into five branches, which are bifurcate or trifurcate, and unequally disposed. The lateral saddle is smaller than the siphonal, and divided into two unequal foliations; the internal is the larger and formed of three foliations. The lateral lobe is oblique, and furnished with four unequal branches. The auxiliary saddle is small, and formed of three leaves, and there are two or three small additional oblique auxiliary lobes.

Affinities and Differences.—This species very much resembles *Aeg. Valdani;* it is, however, a thicker shell, and the whorls are wider and not so high as in that species. It has only one row of tubercles on the sides, and the ribs are straighter, more erect, and prominent, and arise much nearer the spiral suture than in *Aeg. Valdani.* The lobe-line differs, likewise, in its style of ramification; the aperture is wider, more angular, and narrower near the spiral suture than at the outer margin, the opposite to the form and dimensions that prevail in *Aeg. Valdani.* It much resembles some of the young shells of *Arietites Sauzeanus* from the *Ariet. Bucklandi-beds* of the Lower Lias; the absence of a keel and the ribbing on the siphonal area clearly distinguish the two shells from each other. It resembles *Aeg. brevispina* in some respects; still the absence of a carina in that species affords a diagnostic character between them.

Locality and Stratigraphical Position.—I have collected this Ammonite from the zone of *Aegoceras Ibex* in the brick-pits of the Middle Lias at Leckhamptom, near Cheltenham, associated with *Aeg. Valdani*, *Aeg. Loscombi*, and *Aeg. Ibex.* It has been found in the same horizon at Munger, near Radstock, by Mr. Tawney, F.G.S.; in the *Aeg. Jamesoni-* and *Ibex-beds* at Fenny Compton by Mr. Beesley, F.G.S.; in beds of the same age near Ilminster, Somersetshire, by Mr. Chas. Moore, F.G.S.; and between Lyme Regis and Charmouth, Dorset, associated with *Aeg. Loscombi*, by several collectors.

In France it is found at Coutards, near St. Amand, Cher; at Evrecy and at Curcy, Calvados; and near Semur, Côte d'Or. In the Middle Lias at Ofterdingen, Germany.

AEGOCERAS BREVISPINA, *Sowerby*. Pl. XXXII, figs. 2, 3, 4; Pl. L, figs. 13, 14.

AMMONITES BREVISPINA, *Sowerby*. Min. Conchology, vol. vi, p. 106, tab. 556, fig. 1, 1827.
— NATRIX, *Zieten*. Versteinerung Württembergs, p. 5, tab. iv, fig. 4, 1830.
— — ROTUNDUS, *Quenstedt*. Cephalopoden, p. 85, t. iv, fig. 17, 1849.
— LATÆCOSTA, *Quenstedt*. Ibid., t. iv, fig. 15, 1849.
— BREVISPINA, *d'Orbigny*. Pal. Franç. Terr.; Jurass., t. i, p. 272, pl. 79, 1842.
— — *Simpson*. Fossils, Yorkshire Lias, p. 69, 1855.
— — *Wright*. Quart. Journ. Geol. Soc., vol. xiv, p. 28, 1858.
— — *Schlönbach*. Eisenstein d. Mittl. Lias; Zeitschr. Deutsch. geolog. Gesellsch., p. 517, Jahr 1863.
— — *Dumortier*. Dépôts Jurass. du Bassin du Rhône, vol. iii, p. 97, 1869.
AEGOCERAS BREVISPINUM, *Tate and Blake*. Yorkshire Lias, p. 280, 1876.

Diagnosis.—Shell discoidal, depressed; whorls slightly involute, flattened on the sides, and ornamented with blunt, narrow, oblique ribs, on which two small tubercles are developed, one near the spiral suture, and one near the margin of the area, with wide, concave spaces between the ribs; siphonal area narrow, convex, and crossed by a transverse extension of the ribs between the marginal tubercles; lobe-line extremely complicated; aperture oblong, with vertical sides and convex outer surface.

Dimensions.—Transverse diameter 93 millimètres; width of the umbilicus 50 millimètres.

Description.—This is a very rare Ammonite in the English Lias, and the typographical error in the lettering of Sowerby's plate has created much confusion anent the identification of the shell he called *A. brevispina*, for the text and the numbering of Pl. 556 do not agree. Fig. 1 in Sowerby's plate 556 represents *Am. brevispina*, Sow., and fig. 2 in same plate, *Am. latæcosta*, Sow. The numerals have been reversed in error.

I have had Sowerby's original type specimens redrawn in Pl. XXXII of this work in order that the doubt and confusion may be removed. On comparing the type fragments of *Aeg. brevispina* with *Am. natrix*, Zieten, from the Middle Lias of Balingen, Swabia, I find them to be identical; the spines on the ribs nearest the spiral suture are nearly obsolete, and those at the margin are short and well-developed processes, characterised by the specific name *brevispina*. The type specimen was collected by the late Sir Roderick Murchison from the Middle-Lias Shales at Pabba; and I have had another specimen sent me by Professor Geikie, F.R.S., for determination, collected by him from the Middle Lias Pabba.

The specimen figured in Plate L, figs. 13 and 14, was collected by the Rev. J. E. Cross, F.G.S., from the *Aeg. Jamesoni*-beds of Robin Hood's Bay. In this specimen the sides of the whorls are much flattened, and each small, oblique, forward-directed rib carries two small tubercles; the spire is so slightly involute that both tubercles are visible on the sides in all the six turns of the spire. The siphonal area of this specimen, shown in fig. 14, exhibits a convex surface crossed at intervals by the ribs which stretch transversely from one tubercle to the other. The intermediate concave valleys are smooth and without ornament. The lobe-line is very complicated (Pl. XXXII, fig. 4). The siphonal lobe is shorter and wider than the principal lateral, and ornamented on each side with four branches, each many-digitate. The siphonal saddle is as large as the principal lateral lobe and divided into two equal foliations by a projecting process. The principal lateral lobe has a very irregular figure provided with three large ramified terminal branches and several small upper ones. The lateral saddle smaller than the siphonal is divided into two unequal foliations, of which the internal is the larger. The lateral lobe and the auxiliary lobes are small and very oblique, the whole forming a highly complicated structure.

Affinities and Differences.—This species resembles *Aegoceras Valdani* and *Aeg. Birchii* in having two rows of spines upon the lateral ribs of its shell. It differs, however, from *Aeg. Valdani* in possessing a round siphonal area, crossed by folds and depressions, and a more simple lobe-line; and from *Aeg. Birchii* in having flatter ribs, smaller tubercles, a narrower siphonal area and wider folds thereon, and in possessing a much less complicated style of lobe-line.

Locality and Stratigraphical Position.—It occurs in the Middle Lias of Pabba in the *Jamesoni*-zone, likewise in the same horizon at Robin Hood's Bay, Huntcliff, and Normanby, Yorkshire. The specimens figured Pl. L, figs. 13, 14, came from Robin Hood's Bay.

Foreign Distribution.—In France it is found at Saint-Christophe, Saône-et-Loire; Saint-Amand, Cher. In North Germany it is the associate of *Aegoceras Jamesoni* in all the localities that I have noted for that Ammonite. In South Germany it occurs at Gammelshausen, Hechingen, and Balingen.

Fourth Section.—Involuti.

Aegoceras pettos, *Quenstedt*. Pl. XXXVII, figs. 5—7, Pl. LXIX, figs. 5—6.

Ammonites crenatus, *Zieten*. Versteinerung. Württembergs, p. 1, tab. i, fig. 4, 1830.
— pettos, *Quenstedt*. Flözgebirge Würtembergs, p. 178, 1843.
— Grenouillouxi, *d'Orbigny*. Paleontol. Française; Terr. Jurassique, tome i, p. 307, pl. 96, 1842.
— pettos, *Quenstedt*. Die Cephalopod., p. 179, tab. 14, fig. 8, 1849.
— — *Oppel*. Mittlere Lias Schwab., Jahr. Wurtt., p. 93, 1853.
— — *Oppel*. Die Juraformation, p. 165, 1856.
— — *Schlönbach*. Eisenstein d. Mittl. Lias, Zeitsch. Deutsch. geol. Gesell., p. 527, 1863.
— — *Beesley*. Lias of Fenny Compton, Proceedings Warwick. Nat. Field Club, p. 16, 1877.
Aegoceras — *Neumayr*. Zeitschrift der Deutsch. geol. Gesellsch., p. 906, 1875.
— Grenouillouxi, *Tate and Blake*. Yorkshire Lias, p. 280, 1876.

Diagnosis.—Shell discoidal, depressed; umbilicus narrow, deep; whorls half involute, sides ornamented with twenty-five short, oblique, mucronated ribs; from each tubercle three transverse striæ proceed across the siphonal area, which is wide, depressed, slightly convex, and without a carina; aperture depressed, narrow in the vertical, wider in the transverse diameter.

Dimensions.—Transverse diameter 33 millimètres; width of umbilicus 15 millimètres; height of aperture 8 millimètres; transverse diameter 15 millimètres; amount of involution one half the height of the whorl.

Description.—This is a very rare fossil in the Middle Lias of England, although a very common Ammonite in the Numismalismergel of Germany, and of the Lias moyen of France. The shell is discoidal, compressed, and with a very deep umbilicus; from the spiral suture a series of short, oblique, regular ribs proceed, which end about the middle of the whorl in a rounded tubercle on the mould, and a thorny spine when the test is preserved, from each tubercle a fasciculus of two or three striæ passes across the area and join those from the opposite side; the siphonal area is convex and depressed, and well defined by the oblique tubercles developed on the margin, from whence the fasciculi of transverse striæ proceed to unite with their fellows from the opposite side along the middle line of the area. The whorl is widest along the row of the mucronated ribs, whence it slopes sharply inwards towards the spiral suture, for this reason, the umbilicus is deeply concave; the line of the spiral suture lies outside the tubercles, and the umbilicus thus acquires an ornate appearance. The aperture is transverse, depressed, arched, and angular on the sides; the septa are symmetrical, and the lobe-line describes three lobes and three saddles. The siphonal lobe is wider, and as long as the principal lateral; it is ornamented on each side with four branches, of which the two superior form single points; the third has two, and the fourth four. The siphonal saddle is a little wider than the principal lateral lobe, its space is divided laterally into wide leaves, and terminates in one bi-lobed and two tri-lobed folioles. The principal lateral lobe is outwardly formed of three digitations, and internally of six unequal processes, and terminates in one long digit. The lateral saddle, one third wider than the principal lateral lobe, divides into two nearly equal-sized leaves, each formed of three folioles. The small lower lateral lobe has an irregular figure, one long lateral digit is directed inwards, and there are two small laterals on each side and a long terminal process. The auxiliary saddle, half the size of the lateral, is divided into two portions; the small auxiliary lobe is oblique, and formed of a single digitation.

Affinities and Differences.—This shell very much resembles *Stephanoceras Blagdeni*, Sow., figs. 157, 158, p. 251, from the Inferior Oolite. In the breadth of the whorls it is a very variable species; the marginal tubercles are also always more or less approximated, and the transverse striæ across the siphonal area are not by any means constant as regards number and elevation. It cannot be mistaken for any other shell in the Middle Lias, as its specific characters are so prominent and well developed.

Locality and Stratigraphical Position.—It has been collected from the *Jamesoni* beds at Fenny Compton, Warwickshire; Munger and Paulton, Somerset; and Robin Hood's Bay, Yorkshire.

In France it is rare at Coutards près St. Amand-Montrond, Cher; Avallon, Yonne.

In Germany it is found in the *Jamesoni*-bed at Ofterdingen and Gammelshausen.

I have several specimens from the Numismalismergel at Riederich near Metzingen and . One of these is figured Pl. LXIX, figs. 5, 6.

AEGOCERAS GAGATEUM, *Young and Bird.* Pl. XXXVII, fig. 8, 9.

AMMONITES GAGATEUS,		*Young and Bird.*	Yorkshire Coast, 2nd ed., p. 255, pl. xii, fig. 7, 1828.
—	—	*Simpson.*	Monograph on the Ammonites of the Yorkshire Lias, p. 13, 1843.
—	—	—	Fossils of the Yorkshire Lias, p. 45, 1855.
—	NEGLECTUS,	—	Ibid., p. 45, 1855.
—	INTEGRICOSTATUS,	—	Ibid., p. 46, 1855.
—	CERCUS,	—	Ibid., p. 47, 1855.
—	ILLATUS,	—	Ibid., p. 39, 1855.
AEGOCERAS GAGATEUM,		*Tate and Blake.*	Yorkshire Lias, p. 275, 1876.

Diagnosis.—Shell discoidal, depressed; umbilicus wide, whorls round, inner margin rather prominent ; ribs sharp, annular, elevated, inclined backwards, separated by wide deep, concave spaces ; siphonal area convex, each rib as it passes across the area has a slight elevation at the middle with an elevated line on the concave surface ; aperture roundish, depressed, widest in the transverse diameter.

Dimensions.—Transverse diameter 37 millimètres ; width of the umbilicus 20 millimètres ; height of the aperture 10 millimètres ; transverse diameter 11 millimètres.

Description.—This rare and beautiful little shell has sharp, elevated, and very prominent ribs, as each of these passes over the siphonal area it is slightly thickened and raised in the centre ; the ribs are separated by concave spaces, the whorls being narrower on the sides than on the area ; they diminish very gradually and regularly, " the smaller whorls showing their prominent ribs like rows of jet beads ;" hence Young called it *gagateus ;* the ribs on the sides first incline backwards and afterwards arch forward before they cross the siphonal area.

This Ammonite resembles *Aegoceras planicosta* and *Aeg. capricornus,* but is very distinct from both, and has a life in time intermediate between these two well-known forms. The ribs are very prominent and the inner edge of the whorls much elevated, sometimes overhanging the line of the spiral suture ; the whorls being only slightly involute ; the spire is occasionally one-sided and a little distorted, when it very much resembles *Turrilites Coynarti*, d'Orbigny.

Affinities and Differences.—This species occupies an intermediate position in structure between *Aegoceras planicosta* and *capricornus.* It wants the flattening of the ribs seen in *Aeg. planicosta,* where they cross the siphonal area, and the spines which are developed on their sides. The sharpness, narrowness, and elevation of the ribs distinguish it from *Aeg. capricornus*, which it otherwise very much resembles.

Locality and Stratigraphical Position.—Young's type specimens were collected from the hard bands in the Alum-shale of the Hawsker shore. Tate and Blake state that they obtained it from the zone of *Ammonites oxynotus,* of which it is highly characteristic, at Robin Hood's Bay, Warter, and Market-Weighton. It appears to be absent from the Lower Lias beds of the Midland Counties.

Aegoceras latæcosta, *Sowerby.* Pl. XXXII, fig. 1.

Ammonites latæcosta, *Sowerby.* Min. Conch., vol. vi, p. 106, pl. 556, fig. 2, 1827.[1]
— brevispina, *d'Orbigny.* Pal. Franç. Terr. ; Jurass., vol. i, p. 272, 1842.

Diagnosis.—Shell discoidal, compressed, radiated ; whorls five, exposed ; radii large, sharp, slightly waved, much flattened and widened as they pass over the rounded front ; aperture oblong.

[1] In Sowerby's description of his plate 556 *for* fig. 1 *read* fig. 2.

Description.—The above diagnosis and the following description are in Sowerby's own words:—"The flattened sides of this Ammonite distinguish it from the young state of *A. planicosta* independently of its much larger size. When young neither has any appearance of spines; when old the last whorl of the *latæcosta* has only slight indications of tubercles, which consist of two small knots upon each ray on each side. The *planicosta* has one large spine in place of two, and that only upon some of the rays. A Lias fossil. All the specimens I have seen except one are from the alluvium; that one is from Lyme; it is about three inches and a half in diameter, and was liberally presented by Mrs. Murchison. One specimen, nearly four inches in diameter, shows the little knots upon the rays; it is in the collection of W. Peete, Esq., of Dartford. Several small ones have been found by Miss Baker, of Braunston, in what is called a gravel-pit."

Having examined the original Sowerbyan type of *latæcosta*, and compared it with other Ammonites from the same Green Ammonite-bed, I am prepared to state that *latæcosta*, Sow., is the middle-age condition of *Aegoceras Henleyi*, which I shall describe in the following article. As this statement may excite doubts in the minds of some persons, I have taken the precaution to have Sowerby's type shell, now in the British Museum, drawn, Pl. XXXII, fig. 1; and I have quoted *in extenso* Sowerby's own words, viz. those he had written on the subject; for nothing is so difficult to eradicate as our early notions, whether true or false, of the specific forms of organic bodies.

AEGOCERAS HENLEYI, *Sowerby*. Pl. XXXIII, figs. 1, 2, and 3.

AMMONITES HENLEYI, *Sowerby*. Mineral Conchology, vol. ii, p. 161, tab. 172, 1817.
— HENLEYI, *Reynès*. Géol. et Paléontol. Aveyronnaises, p. 88, pl. i, fig. 2, 1868.
AEGOCERAS — *Tate and Blake* (pars). Yorkshire Lias, p. 281, 1876.

Diagnosis.—Shell with external whorl inflated, internal whorls discoidal and compressed; composed of six volutions, all exposed; inner whorls with simple, obtuse, annular ribs, separated by concave valleys, the ribs flattened as they pass over the siphonal area; part of the outer whorl much expanded, and ornamented with numerous fine, narrow ribs on the sides, which split up beyond the outer tubercles into two or three branches, before they pass across the area; all the ribs have two tubercles more or less developed, and very prominent on those of the last whorl; aperture large, oblong, without processes.

Dimensions.—Transverse diameter 135 millimètres; width of the umbilicus 55 millimètres; height of the aperture 55 millimètres; transverse diameter 50 millimètres.

Description.—Much confusion has long existed regarding the natural history of this Ammonite, so much so that nearly all the authors have mistaken *Aegoceras striatum*

Reinecke, for *Aeg. Henleyi*, Sowerby, although the two fossils are sufficiently distinct from each other, *Aeg. striatum* having large, highly involute whorls, a narrow umbilicus, with a constant uniform growth and ornamentation, whilst *Aeg. Henleyi* has a slightly involute shell with a wide umbilicus, and changes its outward whorl in a remarkably sudden manner at about its sixth volution. In this stage of its growth it much resembles *Aeg. striatum;* and, as the inner whorls are seldom preserved with the outer whorl in consequence of the evolute character of the shell, the two species have been usually grouped together and known in most works as *Aeg. Henleyi*, whilst Reinecke's capital species has been entirely lost sight of.

In early age this Ammonite has a compressed discoidal shell, with slightly involute whorls, flattened on the margin, and ornamented with simple, obtuse ribs on the sides, each having two small tubercles; the inner row very small, the outer row larger, and both can be detected with the finger when they are seen with difficulty. From the outer tubercles the rib forms a prominent arch over the siphonal area with deep valleys between. In this condition it is figured and described as *Aeg. latæcosta.* In the adult state the shell is entirely transformed by the sudden enlargement of the body-chamber (fig. 2), the ribs of which become much smaller and more numerous, and the two rows of tubercles are enlarged and form conspicuous objects in the ornamentation of the shell; those of the inner row remain small, and those of the outer row grow more elongate; and from each the rib splits into two or more branches before it crosses the wide siphonal area, which region is thus highly sculptured by the numerous fine lines that traverse it from side to side (fig. 3). A change of form in the morphology of the shell is observed in most Ammonites at different periods of their lives, as we have seen in *Aeg. planicosta*, *Aeg. biferum*, and others; but in none is the transformation scene so rapid and complete as in *Aeg. Henleyi*, and in a nearly allied form, *Aeg. heterogenum.* When examining my specimens many naturalists have remarked that they looked as if two different Ammonites had been joined together by mistake.

When Sowerby figured the specimen collected by Mr. Henley, it was only the body-chamber that was known, which forms the arc of a much larger circle than a corresponding fragment of *Aeg. striatum;* this important fact in relation to a specific character was overlooked, and its general likeness led to the belief in their identity; nor was it until the figured specimen was discovered that the difference became evident which exists between *striatum* and *Henleyi*.

The lobe-line is very imperfectly shown; the siphonal lobe is as long as the principal lateral, and divides into several small side digitations (fig. 1). The siphonal saddle is not shown. The principal lateral lobe has several small side and two long terminal branches. The lateral saddle is small, and so likewise are the lateral lobe and the auxiliaries.

The aperture is very large, in consequence of the rapid expansion of the body-chamber (fig. 2); it is arched above and flattened at the sides, and is apparently destitute of any lateral appendages.

Affinities and Differences.—In the young shell, *Aeg. latæcosta* resembles *Aeg. capricornus,* although the style of ribbing in the two shells is different; *Aeg. capricornus* has rounder whorls with simple obtuse ribs without spines. Compare Pl. XXXII, fig. 1, with Pl. XXXIV, fig. 1.[1] In both species it is the sixth whorl which becomes suddenly enlarged, *Aeg. latæcosta* becoming *Aeg. Henleyi,* and *Aeg. capricornus* evolving *Aeg. heterogenum.* No description can do justice to the remarkable morphological change effected in the sixth whorl of their shells, and so I have given good figures of the best examples I know, for it is very difficult to obtain a specimen of *Aeg. heterogenum* now on the Yorkshire coast, and it is equally rare to find one of *Henleyi* at Charmouth; in fact, the example I have figured in Plate XXXIII is the only one I know that shows the inner and outer whorls *in sitû,* as it lived in the Middle-Lias Sea.

Locality and Stratigraphical Position.—I have obtained all my specimens of *Aeg. Henleyi* from the Green Ammonite-bed, near Charmouth, where it is associated with *Aeg. Davœi, Aeg. Bechei, Lytoceras fimbriatum,* and *Phylloceras Loscombi;* for details of the petrology of this remarkable bed the reader is referred to p. 89. A portion of the shell is preserved on one of the whorls, where it is seen to be very thin, and many of the fine striæ which cross the area are only feebly impressed on the mould. In one large specimen with six whorls the *latæcosta* condition continues up to a diameter of 130 millimètres, whilst in a dwarfed shell with six whorls it continues to 70 millimètres, from which I infer that it is not the size of the shell, but the number of the whorls which indicates the age of the Ammonite, and determines the excessive development of the body-chamber of this remarkable Ammonite. *Aeg. Henleyi* appears to be a rare species in France. The late Dr. Reynès, who made the study of Lias Ammonites a speciality, knew only two specimens in the Aveyron, both of which had been collected from limestones of the Middle Lias at St. Jean-d'Alcapies in company with *Lytoceras fimbriatum,* Sow., *Aeg. Bechei,* Sow., and *Gryphæa cymbium,* the same associates with which it lies in the Green Ammonite-bed of the Dorsetshire coast.

AEGOCERAS CAPRICORNUS,[1] *Schlotheim.* Pl. XXXIV, figs. 1—8.

AMMONITES CAPRICORNUS, *Schlotheim.* Petrefaktenkunde, p. 71, 1820.
— MACULATUS, *Young and Bird.* Geol. Survey, p. 248, pl. xiv, fig. 12, 1822.
— — *Phillips.* Geol. of Yorkshire, pl. xiii, fig. 11, 1829.
— — *Quenstedt.* Cephalopoden, p. 85, tab. iv, fig. 7, 1849.
— — *Simpson.* York. Lias Fossils, p. 48, 1855.

As to the synonymy of this Ammonite, I may observe that Dr. K. Schlönbach made a very careful study of the Schlotheim Collection in the Mineralien-Kabinet of Berlin,

[1] In the explanation of Pl. XXXIV this species is termed in error *Aegoceras maculatum.*

and states that the name *Ammonites capricornus* was given by Schlotheim to a species, examples of which are there displayed from Whitby (England), and from Amberg and Heinberge near Göttingen (Germany). All the specimens which he saw with the ticket *Ammonites capricornus* undoubtedly belonged to the species which Professor Quenstedt in his works calls *Ammonites maculatus.*

Diagnosis.—Shell flattened and discoidal, whorls round and slightly involute; ribs annular, sharp, and bent towards aperture, with wide concave spaces between; siphonal area round, rib-arch prominent, with numerous striæ between; aperture circular; umbilicus wide.

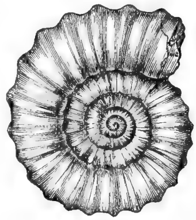


Fig. 189.—*Aegoceras capricornus*, Schloth.

Dimensions.—Transverse diameter 80 millimètres; width of the umbilicus 45 millimètres; height of aperture 25 millimètres; transverse diameter 22 millimètres.

Description.—This is a variable Ammonite as regards the form and size of the ribs, which are quite annular, thickened, and flattened where they pass across the siphonal area. After selecting from a number of specimens I consider the shell figured Pl. XXXIV, figs. 1, 2, 3, a good typical example, and in figs. 4, 5, 6 of the same, I have had a larger specimen delineated. Here we observe the outer whorl becomes greatly enlarged, and two rows of tubercles make their appearance with the commencement of the sixth whorl, whilst the annular ribs of its former condition have assumed a new livery. This is very well seen in the side view where the tubercles first appear, and the great enlargement of the last whorl is well expressed in fig. 6, where the ribs proceeding from the tubercles are seen to split, and the intermediate spaces are covered with transverse striæ.

The figures in this plate are arranged to show that *Aeg. capricornus* or *maculatum* as we usually meet with it, is the young form of a shell resembling *Am. hybrida* of d'Orbigny, figs. 4, 5, 6, and which in better developed specimens we shall find to be the true *Am. heterogenes* of Young.

Affinities and Differences.—The young form of this Ammonite resembles the specimen figured by d'Orbigny as *Am. planicosta,* which certainly is not the *planicosta* of Sowerby. I have already shown by the figures and description of *Aeg. capricornus* that it resembles, however, *Am. latæcosta,* Sow., whilst the round whorls, straight annular ribs without tubercles and circular mouth aperture, indicate close affinities with a nearly allied species.

Stratigraphical Position.—This is a very characteristic Ammonite of the zone in which it is found at the base of the *Amaltheus margaritatus* beds at Huntcliff, Robin Hood's Bay, Staithes, Coatham Scars, and Guisborough, Yorkshire Coast.

AEGOCERAS HETEROGENUM, *Young and Bird.* Pl. XXXV, figs. 4—6; Pl. XXXVI, figs. 1—4.

AMMONITES HETEROGENES, *Young and Bird.* Geol. Surv., p. 264, pl. xiv, fig. 7, 1828.
— HYBRIDA, *d'Orbigny.* Paléontol. Franç. Terr. Jurass., t. i, p. 285, pl. 85, 1842.
— — *Oppel.* Mittlere Lias Schwabens, Jahr. Würt., p. 53, pl. iii, fig. 3, 1853.
— HETEROGENES, *Simpson.* Fossils York. Lias, p. 69, 1855.

Diagnosis.—Shell irregular in form; whorls six, all exposed; inner whorls small, round, and slightly involute, with annular obtuse ribs; body-chamber greatly enlarged, forming the outer whorl; ribs more closely approximated, and having two rows of tubercles developed on each; from the outer marginal tubercle the ribs split up into two or three divisions, and cover the convex siphonal area with fine transverse striæ; aperture wide, oblong; lobe-line highly complicated.

Dimensions.—Transverse diameter 125 millimètres; width of the umbilicus 50 millimètres; height of the body-chamber 50 millimètres; height of penultimate whorl 20 millimètres; height of aperture 52 millimètres; width 50 millimètres.

Description.—This is another very remarkable Ammonite closely related to *Aeg. Henleyi*, like it the body-chamber in the sixth whorl becomes much expanded, and assumes a form and livery widely different from that exhibited in early life. It was well remarked of this species by the Rev. George Young, when he proposed the species, "that it is one of the most singular of all our Ammonites, the outer whorl of which has also two rows of knobs. The interior part of the shell is comparatively flat, with ribs rather prominent and flattened on the back, very much like those of *Am. maculatus;* near the outer whorl the ribs begin to have two slight knobs on the sides, and on that whorl the ribs grow depressed and the knobs elevated, making two prominent rows, as is sometimes the case in the outer whorls of the *Am. perarmatus* in the Oolite formerly noticed. But the most remarkable circumstance to be stated is, that the last part of the outer whorl suddenly swells to a great thickness, as if it had belonged to another shell; the difference being the more striking, as the ribs in this part, instead of being flattened on the back, are split into three at the outer row of the knobs. The mouth, as in the last species, is sub-heptangular. We may name this singular shell *Am. heterogenes.*"

Pl. XXXV, fig. 4, shows the side view of a small specimen. Here the two rows of tubercles are very prominent, the inner row being at some distance from the spiral suture, and the outer row near the margin of the area; the intervening ribs, fig. 5, show the front view of the tubercles: we observe also how the obtuse annular ribs are set widely apart on a whorl of moderate width with tubercles developed on the margin of the round area. In fig. 6 we note the sudden expansion of the body-chamber, the width of the siphonal area, the increasing prominence of the tubercles, and the ribs proceeding from them becoming split up into two or three divisions, thus covering the area with lines of transverse sculpture. In Pl. XXXVI, fig. 1, we have another specimen of still larger size collected in Robin Hood's Bay; here we observe a closer approximation of the ribs as they approach the aperture, and their comparative smallness when contrasted with those on the penultimate whorl. In fig 2 the thick obtuse ribs seen on the front view of this fossil, form a remarkable contrast to the narrow transverse ribs which regularly cover the wide convex siphonal area so well delineated in fig. 3 of the same plate.

The lobe-line is extremely complicated (fig. 4). The siphonal lobe is as long and wide as the principal lateral, and ornamented on each side with extended branches, of which two are transverse. The siphonal saddle as wide as the principal lateral lobe terminates in three foliations, of these the central is the largest, with a trifid foliole; the principal lateral lobe is highly ornate, with two large external and two small internal branches, and a long terminal ramified branch. The lateral saddle ends in two unequal foliations. The lateral lobe is small and divides into three digitations, and the auxiliary lobes are much smaller and end in single digits.

Affinities and Differences.—*Aegoceras heterogenum* very much resembles *Aegoceras Henleyi* in having a youthful form of shell entirely different from its adult condition, both having passed through a remarkable transformation in the figure and capacity of the body-chamber about the sixth volution of their growth. I have compared the two forms very closely with each other, and my specimens lead me to the conclusion that *Aeg. latæcosta*, the young form of *Aeg. Henleyi*, is distinct from *Aeg. capricornus*, the young condition of *Aeg. heterogenum*, and that the adult states of both species are evidently distinct from each other.

Locality and Stratigraphical Position.—This Ammonite is very rare on the Yorkshire coast; it is occasionally found at Huntcliff, and in Robin Hood's Bay in beds referred to the zone of *Aegoceras capricornus.* I have one example from a ferruginous shaly band, and another, figured in Pl. XXXVI, which I collected from the Marlstone of Yorkshire.

Aegoceras acuticostatum, *Wright*, nov. sp. Pl. XXXV, figs. 1—3, 7.

Diagnosis.—Shell discoidal, depressed; whorls rounded and slightly involute; sides ornamented with twenty-four sharp waved ribs, which pass round the margin and disappear from the middle of the siphonal area; umbilicus wide; inner whorls all exposed; aperture oblong.

Dimensions.—Transverse diameter 85 millimètres; width of umbilicus 33 millimètres; height of aperture 30 millimètres; transverse diameter 25 millimètres.

Description.—This is a very distinct form, which belonged to the cabinet of my late friend, Mr. J. Leckenby, F.G.S., and was collected from the *Aegoceras Jamesoni* beds of

Robin Hood's Bay; it very much resembles one of the forms of *Aeg. Jamesoni*, var. *sagittarium,* in the cabinet of the Rev. J. E. Cross, F.G.S., and may indeed prove to be such, but in the absence of more specimens for comparison I shall retain the name I gave it long ago.

It is a regular, well-formed Ammonite, with rounded whorls, which are only slightly involute. The ribs, which are sharp and narrow with a sigmoidal flexure, arise from a thickened root. At the spiral suture they wind up the side and over the margin (fig. 1), and vanish in the middle of the siphonal area (fig. 3), which is convex and smooth; near the turn of the penultimate whorl (fig. 2) the ribs are sometimes enlarged before they terminate, leaving only a narrow smooth space in the middle of the area. The umbilicus is wide, and the inner whorls are all fully exposed. The aperture is oblong and a little flattened at the sides.

The lobe-line (fig. 7) is apparently simple; the siphonal lobe is longer and wider than the principal lateral, and has a few digitations with two terminal points. The siphonal saddle is small and terminates in three small leaves. The principal lateral lobe is narrow and oblique with four digitations on each. The lateral saddle is wide and much larger than the siphonal, it terminates in three chief foliations and several smaller ones. The lateral lobe is larger than the principal lateral, with three lateral on each side and two terminal digitations. The auxiliary saddle has a foliated termination, and the auxiliary lobes are small with oblique digitations.

Affinities and Differences.—This Ammonite resembles some of the transition phases in the evolution of *Aeg. sagittarium.* I know of no other form with which to compare this Cephalopod, which remained long unnamed in my old friend's collection, and is now figured and described for the first time.

Aegoceras Portlockii, *Wright,* nov. sp. Pl. XLVIII, figs. 4, 5.

Diagnosis.—Shell discoidal, compressed, and carinated; whorls compressed, slightly involute, thicker at the spiral suture, and tapering towards the keel; sides ornamented with stout regular ribs, having a well-defined sigmoidal figure, and being well rounded throughout; carina stout, into which the ribs appear to blend, the space between the ribs concave and smooth.

Dimensions.—I have only the fragment of a whorl.

Description.—This fragment was collected by the Irish Geological Survey, and represents a form which I have from the *Aeg. Jamesoni* beds of Robin Hood's Bay. The whorls are wide and slightly involute; they are covered with strong, regular rounded ribs, having a sigmoidal flexure, and all obliquely placed at regular intervals apart, and concave intermediate spaces between them. The carina is thick and prominent, and the ribs, slightly enlarged before they terminate, appear to blend into the keel. The specimen is only a fragment of a whorl, and belongs to the Museum of the Irish Survey, Dublin. It was collected by the officers of the Irish Geological Survey, and was obtained from the *Aeg. Jamesoni*-bed of the Middle Lias at Carncastle.

This Ammonite is noted in General Portlock's 'Report on Londonderry,' p. 133, under the name *Ammonites radians*, Reinecke, and was found in a highly calcareous bed, approaching to impure grey limestone, at Carncastle, Ballygalley Head, County Antrim.

AEGOCERAS CARUSENSE, *d'Orbigny*. Pl. L, figs. 9, 10.

AMMONITES CARUSENSIS, *d'Orbigny*. Paléont. Franç. Terr. Jurass., t. i, p. 284, pl. 84, figs. 3—6, 1842.

Diagnosis.—Shell compressed, discoidal; whorls narrow, numerous, and slightly involute; sides depressed, and encircled by sharp, straight annular ribs; siphonal area convex, and crossed by transverse ribs; umbilicus widely open; aperture round.

Dimensions.—35 millimètres; width of the umbilicus 20 millimètres; height of aperture 4 millimètres; width 4 millimètres.

Description.—This elegant little Ammonite was collected in great numbers many years ago from the *Aeg. Jamesoni* beds near Cheltenham, associated with the young shells of *Aeg. densinodum*. I was long under the impression that it might be the young form of a larger Ammonite, still as I have never met with one larger than the figured specimen, which possesses its body-chamber, I have come to the conclusion that it is the complete Ammonite.

The shell is suborbicular and compressed; the whorls are very slightly involute, and often distorted, so that this Ammonite has been mistaken for a Turrilite. The whorls are rounded on the sides, and encircled by twenty-nine sharp, straight, annular ribs, which bend gently backwards where they cross the area; sometimes they are interrupted in their transit, but oftener they pass entire. This shell appears to undergo no change in the different phases of its life. The spire is formed of seven narrow, depressed whorls, uniformly ornamented with regular, straight, sharp ribs, and narrow, concave spaces between. The aperture is round and slightly compressed at the sides.

The lobe-line is very simple. The siphonal lobe is longer and wider than the principal lateral, with simple digitations on its margin. The siphonal saddle is twice the size of the principal lateral lobe, with four simple leaves at its termination. The principal lateral lobe is very small, with a few digits on its sides. The lateral saddle is large, ending in three irregular foliations. The lateral lobe is very short, and ends in three digits, and the auxiliary lobe has only a single point.

Affinities and Differences.—It resembles the young forms of *Aeg. densinodum*, which with age develops spines; this *Aeg. Carusense* never does. It is altogether a unique Ammonite from the basement bed of the Middle Lias.

Locality and Stratigraphical Position.—I have found this species in the *Aeg. Jamesoni* beds, Swindon Road, near Cheltenham.

AEGOCERAS SLATTERI, *Wright*, nov. sp. Pl. L, figs. 1—8.

Diagnosis.—Shell discoidal, depressed; whorls high, two thirds involute; sides ornamented with thick, obtuse, curved ribs, which alternate with concavities of the opposite side; siphonal area convex and smooth, the knobs of the ribs alternating on the margin; aperture oblong, narrow.

Dimensions.—Transverse diameter 55 millimètres; width of the umbilicus 15 millimètres; height of aperture 23 millimètres; transverse diameter 13 millimètres.

Description.—This singular Ammonite was collected by my friend Mr. T. J. Slatter, F.G.S., of Evesham, from the Lias of Broughton, near Pershore. The specimens are all fragmentary, and therefore I describe it with some hesitation; the shell is discoidal and much compressed; the whorls high and quite one half involute (fig. 1); the sides ornamented with bent, obtuse, recurved ribs, which thicken out into knobs at the margin of the siphonal area; the ribs on the right side of the shell correspond to concavities on the left, so that the costæ on the right and left sides alternate with each other, which becomes very obvious when we examine the specimens (figs. 2, 4, 5). In early life the shell appears to have resembled an *Amaltheus*, and had a small carina in the centre of the area (figs. 6, 7), which carina appears to be covered over by the future whorl as in fig. 3, and to be indicated in fig. 4. The thin shell is only partially retained on a portion of some of the fragments. In the larger segments the siphonal area is rounded and marked by transverse lines, and the terminal knobs of the ribs form conspicuous objects in the specimen delineated in fig. 5.

The lobe-line (fig. 8) is very simple. The siphonal lobe is about the size of the principal lateral with three lateral digitations on each side, and a single terminal point. The siphonal saddle is wide and deep and terminates in three principal foliations. The principal lateral lobe is nearly as long and a little wider than the siphonal, and has three lateral digitations on each side, with a bifid termination. The lateral saddle in size and structure very much resembles the siphonal, and has four terminal folioles around its termination. The lateral lobe is smaller than the principal lateral, the outer margin is serrated, and its terminal portion bushy. The auxiliary lobe is very small and simple.

Affinities and Differences.—The style of the ribs in this species has no parallel among the Lias Ammonites; at first I thought it might be an accidental monstrosity or an acquired alternate character of ribbing from descent, as all the specimens hitherto found possess the alternation of the ribs on the two sides of the shell. Until more specimens are found I must treat it as a distinct species, and dedicate it to my friend whose industry disinterred it and brought it under my notice.

Stratigraphical Position.—Mr. Slatter found it in the Lias beds at Drake's Broughton, near Pershore, Worcestershire, where it was associated with the following list of fossils which he has kindly contributed.

List of Fossils from the Lower and Middle Lias, Broughton, near Pershore.

Cephalopoda.

Aegoceras Slatteri, Wright.
— *sagittarium*, Blake.
Amaltheus oxynotus, Quenst.
— *Simpsoni*, Bean.
Phylloceras Loscombi, Sow.
Phylloceras Salisburgensis, Von Hauer.
— *Nodotianus*, d'Orb.
Belemnites brevis secundus, Quenst.
— *acutus*, Mill.
Nautilus striatus, Sow.

Gasteropoda.

Cerithium rotundatum, Terq.
— *Collenoti*, Terq. et Piette.
Chemnitzia crassissima, Tate.
Dentalium minimum, Strickland.
— *elongatum*, Münst.
Pleurotmaria foveolata, Deslong.
Trochus Thetis, Münst.
Actæonina secale, Terq.
— *fragilis*, Dünk.
— *striata*, Terq. and Piette.
— *triticum*, Terq.
Turbo admirandus, Tate.
— *solarium*, Terq. and P.

Lammellibranchiata.

Macrodon numismalis, Tate.
— *intermedius*, Simp.
Astarte amalthei, Quenst.
— *cingulata*, Terq.
Avicula cuneata, Terq. and Piette.
— *inæquivalvis*, Sow.
Cardinia hybrida, Stutch.
— *crassissima*, Stutch.
Cardita multicostata, Phillips.
Hippopodium ponderosum, Sow.
Leda acuminata, Goldf.
Nucula inflexa, Quenst.
— *Galathæa*, d'Orb.
Nucula variabilis, Sow.
— *navis*, Piette.
— *cordata*, Goldf.
Leda Renevierei, Oppel.
Mytilus numismalis, Oppel.
Protocardium oxynoti, Quenst.
— *truncatum*, Sow.
Ostræa arcuata, Lamark.
Plicatula, sp.
Limæa acuticosta, Goldf.
Lima gigantea, var. *minima*, Sow.
Pecten calvus, Goldf.

Brachiopoda.
Rhynchonella variabilis, Schloth.

Annelida.
Ditrypa quinquesulcata, Münster.

Crinoidea.
Pentacrinitis scalaris, Goldf.

Aegoceras polymorphum, *Quenstedt.* Pl. XL, figs. 1—3.

Ammonites polymorphus,	*Quenstedt.*	Cephalopoden, p. 86, tab. iv, fig. 13, 1849.
— — lineatus,	—	Der Jura, p. 128, tab. xv, fig. 14, 1858.

Diagnosis.—Shell discoidal, compressed, with numerous—about seven—whorls, which are slightly involute, and have their sides covered with innumerable fine hair-like striations, which arise above the spiral suture and ascend obliquely forwards towards the siphonal area, over which they pass and join the striæ from the opposite side. Shell extremely thin, leaving all the markings on the mould; body-chamber occupies nearly an entire whorl.

Dimensions.—Transverse diameter 45 millimètres; width of the umbilicus 22 millimètres; height of the aperture 15 millimètres; transverse diameter 9 millimètres.

Description.—This is a very difficult fossil to determine, as the specimen is badly preserved, and is the only one that has been found. I have, however, put it well together, and enlarged the drawing two diameters; the shell is in part existing, and is extremely thin. The whorls are only slightly involute, and have their sides ornamented with numberless fine striations, which arise above the spiral suture and are directed obliquely forwards towards the aperture; they all pass over the siphonal area, forming a series of little ridges there; the body-chamber occupies nearly an entire whorl, judging from the portion that remains and what is lost.

The aperture is oblong, arched above, and flattened at the sides; there does not appear to have been any lateral processes; the mouth aperture corresponding with the oblique sweep of the hair-like ribs.

The lobe-line is not complicated, and resembles the style of *Aeg. Jamesoni.* The siphonal lobe (fig. 3) is narrow, and as long as the principal lateral lobe. The siphonal saddle is wide, and ends in four foliations. The principal lateral lobe is long, and has several lateral and two terminal branches, both of which have trifid processes. The lateral saddle is smaller than the siphonal, and ends in one large internal and two smaller external foliations. The lateral lobe is very small and ends in three points.

Affinities and Differences.—This Ammonite so closely resembles *Am. polymorphus lineatus,* Quenstedt, that after much consideration I have determined to treat it as such, although I confess my disinclination to decide species upon such insufficient evidence as this specimen affords; should other examples in better preservation be found the name may either be retained or another specific appellation given. The *Polymorphi*, according to Quenstedt, exhibit many varieties, as shown in *P. lineatus*, *P. costatus*, *P. interruptus*, *P. mixtus*, and *P. quadratus*, and so for the present, I have considered this species as one of the group.

Locality and Stratigraphical Position.—Found in the Middle Lias of North Lincolnshire by the Rev. J. E. Cross, F.G.S., to whose cabinet it belongs.

AEGOCERAS CURVICORNE, *Schlönbach*. Pl. XXXI, figs. 3 and 4.

AMMONITES CURVICORNIS,	*Schlönbach.*	Eisenstein des Mittl. Lias, Zeitsch. Deutsch. geol. Ges., Bd. xv, p. 522, pl. xii, fig. 4, 1863.
— MACULATUS ANGULATUS,	*Wagener.*	Liasschichten Thalmulde Rheinl. Westphal. Verhandl., p. 166, 1860.
— CURVICORNIS,	*Schlönbach.*	Beiträge zur Palæontologie der Jura-Form. Palæontographica, p. 163, 1865.

Diagnosis.—Shell discoidal, compressed, with six round, bold-ribbed, slightly involute whorls; sides ornamented with fifteen thick prominent ribs, which support two thorn-like spines, the ribs and costæ separated by wide concave valleys covered with striæ; siphonal area wide and convex; thick ribs arched forwards, passing across from the marginal tubercles; concavities deeply sculptured with fine bent striæ; aperture round.

Dimensions.—Transverse diameter 80 millimètres; width of the umbilicus 40 millimètres.

Description.—I have long known this Ammonite from the Green Ammonite bed of Charmouth, and at one time inclined to the opinion that it was a distinct species, until an example showing the transition to an enlarged body chamber at the same age as in *Aeg. Henleyi* was found; this led to a restudy of the series, and the conclusion that *Aeg. curvicorne* is an extreme form of *Aeg. latæcosta*, having round, depressed whorls, with extremely sharp ribs and prominent thorn-like spines, and that on attaining the sixth volution of its spire it commences the expansion and enlargement of the body chamber.

Among the group of specimens of *Aeg. capricorne* in the Berlin Museum, V. Schlotheim has distinguished by distinct names the following varieties:—*a. Am. capricornis angulatus*; *b, Am. spathosis*; *c, Am. capricornis dorsuosus*; it is to the first of these varieties that Dr. Wagener has referred the fossil now under consideration, in this opinion I am inclined to concur, and regard *Aeg. curvicorne* as a marked variety of the early stages of *Aeg. Henleyi*, with depressed whorls, prominent ribs, and constricted spire; having the same expanded body chamber in the sixth volution of development as in the type form.

Affinities and Differences.—This fossil closely resembles some forms of *Aeg. capricornus* or *maculatum*, and may be only a variety with more pronounced characters of that species.

Locality and Stratigraphical Position.—This specimen was collected from the Middle Lias Limestone at Charmouth, where it appears to be rare.

AEGOCERAS STRIATUM, *Reinecke.* Pl. XLII, figs. 1—5.

NAUTILUS STRIATUS,		*Reinecke.* Naut. et Arg., No. 32, p. 85, pl. viii, figs. 65, 66, 1818.
AMMONITES HEPTANGULARIS,		*Young and Bird.* Yorkshire Coast, 2 ed., p. 263, pl. xiv, fig. 1, 1828.
—	STRIATUS,	*Zieten.* Versteinerung. Württemburgs, p. 7, tab. v, fig. 6, 1830.
—	CHELTIENSIS,	*Murchison.* Geol. of Cheltenham, 1st Edit., p. 19, 1834.
—	STRIATUS,	*Römer.* Nord-deutsch. Oolith-gebirg, p. 199, 1836.
—	—	*Bronn.* Leth. geog., p. 449, tab, xxiii, fig. 7, 1837.
—	—	*Quenstedt.* Flözgebirge, Würtembergs, p. 177, 1843.
—	—	— Cephalopoden, p. 135, tab. ix, fig. 24, 1849.
—	HENLEYI,	*d'Orbigny.* Paléontol. Française Terr. Jurass., p. 280, pl. lxxxiii, 1842.
—	—	*Simpson.* Fossils of the Yorkshire Lias, p. 70, 1855.
—	STRIATUS,	*Quenstedt.* Der Jura, p. 134, tab. xvi, figs. 9, 10, 1858.
—	—	*Dumortier.* Depôts Jurass. du Bassin du Rhone, III, p. 76, pl. xviii, fig. 1, 1869.
AEGOCERAS STRIATUM,		*Tate and Blake.* Yorkshire Lias, p. 281, 1876.

Diagnosis.—Shell inflated, whorls depressed, one half involute, sculptured with numerous delicate, longitudinal striations; outer whorl very thick; sides flattened and provided with two rows of tubercles; ribs arise near the siphonal suture, and unite in the inner row of tubercles; from thence sometimes one, sometimes two, short, straight, slender ribs proceed and unite in the second series of tubercles which bound the margin of the siphonal area; from each marginal tubercle nearly always two strong ribs proceed, which pass transversely across the area; umbilicus small, deep, and narrow; inner row of tubercles alone visible in the spiral volutions; aperture roundish or of a heptangular form.

Dimensions.—Transverse diameter 130 millimètres; width of the umbilicus 34 millimètres; height of the aperture 65 millimètres; transverse diameter 75 millimètres. The smaller specimen has the same relative proportions and dimensions.

Description.—I have already pointed out the error palæontologists have committed in confounding this shell with the true *Aeg. Henleyi*, Sow., although it had long ago been accurately described by the Rev. George Young in his 'Yorkshire Coast,' who says:

—"This is a rare and singular shell from the Hawsker shore, armed with a double row of spines placed on angular ridges on the sides. Between the two rows are irregular ribs, running from the inner knobs to the outer, and each generally splits into two elevated ribs on the back, partly fimbriated, whereas on the inner part of the whorl, within the interior row of knobs, the ribs are replaced by numerous slender striæ. The space between the rows is also slightly striated; the whorls are few, the outer being very large, and the central part forming a deep cavity or umbilicus; interior whorls are much concealed; the back is rounded, but seems to acquire an angle behind, near the aperture, which therefore approaches the heptangular. On account of this we may name this species *Am. heptangularis.*" It is very evident from this description that Young had clearly discerned the specific distinction between this shell and *A. Henleyi*, a difference which has been entirely overlooked by many subsequent authors. Sir Roderick Murchison, in his 'Geology of Cheltenham,' figured this fossil as *Am. Cheltienensis*, and subsequently d'Orbigny, in his 'Paléontologie Française,' gave a very fine figure of it under the name *Am. Henleyi*, whilst he correctly quoted Reinecke's figure and species, and erroneously confused it with Sowerby's *Henleyi* in his synonymy of the species.

The shell is largely inflated and ornamented longitudinally with innumerable small fine striations; the sides of the shell have throughout two rows of large tubercles, the inner row connected with the spiral suture by numerous fine striæ, and the outer with the inner row by short, straight, split ribs. The outer row of tubercles is developed on the margin of the siphonal area, and from each tubercle proceeds the strong band which passes across the area, and joins its fellow on the mesial line from the opposite side. The siphonal area is convex, depressed, and boldly sculptured with transverse bands and intermediate concave depressions. The outer whorl is very large, and nearly conceals the penultimate whorl, which is more than one half involute. The whorls in this Ammonite increase very rapidly in every dimension, and they consequently leave a narrow, deep umbilicus, in which less than half of the inner whorls are visible, the internal row of tubercles decorating the margin of the spire.

The lobe-line is very complicated. The siphonal lobe (fig. 5) is a little shorter and narrower than the principal lateral lobe, and ornamented with three branches. The siphonal saddle as wide as the principal lateral lobe, terminates in three foliations of oak-leaf forms. The principal lateral lobe terminates in three large branches, with lateral ramifications. The lateral saddle terminates in two unequal foliations. The lateral lobe is oblique, smaller than the principal, but has a similar figure. The auxiliary saddle has three contracted foliations, and the auxiliary lobe ends in several digitations.

The aperture is large, wide, and expanded, and has a rounded or a heptangular form.

This species assumes in early life the specific form and ornamentation I have described, and does not pass through any apparent metamorphoses so peculiarly characteristic of *Aeg. Henleyi* and *Aeg. heterogenum.* The longitudinal striations so distinctive of the species are found only in the structure of the shell, and are not observed on the mould, whilst the ribs and tubercles on the sides and siphonal area are distinctly visible throughout.

Affinities and Differences.—The outer whorl of *Aeg. striatum* resembles the body chamber of *Aeg. Henleyi*, but the inner whorls are quite distinct in form and structure in the two shells. The umbilicus is deep and narrow in *Aeg. striatum* and wide and open in *Aeg. Henleyi*, and the arc of the circle described by *Aeg. striatum* is that of a much smaller circle than the one which is represented by *Aeg. Henleyi*. The one Ammonite (*Aeg. Henleyi*) undergoes an important change of form about the sixth whorl of its age the other (*Aeg. striatum*) appears to retain its form and characters without much change through life.

Locality and Stratigraphical Position.—This appears to be a very abundant and leading Ammonite of the Middle Lias, with an extensive distribution in time and space. It is found in the *Henleyi* zone at Fenny Compton, Warwickshire; Radstock, Somersetshire; Lyme Regis, Dorsetshire; and Robin Hood's Bay, Yorkshire. In Gloucestershire it is found in the *Aeg. Henleyi* zone of the Cotteswolds Hills at Hewletts, near Cheltenham, Whitcombe, near Gloucester, and in other exposures of these beds.

Foreign Distribution.—In France the late Professor d'Orbigny noted this species at Saint Amand, Cher; Fontaine-Étoupe-Four, Croisilles, Curcy, Landes, Calvados; Breux, Meuse; Mulhausen, Bas Rhin; Pouilly, Semur, Venarey, Côte-d'Or; Avallon, Yonne; the late Mons. Dumortier cites Saint-Fortunat, Saint-Cyr, Saint-Diedier, Rhône; he collected a magnificent example, 190 millimètres in diameter, in a region where Jurassique fossils are little known, in the middle of France, at the foot of the Pyrenees, at Albas, Aude. In Germany the typical example figured by Reinecke was discovered in Coburg. In Swabia it is found pyritic, associated with *Amaltheus ibex* in the middle region of *Amaltheus margaritatus*, but it is not obtained from either higher or lower zones.

Aegoceras Bechei, *Sowerby*. Pl. XLI, figs. 1—5.

Ammonites Bechei, *Sowerby*. Mineral Conchology, vol. iii, p. 143, pl. 280, 1821.
— — *Zeiten*. Versteinerungen Württembergs, p. 37, tab. xxviii, fig. 4, 1830.
— — *d'Orbigny*. Paléontol. Française Terr. Jurass, t. i, p. 278, pl. lxxxii, 1842.
— — *Quenstedt*. Cephalopoden, p. 135, 1849.
— — *Von Strömbeck*. Obere Lias. Zeitschr. Deutsch. geol. Gess., v, p. 82, 1853.
— — *Simpson*. Fossils of the Yorkshire Lias, p. 70, 1855.

Diagnosis.—Shell globose, last whorl much inflated, highly involute, and entirely covered with fine longitudinal striations; sides ornamented with two rows of small tubercles united by short bifurcated ribs; from the outer row of tubercles bifurcate and trifurcate ribs proceed across the siphonal area. Passing over the sides and across the area many single ribs ascend between the tubercles. Siphonal area rotund and highly convex, beautifully sculptured with longitudinal striæ and transverse ribs; aperture widely expanded, a little flattened on the sides, and very convex externally.

Dimensions.—Transverse diameter, 120 millimètres; width of umbilicus, 10 millimètres; height of aperture, 70 millimètres; width of aperture, 70 millimètres; the smaller specimen has the same relative proportions.

Description.—This fine Ammonite has a very globose shell and greatly enlarged outer whorl; the sides between the two rows of tubercles are slightly flattened; the small ribs below are nearly straight, about two to each tubercle, with one between the tubercles; the umbilicus is deep and narrow, so that the spire is nearly entirely concealed. The longitudinal striæ are sharply defined and limited to the structure of the shell, being absent from the mould.

The siphonal area is rotund and very convex, from each tubercle of the marginal row, a bifurcate, and then a trifurcate, rib proceeds transversely across the area, with one or two single ribs between the bifurcations, these form a very regular series of transverse ribs with corresponding concavities between, the whole being intersected by numerous close-set, longitudinal striæ, which are extremely well defined in this species, and produce a highly ornate surface on the extremely convex siphonal area of its beautiful shell.

The aperture is as wide as it is high, and occupies more than half the diameter of the shell; it has a rounded figure, slightly flattened on the sides, corresponding with the depressed space between the lateral rows of tubercles. The lobe-line is extremely complicated and much resembles the lobe-line of *Aeg. striatum.* The siphonal lobe (fig. 5) is much shorter and narrower than the principal lateral, and ornamented on each side with three branches, of which the terminal one is bifurcate. The siphonal saddle is smaller than the principal lateral lobe, and terminates externally in three ramified foliations, and internally in one. The principal lateral lobe is large, formed of two branches on each side, and a long central branch with a bifurcate terminal digitation. The lateral saddle terminates in three foliations on each side. The lateral lobe has two external branches and one terminal digitation. The auxiliary saddle has three foliations. The auxiliary lobes, four in number, are all small and oblique, and gradually decrease in size from without inwards.

Affinities and Differences.—This species undoubtedly resembles *Aeg. striatum,* and by many continental authors is considered to be identical with it. Still I am satisfied the following differences are sufficiently permanent to justify their separation. In *Aeg. Bechei* the whorls are much more involute, and the umbilicus narrower and deeper than in *Aeg. striatum.* The tubercles, likewise, are smaller, the ribs much more slender, and the longitudinal striæ sharper and better defined than in the latter species. Herr

Köchlin Schlumberger[1] has, through a series of strict investigation of a quantity of material from Mende, Lozère, and Venarey, Côte d'Or, arrived at the conclusion that *Am. Henleyi* and *Am. Bechei*, as figured by d'Orbigny, do not belong to two different species, but constitute only varieties which, through transition forms, are completely united into one species. The two forms are bracketed together in the works of Quenstedt, Oppel, Dumortier, and by Professors Tate and Blake in their Yorkshire Lias. Still, notwithstanding these authorities, the fact remains that the two species lie close together in the same bed on the Dorsetshire Coast, without any transition forms uniting them.

Locality and Stratigraphical Position.—This Ammonite is found in the Upper Marls without mica, near Charmouth, Dorset, in which many specimens are found associated with *Lytoceras fimbriatum*, *Aegoceras striatum*, *Phylloceras Loscombi*, *Nautilus semistriatus*, &c. I have found a specimen in the Green Ammonite Bed of the same section above the marls in company with *Aeg. Davœi* and *Monotis inæquivalvis*. It likewise has been collected from the Middle Lias at Fenny Compton, Warwickshire, and in Northamptonshire, as well as in Robin Hood's Bay, Yorkshire, from the zone of *Aeg. capricornus*=*Aeg. Henleyi*.

Foreign Distribution.—In France it has been collected in the Middle Lias below the beds with *Gryphæa cymbium* at Saint-Rambert, Ain; at Courtards, near Saint-Amand, Cher; at Fresnay-le-Puceux, at Curcy, at Vieux-Pont, Calvados; at Semur and Venarey, Côte-d'Or; and Avallon, Yonne, by several distinguished palæontologists. Professor Quenstedt says Sowerby makes two species, *Am. Bechei* and *Am. Henleyi*, out of *Am. striatus*, observing "*Am. Bechei*, with its rounded back, finer ribs, smaller tubercles, and more rapid increase in thickness, is very often found in Würtemburg. Whilst *Am. Henleyi*, with its hexagonal mouth-opening, larger ribs, stronger tubercles, slower increase in thickness, and indistinct longitudinal striæ, lies deeper, and in Würtemberg is more rare." 'Cephalopoden,' p. 135.

Family.—ARCESTIDÆ,[2] *Mojsisovics*, 1875.

This interesting family, containing the genera *Arcestes*, *Didymites*, *Lobites*, *Ptychites*, *Pinacoceras*, *Sageceras*, *Amaltheus* and *Schloenbachia*, and comprising for the most part the first Ammonites that appeared in the Trias seas, has the ancient genus *Arcestes*, Suess, as its type. The shell is usually more or less globose, or has largely inflated sides, occasionally it is compressed and carinated; it is either smooth, or possesses an ornate surface, formed of transverse folds, costæ, or fine longitudinal striations. The lobe-line in *Arcestes* is very complicated and formed of many divisions, each having a central stem with short, transverse, and oblique digitations, the whole constituting most intricate folia-

[1] 'Bullet. Soc. Géol. de France,' Juin, 1854, p. 628.

[2] See page 238 of this Monograph.

tions on the mould. The body-chamber is long in the older forms, thus in *Arcestes* it is a whorl and a half, and in *Amaltheus* two thirds of a whorl in length. The mantle-impression in *Arcestes* has left deep constrictions around the aperture of the body-chamber, which are absent from the polythalamous portion of the shell.

Arcestes, Didymites, Lobites, Ptychites, Pinacoceras and *Sageceras*, are obtained only from the Trias; *Amaltheus* from the Trias, Lias, and Jurassic rocks, and *Schloenbachia* is limited to the Cretaceous formation.

Genus III.—AMALTHEUS. *Montfort*, 1808.

Genus—AMALTHEUS,	*Montfort.*	Conchyliologie Systematique, t. i, p. 91, 1808.
Family—AMALTHEI,	*von Buch.*	Ueber Ammoniten, Abh. Akad. Berlin, pp. 143, tab. 3, fig. 3, 1832.
—	*d'Orbigny.*	Paléontologie Française Terr. Crétacés, t. i, p. 407, 1840.
AMALTHEEN,	*Quenstedt.*	Cephalopoden, p. 92, 1849.
AMALTHEI,	*Giebel.*	Fauna der Vorwelt, b. iii, p. 537, 1852.
—	*Pictet.*	Traité de Paléontologie, 2nd ed., t. ii, p. 676, 1854.
—	*Seebach.*	Hannoversche Jura, p. 139, 1864.
OXYNOTEN,	*Beyrich.*	Ueb. Cephalopd. Muschelkalk. der Alpen, p. 136, 1867.
Genus—PLEUROCERAS,	*Hyatt.*	Bulletin Mus. Comp. Zool. Harvard Coll., p. 89, 1866.
AMALTHEUS,	*Hyatt.*	Ibid., p. 90, 1866.
—	*Mojsisovics.*	Jahrb. geol. Reichsanstalt, p. 580, 1869.
—	*Waagen.*	Palæontographica, b. xvii, p. 201, 1870.

This genus is characterised by having a compressed discoidal shell; the siphonal area narrow, sharp, and keeled; the ribs when present are all flexed forward and end in a keel or plaited ridge (fig. 190). The external shelly lamina in some species develops fine longitudinal spiral lines. The body-chamber is short, about one half to two thirds of a whorl. The mouth-border of the shell is simple, the ventral portion ending in a long projecting process. The lobe-line is extremely complicated and very difficult to trace. The siphonal lobe is shorter than the principal lateral, which is mostly broad and wedge shaped.

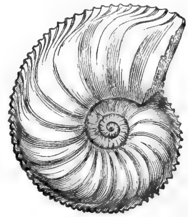


FIG. 190.—*Amaltheus cordatus*, Sow.

This genus presents three distinct types of shell form which appeared together about the same period of time, they are therefore not derived from each other, but descendants of different groups; the first of these has *Amaltheus Greenoughi* and *Amal. Guibalianus*, the second *Amaltheus oxynotus*, and the third *Amaltheus margaritatus* as their representatives.

Dr. Waagen states that a horny divided *Anaptychus* has been found in some species.

This genus has an extensive range in time. In the Trias is found *Amal. megalodiscus*, Beyrich, *Amal. Sansovinii*, Mojsisovics. In the Lias *Amaltheus Greenoughi*, Sow., *Amal. Guibalianus*, d'Orbigny, *Amal. oxynotus*, Quenst., *Amal. Lymensis*, Wright, *Amal. margaritatus*, Montfort, *Amal. spinatus*, Brug. In the inferior Oolite, *Amal. discus*, Sow., *Amal. Truelli*, d'Orbig. In the Oxfordian, *Amal. Chamusseti*, d'Orb., *Amal. cordatus*, Sow.

Amaltheus Greenoughi, *Sowerby*. Pl. XLIV.

Ammonites Greenoughi, *Sowerby*. Mineral Conchology, vol. ii, p. 71, tab. 132, 1816.
— — *De Haan*. Ammonit. et Goniatit., p. 131, 1825.
— — *Lonsdale*. Trans. Geol. Soc., 2nd series, iii, p. 272, 1832.
— — *Guidoni*. Boué Journal de Geologie, iii, p. 276, 1831.
— — *Morris*. Catalogue of British Fossils, p. 173, 1843.
— — *Giebel*. Fauna der Vorwelt, iii, p. 554, 1852.
— — *Studer*. Geologie der Schweiz, ii, p. 36, 1853.
— — *Von Hauer*. Deutsch. Akad. Wissenschaften Cephalopoden Nordöst. Alpen, p. 46, taf. xii, 1856.

Diagnosis.—Shell large, discoidal, compressed; whorls two-thirds involute, outer whorl slightly convex, obscurely undulated by sixteen to eighteen straight, nearly obsolete ribs; inner whorls with prominent costæ; mouth-aperture elliptical and deeply indented by the penultimate volution.

Dimensions.—Plate one half the natural size. Transverse diameter of the specimen 440 millimètres; width of the umbilicus 150 millimètres; height of the last whorl 180 millimètres.

Description.—I searched the Sowerbyan Collection of Ammonites in the British Museum with green labels attached, Sowerby's mark of the figured species, for the original *Am. Greenhoughi*. The type was in such a state of decomposition from the iron pyrites it contained that it could not be disturbed unless at the risk of its falling to pieces. On searching among the Ammonites stored upon the top of the glass cases in the duplicate room, I found a magnificent specimen of this Ammonite which forms the subject of Plate XLIV, the figure being one half the natural size; unfortunately it had no label attached indicating its locality, but from the petrological character of the matrix in which it was embedded, it probably came from the Lias at Lyme Regis.

Sowerby[1] says "this rather singular Ammonite is often formed of pyrites of rich golden and iridescent tints, and crystallised in the greatest variety of forms, from octaëdron to the icosaëdron, following the undulations of the chambers and the most attenuated ramifications of the spreading folliculæ, sometimes forming in the place of shells, &c. &c., occasionally filled with a great variety of crystals of carbonate of lime an inch or more in length." Specimens vary in size from twelve to eighteen inches or even more. The outer whorl has

[1] 'Mineral Conchology,' vol. ii, p. 71, 1816.

generally few or no undulations, while they are more distinct in the centre, which, if even separated, might be mistaken for another species."

The younger shells of this species, according to von Hauer, differ much from the old form figured Pl. XLIV. In a shell of from four to five inches in diameter, a distinct, extremely thick keel, was found upon the middle line of the siphonal area, which in larger specimens, about eight and a half inches in diameter, had disappeared. Younger shells have the sides of the whorls covered with numerous straight ribs, which bend forward towards the aperture as they approach the margin of the area. The ribbing of the inner whorls is very well seen in the umbilicus of our figure. The outer whorl is very large and capacious; the sides are convex and ornamented with obscure undulations representing ribs, which, now becoming broad folds, disappear in old age.

Von Hauer has given two very good figures showing the lobe-line of this Ammonite. The siphonal lobe of a large specimen has two expanded branches, each having several lateral digitations. The siphonal saddle is wide and terminates in six folioles arranged almost in pairs; the principal lateral lobe is longer and narrower than the siphonal; it has three branches on each side and a projecting terminal one; the lateral saddle is wide and deep, and terminates in a bifid and trifid and several lateral folioles; the lateral lobe is smaller than the principal; it has two lateral branches on each side, and a pointed terminal one; the auxiliary lobes and saddles become much smaller between the inner lateral lobe and the spiral suture.

Affinities and Differences.—Specimens from six to eight inches in diameter resemble *Amaltheus Guibalianus* in the general form of their shells and in the presence of a keel. In larger shells the resemblance between these species diminishes and the adult conditions of both are widely distinct from each other.

Locality and Stratigraphical Position.—The figured specimen has no locality attached to it, but the rock appears to resemble the Lias of Lyme. I have seen two fine large specimens of this Ammonite at Charmouth. Both of these came from the Lower Lias. As the collector in whose possession they were had not brought any other shells from the bed I was unable to determine the horizon. Two large Ammonites referred to this species were obtained from the *Amal. oxynotus*-beds of Robin Hood's Bay, and are recorded with doubt by Professor Blake as representing *Amal. Greenhoughi.*

Monsieur Dumortier recognised some fragments of this Ammonite at Saint Fortunat, Rhône; Nolay, Côte-d'Or, in beds belonging to the zone of *Amaltheus oxynotus.*

Amaltheus Guibalianus *d'Orbigny.* Pl. XLV, figs. 1—7.

Ammonites Guibalianus, *d'Orbigny.* Paléontol. Française Terr. Jurass., i, p. 259, pl. 73, 1842.
— — *Quenstedt.* Leonard and Bronn, Jahrbuch, p. 89, 1845.
— — — Cephalopoden, i, 351, 1849.

AMMONITES GUIBALIANUS, *Bronn.* Gesch. d. Natur., iii, pt. i, p. 44.
— — *Oppel.* Die Juraformation, p. 86, 1856.
— — *Dumortier.* Depôts Jurass. du Bassin du Rhône, ii, p. 140, 1867.

Diagnosis.—Shell compressed, carinated; whorls compressed, and extremely involute; sides convex, numerous sigmoidal ribs extend from the spiral suture to the carina, with short supplementary ribs on the upper half of the wider valleys; siphonal area narrow, with sloping sides, a central carina, and oblique transverse ribs, aperture elliptico-lanceolate, much indented by the penultimate whorl; lobe-line extremely complicated.

Dimensions.—Transverse diameter of figs. 6 and 7, 133 millimètres; width of umbilicus 20 millimètres; height of aperture 75 millimètres; width 35 millimètres. Figs. 3, 4, transverse diameter 70 millimètres; width of umbilicus 16 millimètres; height of aperture 40 millimètres, width 22 millimètres. Figs. 1, 2, transverse diameter 50 millimètres; width of umbilicus 12 millimètres; height of aperture 27 millimètres; width?

Description.—I have figured three specimens of this Ammonite and given their respective dimensions to show that very little change takes place in the growth of this species, which attains dimensions very much greater than the shell figured in 6 and 7 selected for the type figure of this fossil, because in early life its ribs are more defined and in old age they become obsolete. M. Dumortier states "that his largest specimen came from Lournand; it is 245 millimètres in diameter; the width of the last whorl 46/100; the thickness 26/100; the size of umbilicus 18/100. The last whorl has thirty-six ribs or folds slightly marked, and which appear less flexed than the ribs of the inner whorls. This specimen is furnished with lobes up to its extremity, consequently its transverse diameter when provided with its body-chamber must have exceeded 360 millimètres." My largest specimen measures 245 millimètres in diameter, the width is 70 millimètres, the height 120 millimètres, and the width of the umbilicus is 35 millimètres.

The shell is compressed and sharply carinated, and ornamented with from thirty-six to forty ribs; the number, however, differs in different specimens. Most of the ribs pass from the spiral suture to the carina undivided, many of them, however, bifurcate, and a number of short secondary ribs make their appearance between the primaries in the wider valleys (fig. 7). In some young shells the ribbing is very regular (figs. 1 and 2), whilst in others it becomes irregular as in fig. 4, in which the primary ribs are few in number and the secondaries numerous. The ribs describe a sigmoidal flexure and bend forward towards the carina, their increase in number depends either upon the bifurcation of the primary rib or on the introduction of short small secondaries in the upper part of the whorl.

The spire is composed of six whorls which are extremely involute, and the umbilicus is consequently deep and narrow, the inner whorls being mostly concealed by the matrix.

The siphonal area is narrow, and slopes down to the sides; the keel varies, sometimes it is obtuse, sometimes acute, and in general it is marked with fine lines of shell growth, which impart a serrated structure to the carina when the shell happens to be preserved.

The aperture has an elliptico-lanceolate figure, and is deeply occupied by the penultimate whorl.

The lobe-line is very complicated, and drawn with difficulty. Fig. 5 is from a tracing made upon a mould, which shows the lines most distinctly; it differs somewhat from the figure given by d'Orbigny. The siphonal lobe, longer and much larger than the principal lateral lobe, is formed of a large terminal branch and three other branches on each side. The siphonal saddle, much wider than the principal lateral lobe, terminates in five-lobed folioles. The principal lateral lobe has a central stem with two lateral divisions on each side and two terminal branches. The lateral saddle is one third wider than the principal lateral lobe, and terminates in five- or six-lobed folioles. The lateral lobe, much smaller than the principal, has an oblique stem with small lateral branches on each side, and a terminal twig with trifid digits.

The auxiliary saddles, three in number, diminish in size from without inwards, and the three auxiliary lobes are short with many points on their margins.

The septa are closely approximated in the shell, and when the lobe-lines are seen *in sitû* on the sides, they exhibit a most complicated labyrinth of lines very difficult to trace out on the mould.

Affinities and Differences.—This Ammonite occupies, as d'Orbigny remarked, an intermediate position between *Amal. margaritatus* and *Amal. cordatus* (fig. 190). It is distinguished from both by its more prominent and better defined carina, and the absence of the cordlike structure of the one shell and the serrated structure of the other. Its whorls likewise are much more involute, and its lobe-line very different from both.

Locality and Stratigraphical Position.—I have found this Ammonite near Cheltenham, and possess a good series of well-preserved examples from the *Amal. oxynotus*-bed of the Lower Lias. I know no Ammonite which maintains, so constantly and with so little change, its specific form through all its morphological history as does this species.

Amaltheus oxynotus, *Quenstedt.* Pl. XLVI, figs. 4—6.

Ammonites maeandrus ?, *Zieten.* Die Versteinerung. Württembergs, p. 12, tab. ix, fig. 6, 1830.
— oxynotus, *Quenstedt.* Flözgebirge Würtembergs, p. 161, 1843.
— polyophyllus, *Simpson.* Monograph of the Ammonites of Yorkshire Lias, p. 39, 1843.
— Robinsoni, — Ibid., p. 42, 1843.
— Buckii, — Ibid., p. 42, 1843.
— oxynotus, *Quenstedt.* V. Leonhard and Bronn's Jahrbuch, p. 87, 1845.
— cultellus, *Buckman.* Geology of Cheltenham, p. 103, tab. xii, figs. 4, 5, 1845.
— oxynotus, *Quenstedt.* Petrefactenkunde Cephalopod., pp. 98, 262, tab. v, fig. 11, 1849.

AMMONITES OXYNOTUS,		*von Hauer.*	Jahrbuch der k. k. geol. Reichsanstalt, iv, p. 754, 1853.
—	POLYOPHYLLUS,	*Simpson.*	Fossils of the Yorkshire Lias, p. 81, 1855.
—	ROBINSONI,	—	Ibid., p. 83, 1855.
—	BUCKII,	—	Ibid., p. 84, 1855.
—	DEJECTUS,	—	Ibid., p. 85, 1855.
—	OXYNOTUS,	*von Hauer.*	Cephalopod. der Nordöst. Alpen, Deukschr. Akad. Wissensch., p. 48, Taf. xiii, figs. 4—10, 1856.
—	—	*Oppel.*	Die Juraformation, s. 85, 1856.
—	—	*Wright.*	Quart. Jour. Geol. Soc., vol. xvi, p. 407, figs. 1, 2, 1860.
—	—	*Dumortier.*	Dépôts Jurass. du Bassin du Rhône, ii, p. 143, tab. xxxiii, figs. 1—5, 1867.
AMALTHEUS	—	*Tate and Blake.*	The Yorkshire Lias, p. 291, 1876.

Diagnosis.—Shell discoidal, very much compressed; whorls five, extremely involute, inner volutions scarcely exposed; outer whorl very high, half the diameter of the shell; inner margin rounded, sides convex, outer margin thin, sharp, and cutting; sides slightly convex, with thirty to forty irregular folds limited to the middle, and which at two thirds of the whorl bifurcate, the branches bending forward at an acute angle towards the aperture; umbilicus very narrow, aperture lanceolate.

Dimensions.—This species varies much in size, and in old age attained a considerable diameter. I have collected specimens from one inch and a half, or 40 millimètres, up to one foot, equal 300 millimètres, in diameter, with the body-chamber, all of which are in my collection. I consider the shell figured (Pl. XLVI, figs. 4, 5, 6) as a good type form of this species in middle age, and which gives the following measurements:—Transverse diameter 90 millimètres; width of umbilicus 18 millimètres; height of aperture 51 millimètres; greatest width 18 millimètres.

The late Monsieur Dumortier collected a number of specimens of different sizes from Lournand, Jambles, St. Helene, St. Fortunat, and in his excellent work has given the measurements of six of these for comparison.[1]

Diameter.	Height of last whorl.	Thickness of last whorl.	Size of umbilicus.
20 mill.	45/100	25/100	28/100
71 „	45/100	17/100	18/100
86 „	46/100	17/100	19/100
185 „	47/100	20/100	23/100
220 „	45/000	12/100	20/100
330 „	44/000	23/100	21/100

[1] 'Dépôts Jurassiques du Bassin du Rhône,' ii, p. 143.

Description.—In the above measurements we observe that the relative proportion varies chiefly as regards the thickness of the shell and the width of the umbilicus; in other respects, the specific characters are very well maintained.

The shell is discoidal, and very much compressed; the whorls are high and extremely involute; the outer whorl being half the diameter of the shell. The sides are convex, the inner margin gently rounded, and the outer third bevelled away into a thin, sharp cutting edge, which gives value to the name *par excellence*, *oxynotus* (ὀξύς, sharp; νῶτος, back), as it is the sharpest Ammonite extant. The ribs are slight oblique folds, thirty to forty in number, which ascend from the spiral suture two thirds up the side; here the shell begins to bevel off, and the ribs at this point make a sharp angular bend towards the carina (fig. 192), and dividing into two or three costæ as they incline forward to the aperture (fig. 191).

The umbilicus is more or less open in different specimens, being very narrow in young, and becoming wider with increasing age, the amount of involution varying from one fourth to one sixth of a whorl.

The aperture is acutely lanceolate (fig. 192), the sides of the last whorl deeply embracing the penultimate one as shown in fig. 5.

The lobe-line (Pl. XLVI, fig. 6) is very complicated from the close approximation of the septa. The siphonal lobe is wide with two divergent branches, each having three lateral digits on each side, and a ramose terminal tuft. The siphonal saddle is also wide

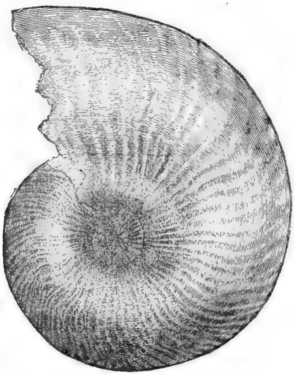


FIG. 191.—*Amaltheus oxynotus*, Qurnst.

FIG. 192.—Front view.

and shallow, and ends in five deep lobe-like folioles. The principal lateral lobe is much smaller than the siphonal, and consists of a central stem with short lateral branches, and a trifid terminal one. The lateral saddle is narrow and deep, and ends in five folioles.

The lateral lobe is short and oblique with five digitations around its margin. The auxiliary saddles are wide and shallow, and the auxiliary lobes mere short digitations.

The morphology of this Ammonite has been closely studied; when examined at 7 millimètres in diameter, the sides of the whorls are slightly more convex in proportion than in older shells, and ten or twelve wide folds are noticed around the umbilicus, the first indications of the lateral ribs; at 20 millimètres, the shell remains still proportionally thicker, the carina very little elevated forms a small round keel separated from the ribs, and the shell in this condition resembles *Am. maeandrus*, Reinecke; at 50 millimètres, the shell assumes its typical form, which it retains to 130 millimètres; it now, however, begins to lose its ribbed foldings on the body whorl; and at 160 millimètres, the cutting edge becomes thickened and the shell less compressed; but from first to last the specific characters scheduled in the diagnosis are well preserved throughout its life history.

The study of some large specimens of this Ammonite with their shell well preserved, enabled the late M. Dumortier[1] to complete an observation he had already made on other Ammonites, on the structure of the shell in a good state of preservation. He found the test to consist of two very distinct laminæ; an internal layer very thick near the umbilicus, diminishing progressively in proportion as it approaches the margin, where it is as thin as a sheet of stout paper; and an external layer, very thin on the contrary, near the umbilicus, and thickening progressively as it approaches the margin, where it acquires a thickness of 3 millimètres. By this arrangement a process of compensation is established by which the general thickness of the shell is maintained throughout.

Affinities and Differences.—Amaltheus oxynotus resembles three other species associated with it in the same zone, these are *Amal. Lymensis*, *Amal. Simpsoni*, and *Amal. Wiltshirei*. It differs from *Am. Lymensis* in having an open umbilicus, a lesser convexity of the sides, and a different style of the ribs; from *Amal. Simpsoni* in having a more compressed shell, much flatter around the umbilicus, and a different texture of shell structure; from *Amal. Wiltshirei*, with its closed umbilicus, in possessing an open umbilicus; ribs entirely different, and a distinct shell structure.

Locality and Stratigraphical Position.—This Ammonite is the leading fossil in beds which separate the zone of *Arietites obtusus* from the zone of *Arietites raricostatus*, and which are so well shown in Gloucestershire, Dorsetshire, and Yorkshire (see p. 52). This bed is very rich in many species of Ammonites.

Foreign Distribution.—It is found in Swabia and Würtemberg. In France it was collected in abundance, according to Dumortier, at St. Fortunat, St. Cyr, Lournand, St. Helene, and Jambles; and, according to Oppel, he found very large specimens in the Blue Limestone of Nancy.

It is singular that d'Orbigny has not figured a true *Amal. oxynotus* in his Paléontologie Française, although it certainly occurs in abundance in the basin of the Rhône.

Ammonites lynx, d'Orb., *Ammonites Coynarti*, d'Orb., and *Ammonites Collenoti*, d'Orb.,

[1] 'Dépôts Jurassiques du Bassin du Rhône,' ii, p. 145.

which some authors consider to be synonyms of *Amal. oxynotus,* are certainly very different species according to our reading of their outlines, markings, and lobe-lines.

AMALTHEUS LYMENSIS, *Wright*, nov. sp. Pl. XLVI, figs. 1—3.

Diagnosis.—Shell discoidal, much compressed; whorls extremely involute, umbilicus occluded by the volutions; outer whorl very high, nearly two thirds the diameter of the shell; sides regularly convex, covered with delicate sigmoidal folds, which make one sweep without interruption from the inner to the outer margin; siphonal area thin, sharp, and cutting, aperture lanceolate, nearly half its height occupied by the turn of the penultimate whorl.

Dimensions.—Transverse diameter 105 millimètres; height of the last whorl 65 millimètres; width 21 millimètres.

Description.—This beautiful Ammonite is the southern representative of *Amal. oxynotus* of the midland and northern counties. It is found in a thin bed of dark pyritic marl near Black Venn, between Charmouth and Lyme. This species is highly charged along the septa with sulphide of iron, whilst the chambers are filled with crystallised carbonate of lime; these specimens are, therefore, well adapted for cutting and polishing from the beautiful contrast afforded by the ferruginous and calcareous elements of which this fossil is composed.

The sides are regularly convex, and ornamented with from fifty to sixty sigmoidal folds, which proceed in regular order from the inner to the outer border, the upper curve of the rib being inclined towards the aperture (fig. 1) without any change in the angle of the curve or bifurcation in the rib itself, as seen in *Amal. oxynotus* (fig. 4); the outer whorl embraces the entire shell, and the umbilicus is entirely occluded thereby.

A section of one of the shells, 45 millimètres in diameter, discloses some points in the anatomy of the shell which cannot otherwise be observed in the outer whorl of this specimen. There are twenty-five chambers, each being surrounded by a thin line of sulphide of iron, the septa between the iron lines being composed of carbonate of lime. The whorls in this specimen are six in number and they are all filled in with crystallised carbonate of lime. The shell is extremely thin, consisting of two lamina, on the outer of which fine hair-like lines of growth impart a delicate and ornate sculpture to it.

The lobe-line is very complicated. I have had a good example carefully figured from an accurate tracing on the mould (fig. 3). The siphonal lobe is wide, and has two small lateral and one large terminal branch on each side, the two sides forming pairs. The siphonal saddle is as large as the lobe, and terminates in two large, bi-lobed folioles, and three smaller, two on the outer and one on the inner side of the saddle. The principal lateral lobe is as long but not so wide as the siphonal; its sides have two small lateral digitations and a terminal one divided into two branches. The lateral saddle is deeper and narrower than the siphonal, and terminates in one short foliole on the outer and a longer and more complicated foliole on the inner side. The lateral lobe is much smaller than the principal lateral, and has three lateral digitations and a longer trifid terminal one. The auxiliary lobe terminates in two folioles, and the other auxiliary lobes and saddles are small, insignificant processes. A comparison between the lobe-line of this shell and that of *Amal. oxynotus* figured on the same plate (fig. 5) will enable the student to realise the difference between the two lobe-lines of these two representative species, which have been hitherto confused together as one and the same species.

Affinities and Differences.—The more regular convex form of the shell, the regularity of the line of flexure of the folds, the difference in the arrangement of the lobe-line, the occlusion of the umbilicus, and extreme involution of the spire, form a group of diagnostic characters by which this Ammonite may be easily distinguished from *A. oxynotus*.

Locality and Stratigraphical Position.—I only know this species from the pyritic Marl Bed near Black Venn, between Lyme and Charmouth, in the zone of *Amal. oxynotus*. On some of the fossils I have observed young shells of *Aegoceras densinodum* adhering to their surface. For the other forms in the *Amal. oxynotus* Bed I must refer to pp. 52—55 of this work.

AMALTHEUS SIMPSONI, *Bean*. Pl. XLVII, figs. 4—7.

AMMONITES SIMPSONI, *Bean*, MS. Simpson's Monograph on Ammonites of the Yorkshire Lias, p. 37, 1843.
— — *Simpson*. Fossils of the Yorkshire Lias, p. 79, 1855.
AMALTHEUS — *Tate and Blake*. Yorkshire Lias, p. 291, pl. viii, fig. 4, 1876.

Diagnosis.—Shell discoidal, very much compressed; whorls four or five, extremely involute, the inner seven eighths concealed; outer volution one half the diameter of the shell, and inflated and rounded near the spiral suture; ribs nearly obsolete; sides with twenty undulating folds limited to the inner two thirds, outer third with numerous fine striæ bent forward toward the aperture; the keel thin, sharp, and cutting; aperture acutely lanceolate.

Dimensions.—Transverse diameter 100 millimètres; height of the outer whorl at aperture 50 millimètres; transverse diameter of the small shell (fig. 6) 40 millimètres; height of the aperture 20 millimètres.

Description.—The only example of this shell I have seen is the one figured, which now belongs to the Woodwardian Museum, and was formerly the property of my old friend Mr. John Leckenby, F.G.S., in whose collection I studied it. This shell is distinguished from *Amal. oxynotus* by the inflation of the inner third of the whorls, the lesser convexity of the middle third, and the thinness and concavity of the outer third, whilst the keel is sharp and cutting. The shell is thin, often preserved, and covered with fine striæ.

The lobe-line (fig. 5) is much more simple than the lobe-line of *Amal. oxynotus*. The siphonal lobe has a few short digitations. The siphonal saddle is oblique, with four or five simple folioles. The principal lateral lobe is short and narrow, with a few lateral digitations; the lateral saddle resembles the siphonal in its simple folioles; the lateral lobe is short and stunted, with a few digitations, and the whole structure appears to be like a dwarfed imitation of the lobe-line of *Amal. oxynotus*.

The morphology of this species is not well known. I have figured two small examples from the same collection, which very much resemble young forms of *Amal. oxynotus* of about a like diameter. It certainly very much resembles that Ammonite, and may prove to be only a variety of that fine shell. The materials at my command, however, are so limited that I cannot venture upon a decided opinion on the subject.

Affinities and Differences.—The affinities all connect this shell with *Amal. oxynotus*, but it differs from that Ammonite in having the inner third of the whorls inflated, the sides without ribs, and a much simpler lobe-line. These characters, although slight, are said to be constant, and are considered to afford proofs of its being really distinct.

Locality and Stratigraphical Position.—The type specimen was collected from the *Amal. oxynotus*-zone, Robin Hood's Bay. It does not appear to have been found, according to Professor Blake, out of Yorkshire.

Amaltheus Wiltshirei, *Wright*, nov. sp. Pl. XLVIII, fig. 3.

Diagnosis.—Shell discoidal, very much compressed, outer volution very large, enveloping all the inner whorls; sides high, convex, and covered with slight sigmoidal folds, best seen on the mould. Shell structure ornamented with very delicate lines, which describe the curve seen on the mould; umbilicus occluded by the outer whorl; siphonal area thin and narrow; keel blunt.

Dimensions.—Transverse diameter 125 millimètres; height of the outer whorl 70 millimètres; width of aperture 24 millimètres.

Description.—This Ammonite was collected several years ago from the Green Ammonite Bed near Charmouth, and since that discovery a second specimen has come into my possession, with some of the associated species embedded in the block. I have examined all the collections of Lias fossils to which I have had access with a view to identify the species, but invariably without success, and conclude the form is new and rare. I have, therefore, very great pleasure in dedicating it to my old friend, our worthy Secretary, the Rev. Professor Wiltshire, F.G.S., as a humble but sincere acknowledgment of the great assistance he has given me in prosecuting this work.

The extreme involution of the shell and the size and height of the outer whorl are the distinguishing features of this Ammonite. The sides are regularly convex, and ornamented with numerous slightly-elevated folds, best seen on the surface of the mould; in the lower two thirds they have a gentle inclination forward, in the upper third they bend more towards the aperture, a style of curvature which appears to be common to the entire group of the *Oxynoti*. The shell is only partially preserved. It is thin on the sides and thicker near the umbilicus; the surface appears to have had fine lines on the surface, which followed the bend of the folds. Both my specimens have suffered in cleaning, and the delicate shell sculpture is indistinguishable. The keel is blunt, from a thickening of the shell around this region, and I have failed to observe the position of the siphuncle. The aperture is extremely lanceolate, and deeply encroached upon by the turn of the spire and the penultimate whorl.

The lobe-line is a very elegant and complicated foliation (fig. 3). The siphonal lobe has two long terminal diverging branches on each side, and several lateral ones with many digitations. The siphonal saddle is very complicated, and divided into two portions by a long central branch; the folioles are numerous, narrow, and deep. The principal lateral lobe is a large complicated structure, it has two large lateral branches internally, and three small digitations externally, and two branched terminal twigs. The lateral saddle is nearly as large as the principal lobe, and ends in four or five long, narrow-branched folioles. The lateral lobe is much smaller than the principal lateral, and has two lateral branches on each side, and a terminal one with three divisions. The lateral saddle is smaller but more regularly formed than the principal saddle, and terminates in many foliations. The auxiliary lobes, four or five in number, are elegantly branched, and the auxiliary saddles diminish in the size and number of their parts as they approach the umbilicus, the great height of the whorl necessitates a greater number and extension of the auxiliary lobes and saddles.

Affinities and Differences.—This Ammonite very much resembles *Amal. Lymensis.* It is altogether a more rotund shell, with more convex sides, and has a different style of lobe-line, which is apparent when we compare Pl. XLVII, fig. 3, with Pl. XLVIII, fig. 3.

Locality and Stratigraphical Position.—This Ammonite was obtained from the Green Ammonite Bed, near Charmouth, containing *Belemnites longissimus*, Miller, and *Belemnites elongatus*, Miller, and others that are indeterminable. I have found no other shells associated with it.

AMALTHEUS IBEX, *Quenstedt.* Pl. XXXIX, figs. 4, 5.

AMMONITES IBEX, *Quenstedt.* Flözgebirge Würtembergs, p. 179, 1843.
— BOBLAYEI, *d'Orbigny.* Paléont. Française Terr. Jurass., p. 251, tab. 69, 1842.
— — *Buckman.* Murchison's Geology of Cheltenham, pl. xii, fig. 1, p. 89, 1845.
— IBEX, *Quenstedt.* Cephalopoden, p. 101, tab. 6, fig. 6, 1849.
— — *Oppel.* Mittlere Lias, Jahr. Würt., p. 87, t. 2, fig. 7, 1853.
— BOBLAYEI, *Morris.* Catalogue of British Fossils, p. 290, 1854.
— IBEX, *Quenstedt.* Der Jura, p. 119, tab. xiv, fig. 5, 1858.

Diagnosis.—Shell discoidal, compressed; whorls two thirds involute, flattened on the sides, and ornamented with twenty-five to thirty short, wavy folds, which vanish at about two thirds the height of the whorl; siphonal area narrow, with twenty-five thick transverse nodules, the apparent termination of the bi-flexed lateral folds; aperture oblong, truncated anteriorly.

Dimensions.—Transverse diameter 80 millimètres; width of umbilicus 15 millimètres; height of aperture 40 millimètres; width 17 millimètres.

Description.—This very beautiful Ammonite is seldom well preserved, it is in general found in nodules of the Middle Lias, sometimes with its shell in a semi-fossil condition, and oftener in the form of moulds with a well defined sculpture thereon. The shell is discoidal and compressed; the volutions, five or six in number, are extremely involute, and the last whorl forms the conspicuous part of the disc; its sides are flattened, slightly convex, and ornamented with a number of bi-flexed folds or ribs, which are more pronounced in middle-aged shells like fig. 5, which shows a specimen in my collection magnified; here the ribs consist of two sets, the inner series occupy two thirds of the whorl, they are all flexed obliquely forward, and terminate abruptly in a thickened portion; the second series commence near the outer third, and pass very obliquely toward the margin where they form thick knobs which extend transversely across the siphonal area; between the series are found free indistinct ribbon-like impressions. In older shells, as in the specimen (fig. 4), the ribs on the middle of the volution are not so prominent, and gradually diminish on the body-chamber. The siphonal area is very narrow, and the obtuse knobs, developed at intervals in this region, resulting from the outer series of ribs impart a striking feature to the shell of this species, and liken it to the horn of an *Ibex.* The aperture is oblong and flattened on the sides; and the volutions of the inner whorls, from the narrowness of the umbilicus, can only be seen in young specimens. The lobe-line is peculiar, and has been well described and figured by d'Orbigny. As none of my specimens show this structure I quote his description.

"The siphonal lobe is as wide and much shorter than the principal lateral lobe, and ornamented with three points, of which the inferior one is bifurcated. The siphonal saddle is as wide as the principal lateral lobe, and terminates in five rounded leaves resembling palettes. The principal lateral lobe is formed of five branches, of which the large terminal one is trilobed. The lateral saddle, as wide as the principal lateral lobe, is composed of six leaves rounded like those in the siphonal saddle. The lower lateral lobe, one third smaller than the principal lateral, is ornamented also with five unequal branches. The other lobes gradually diminish in length and ornamentation as they approach the umbilicus."

Professor d'Orbigny appears to have had more than 100 specimens of this Ammonite before him for comparison, and from his study of these varied forms at different ages has made the following observations.[1] "This species is without contradiction one of the most singular in its varieties of age. Up to a diameter of 7 millimètres it is smooth, with a round inflated margin; its whorls are narrow, and frequently marked with deep furrows, which pass over the siphonal area; these furrows suddenly cease at this period of growth, the whorls become flattened and enlarged, and almost carinated on the siphonal area; they remain thus more or less for some time according to the individuals, and then commence to assume some lateral undulations. The nodosities on the back, and all the external ornaments, only usually show themselves when the shell attains about 20 millimètres in diameter, then the nodosities increase in size with the growth, whilst the radiating ribs of the sides appear, on the contrary, to become attenuated up to the greatest diameter of which we have knowledge. Among the large number of specimens that I have had the opportunity of comparing, I have found one remarkable variety having closer lateral ribs, with the knobs on the back at least three times as numerous as in the other specimens."

Affinities and Differences.—This Ammonite has few affinities in structure with its congeners, the large nodosities formed in the siphonal area by the rib-like structure that develop these, liken it to *Amaltheus margaritatus;* it is readily distinguished from that species by the greater width of the area, by its being more obtuse, and provided with much larger and fewer tubercles than are found in *Amal. margaritatus.* In early age the shell is without lateral spines, and the lobe-line much less complicated than in *Amal. margaritatus.*

Locality and Stratigraphical Position.—I have collected this Ammonite in nodules of ochreous Middle Lias from brick pits at Hewletts Hill, Southam, and Leckhampton, Gloucestershire; and Mr. Beesley records it from the *Jamesoni* Beds at Fenny Compton, Warwickshire. In France it has been collected from the Middle Lias at Coutards, Vallèe de Saint-Pierre, près de Saint-Amand, Cher, Fresnay-le-Puceux, Calvados.

In Germany this shell is found in Swabia associated with *Aeg. Maugenesti*, *Aeg. bipunctatum*, *Aeg. centaurus*, and *Aeg. Valdani.*

[1] 'Paléontologie Française Terr. Jurassique,' tom. i, pp. 252 and 253.

AMALTHEUS MARGARITATUS, *Montfort.* Pls. LIII, LIV, figs. 1—3, and LVI, figs. 6—16, 19, 20.

AMMONIS CORNU STRIATUM STRIIS BARIORIBUS,	*Langius.* Hist. Lapid. Figuratorum Helvetiæ, p. 96, tab. xxv, fig. 2, 1708.
CORNU AMMONIS,	*Seba.* Thes., vol. iv, tab. 107, figs. 6, 10, 13, 1734.
AMMONITE,	*Knorr et Walch.* Tome II, p. 42, pl. A ii, fig. 3, 1768.
AMALTHEUS MARGARITATUS,	*Montfort.* Conchyliologie Systématique, t. i, p. 90, fig. xxiii, 1808.
AMMONITES ACUTUS,	*Sowerby.* Mineral Conchology, vol. i, p. 51, pl. 17, fig. 1, 1813.
NAUTILUS ROTULA,	*Reinecke.* Nautili et Argonautæ, No. 5, p. 59, tab. i, figs. 9, 10, 1818.
AMMONITES STOKESI,	*Sowerby.* Mineral Conchology, vol. ii, p. 205, tab. 191, 1818.
— AMALTHEUS,	*Schlotheim.* Die Petrefactenkunde, p. 66, No 9, 1820.
— — GIBBOSUS	— Ibid., No. 10, p. 66.
— CLEVELANDICUS,	*Young and Bird.* Geol. Surv. Yorksh. Coast, p. 253, pl. 13, fig. 11, 1822.
— ROTULA,	*Haan.* Ammon. et Goniat., p. 106, 1825.
— ACUTUS,	— Ibid., p. 108, 1825.
— AMALTHEUS,	— Ibid., p. 105, 1825.
— CLEVELANDICUS,	*Phillips.* Geology of Yorkshire, pl. xiv, fig. 6, 1829.
— AMALTHEUS,	*Zieten.* Versteinerungen Württembergs, p. 4, pl. 4, fig. 1, 1830.
— — GIBBOSUS,	— Ibid., pl. 4, fig. 2.
— PARADOXUS,	— p. 15, pl. xi, fig. 6.
— AMALTHEUS,	*Roemer.* Norddeutsch. Oolithen-Gebirg., p. 188, 1836.
— —	*Bronn.* Lethæa geog., p. 434, pl. xxii, fig. 13, 1837.
AMALTHEUS MARGARITATUS,	*Tate and Blake.* Yorkshire Lias, p. 293, 1876.

Diagnosis.—Shell discoidal, much compressed ; whorls one half involute, outer whorl flattened on the sides, slightly convex and transversely costated ; costæ in form of doubly bent convex folds, the outer curve inclined forwards towards the aperture ; siphonal area narrow and carinated ; keel formed of short supplemental ribs, which grasp the margin of the whorl and have their angles directed forward, forming a rope-like structure extended along the outer margin ; the external half of the whorls covered with close-set longitudinal lines ; aperture narrow, compressed, and sagittate ; lobe-line highly complicated.

Dimensions.—Large shell, Pl. LIII.—Transverse diameter, 200 millimètres; width of umbilicus, 52 millimètres; height of aperture, 92 millimetres. Small shell, Pl. LVI, fig. 15.—Diameter, 67 millimètres; width of umbilicus, 15 millimètres; height of aperture, 33 millimètres.

Description.—This has been a long well-known shell of the Middle Lias. De Montfort, who established the genus, says "the *Amaltheus* is still more flat than *Planulites* and *Ellipsolitis*. Many of the petrified shells of the genus have still preserved their nacre and lustre, others are ochreous and ferruginous. We find some that are more than five inches in diameter. The back of the *Amaltheus*, instead of being rounded, is carinated and armed with a crest, which renders the mouth triangular lanceolate. The specimen I figure is still nacreous, and came from the environs of Anvers. This genus is very numerous in fossil species; we find them in all the cabinets, but we do not yet know their living analogues, and for this reason we are obliged to place *Amaltheus* among sea shells, which perhaps happily hazard may bring to light some other day."[1]

The shell is very much compressed and carinated; the sides of the whorls are ornamented with slightly elevated transverse ribs, which arise straight from the sides of the spiral suture, they first bend backwards and then incline forward towards the margin, where they vanish; the siphonal area is narrow, and has on its outer border a rope-like prominent keel formed by a number of small short ribs which become imbricated, and incline forward in a ridge-like form (Pl. LIV, figs. 1, 2, 3).

The spire is composed of six whorls (Pl. LIII), which are nearly two thirds involute; the outer whorl very large and embracing, leaves, however, all the inner turns of the spire visible. The whorls are very much compressed, they are thickest around the umbilicus and taper gently away towards the outer border. In well-preserved specimens more than two thirds of the width of the whorl is covered with fine, close-set, punctated lines, which follow the turn of the spire, and apparently proceed from the outer lamina of the shell; they are very well represented in Pl. LIII and Pl. LVI, figs. 10 and 15. The aperture is very narrow and compressed (Pl. LIV, fig. 1), and forms an acute angle with slightly convex sides. The lobe-line is very complicated (Pl. LIII, fig. 1). The siphonal lobe is as wide but shorter than the principal lateral lobe, and ornamented on each side with two large lateral, each subdivided into several secondary, branches. The siphonal saddle is much wider than the principal lateral lobe, and terminates in five long leaves separated by prominent branches. The principal lateral lobe is highly developed, consisting of a central stem and several branches, two smaller internal and one larger lateral branch, with a long terminal branch having several lateral digitations. The lateral is much smaller than the siphonal saddle, and terminates in four folioles much divided around their edges. The inner lateral lobe is much smaller than the principal lateral, and has a central stem with four lateral branches, all the sides of which are much incised. The auxiliary saddle is small with two terminal foliations, and the auxiliary lobes are small with sharp

[1] 'Conchyliologie Systematique,' tom. i, p. 91, 1808.

points for digitations. A radial line extended from the umbilicus to the siphonal lobe would pass through the middle of the principal lateral and touch the points of all the others.

The evolution of this Ammonite is extremely interesting. Several years ago I obtained a series of young shells from the *Amal. margaritatus*-bed near Reutlingen, Würtemberg, which show the morphological phases through which the shell passes. When it has attained the diameter of 10 millimètres, the sides of the whorls are round, and the straight ribs develop small tubercles about the middle, each rib then curves forward towards the keel (Pl. LVI, figs. 13 and 14); in the next stage (figs. 11, 12) the ribs are better defined, and the tubercles more prominent; the siphonal area is proportionally much wider and forms a ridge with two angles as is shown in the aperture (fig. 12). Another variety, about the same age, is delineated in figs. 8, 9, the whorls are wider, and the ribs and tubercles more pronounced in figs. 19, 20. When the diameter of 17 millimètres is attained the whorls are still round, the ribs distinct, and develop a tubercle near the middle of their height, the ribs then bend sharply forward towards the aperture; the keel is now prominent with ridge-like, short, supplementary ribs set obliquely forward between the primaries. Fig. 10, with a diameter of 22 millimètres, has the ribs well-marked, the tubercles blunted, and the outer half of the whorl encircled by fine longitudinal lines; the keel well marked and carinated, is notched by the angular ridge-like pieces. Figs. 6, 8, representing a form of 20 millimètres in diameter, has all the parts of the shell already described more fully developed, and the siphonal area exhibits its sharp prominent ridge and angular sides, bounded by a prominent tubercle on each side. A specimen before me, 31 millimètres in diameter, is a perfect example of the form figured by Quenstedt as *Amaltheus coronatus*, which has round whorls, short thick ribs, prominent tubercles, and two branches from each inclined towards the aperture; the keel prominent and nodulated, is altogether a very pronounced variety of the usual type. When the shell has attained 40 millimètres in diameter it then becomes *Amal. depressus*, Quenst. The ribs are biflexed and flat; the keel rope-like and carinated, and the shell ornate with longitudinal punctated lines which encircle the outer whorl; the spines begin now to disappear, though they are seen all round the turns of the inner whorls when we examine the umbilicus. When the tubercles cease to be developed the shell assumes the form of its adult condition. In another specimen, of 70 millimètres diameter, the shell has attained all the characters so well displayed in the large adult shell, beautifully delineated in Pl. LIII.

Affinities and Differences.—The remarkable form which the keel assumes in this species resembles *Amaltheus ibex*, but is distinguished by its narrower area, acute rope-like carina, more triangular whorls, and more complicated lobe-line; some of its varieties assume shapes that resemble *Amal. spinatus*, but the ribs and spines of that species, with the thickness of its whorls, and the breadth of the siphonal area, form distinguishing characters by which the two species may be readily diagnosed from each other.

Locality and Stratigraphical Position.—I have collected fine specimens of this

Ammonite from the Marlstone Rock Bed at Gretton, near Winchcombe, and at Dumbleton and Alderton, Gloucestershire; South Petherton, Somerset; near Charmouth, Dorset; associated with *Lytoceras fimbriatus,* where I have found them in the same block of rock. Professor Judd has collected numerous specimens of large size and great beauty in the Middle Lias Clays of Ouston, Billesdon, Roscart, Rutlandshire. In Yorkshire it is collected at Hawsker, Staithes, Rockcliff, Hummersea, Huntcliff, and Saltburn, from coast sections of the Marlstone Beds.

In France it has been collected from the Upper Beds of the Middle Lias in all the departments in which strata belonging to the *Amal. margaritatus* zone occur.

In Germany, in Alsace, near Uhrweiler, it is found in all its varieties in blue clay, beautifully preserved with its calcareous shell; at Metz, near the banks of the Moselle, imbedded in blue clay in great numbers. It is found in Swabia in many localities, and is widely distributed through the Middle Lias of Würtemberg; it is found at Wasseralfingen, Kirchheim, Metzingen, Sondelfingen, Breitenbach, Hinterweiffer, Hechingen, Frommern, Aselfingen, and at Wutach, according to Oppel, and in numerous localities throughout North Germany according to Brauns.

AMALTHEUS ENGELHARDTI, *d Orbigny.* Pl. LXX.

AMMONITES ENGELHARDTI, *d'Orbigny.* Paléontol. Française; Terr. Jurass., i, pl. 66, p. 245, 1842.

Diagnosis.—Shell discoidal, compressed; whorls compressed; sides flat and longitudinally costated; costæ consist of elevated ridges of shell closely approximated with longitudinal narrow valleys between the ridges; external costæ more closely approximated; siphonal area narrow, sharp, and cutting; aperture oblongo-lanceolate.

Dimensions: English specimen.—Transverse diameter 205 millimètres; width of umbilicus 30 millimètres; height of aperture 110 millimètres.

French type specimen.—Transverse diameter 250 millimètres, in relation to the diameter width of the last whorl $\frac{40}{100}$; amount of involution $\frac{12}{100}$; thickness of the last whorl $\frac{16}{100}$; width of umbilicus $\frac{20}{100}$.

Description.—The shell of this interesting Ammonite is much compressed, subcarinated, and ornamented on the sides with small longitudinal costæ, not much elevated, and more closely approximated on the outer half of the shell. When the shell, which is extremely thin, is preserved the longitudinal costæ are crossed by very fine transverse striæ resulting from the growth of the shell, and giving a highly ornate appearance to the sides of the whorl. The extreme tenuity of the shell renders the opportunity rare for inspecting.

PLATE XLIX.

Zone of Aegoceras angulatum.

Fig. 1. Aegoceras laqueolus, *Schloenbach.* Side view, natural size. Obtained by the late Mr. Lamley from the Lower Lias at Halford, between Stratford-on-Avon and Shipston-on-Stour, and presented by him to the Warwick Museum. Kindly communicated by Robert Tomes, Esq., F.G.S.

Zone of Amaltheus margaritatus.

4. Harpoceras nitescens, *Young* and *Bird.* Side view, magnified two diameters. Marlstone. My collection.

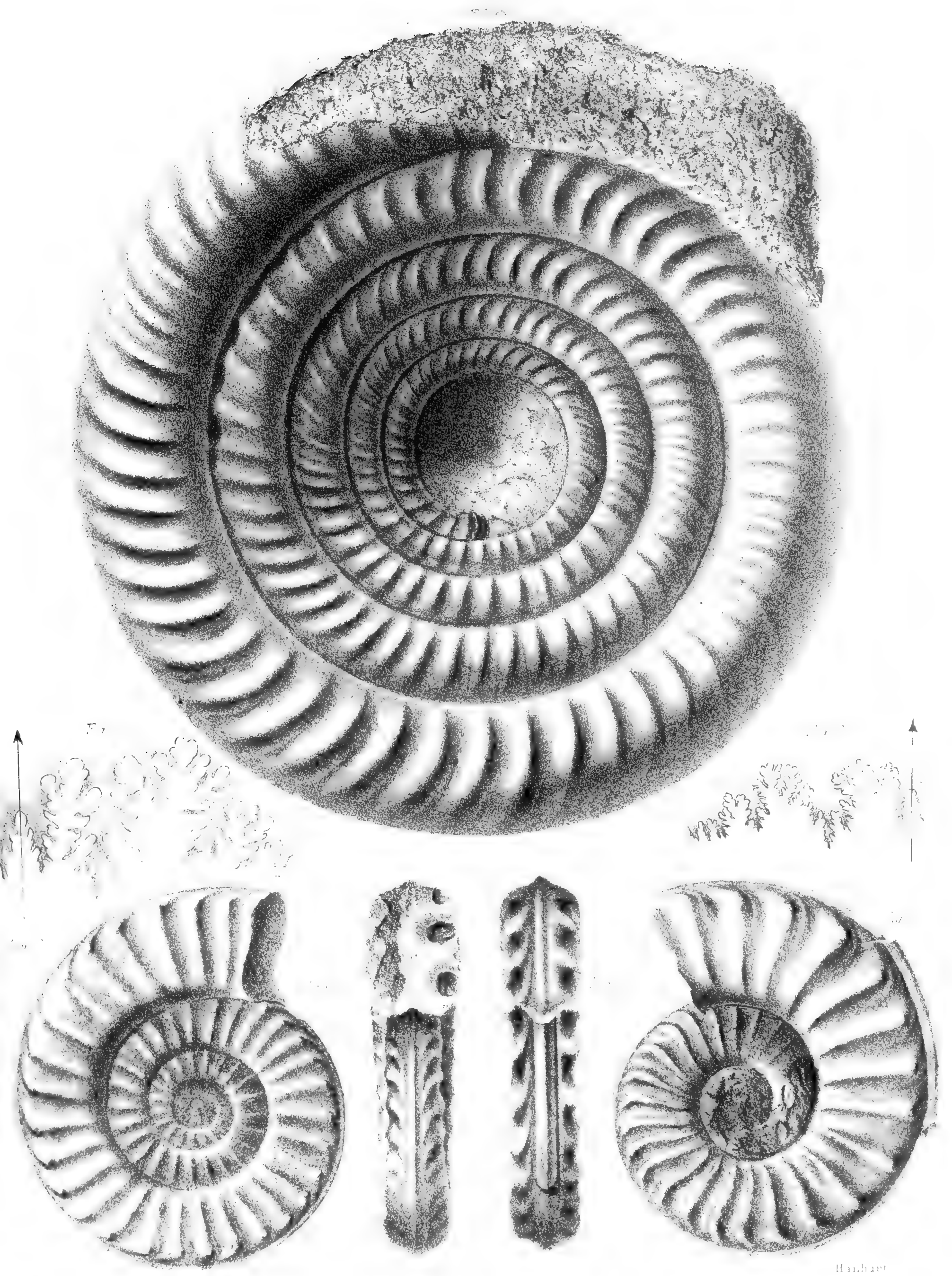
5. — — — View of siphonal area, showing the siphuncle below the keel of the shell. My collection.

3. — — — Lobe-line of the same shell, magnified.

6. — — — Another specimen, natural size.

7. — — — Siphonal area. My collection.

2. — — — Lobe-line of the same, magnified.



Hanhart

PLATE L.

Zone of Amaltheus oxynotus ?

Fig. 1. Aegoceras Slatteri, *Wright*. Side view, natural size. T. J. Slatter, Esq., F.G.S.

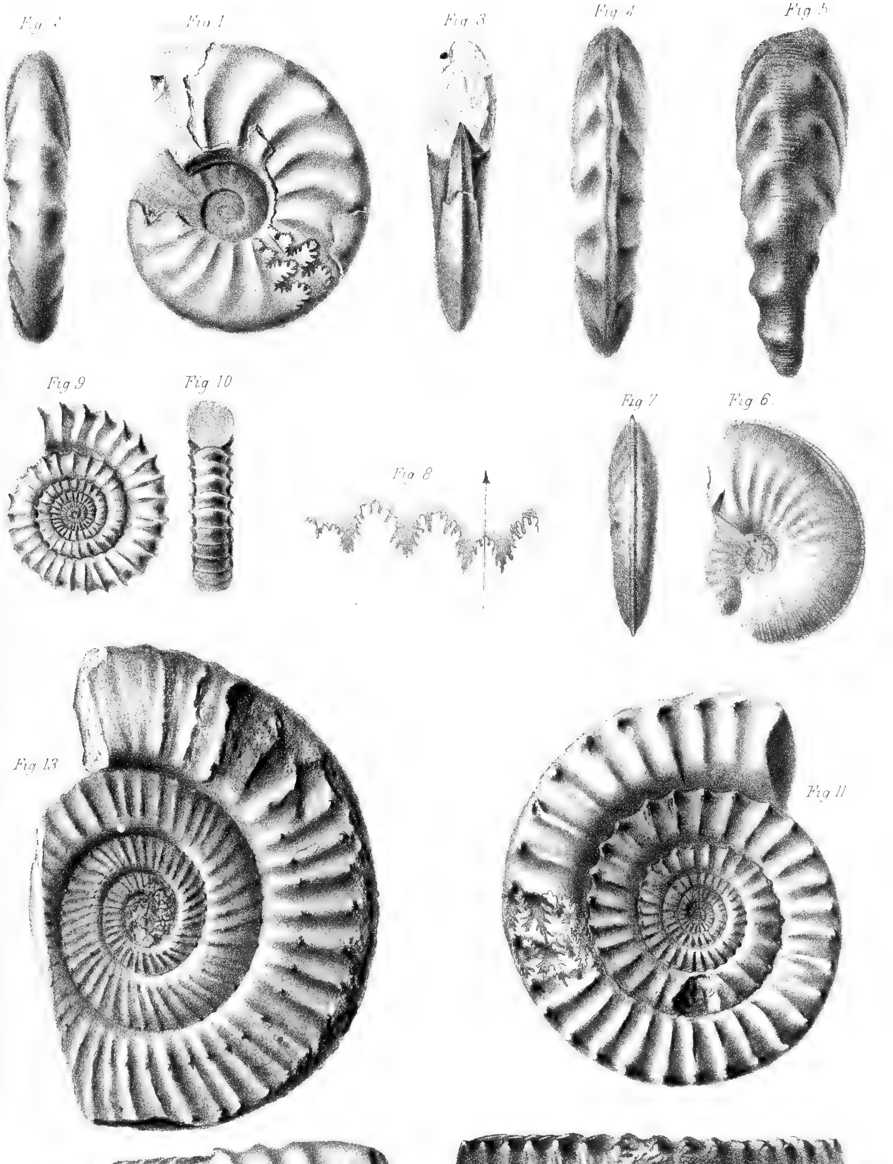
2. — — — Siphonal area, do.
3. — — — Front view.
4. — — — Siphonal area.
5. — — — Do.

All the specimens of this species are in his collection.

6. — — — Young shell showing a keel, natural size.
7. — — — Do. do. siphonal area with keel.
8. — — — Lobe-line, magnified.

Zone of Aegoceras Jamesoni.

9. — carusense, *d'Orbigny*. Side view, natural size. My collection.
10. — — — Siphonal area.
11. — densinodum, *Quenstedt*. Side view, natural size. do.
12. — — — Siphonal area, do.
13. — brevispina, *Sowerby*. Side view, do. Collection of the Rev. J. E. Cross, F.G.S.
14. — — — Siphonal area, natural size.



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Hanhart imp

PLATE LI.

Zone of Aegoceras Jamesoni.

Fig. 1.	AEGOCERAS	JAMESONI,	*Sowerby.*	Side view, natural size, large ribbed variety.
2.	—	—	—	Siphonal area, do. Collected at Mungar, and belongs to the Bristol Museum.
3.	—	—	—	Side view, natural size. Hechingen. My collection.
4.	—	—	—	Do. do. Pabba. do.
5.	—	—	—	Young shell, do. Leckhampton. do.
6.	—	—	—	Siphonal area, same shell.

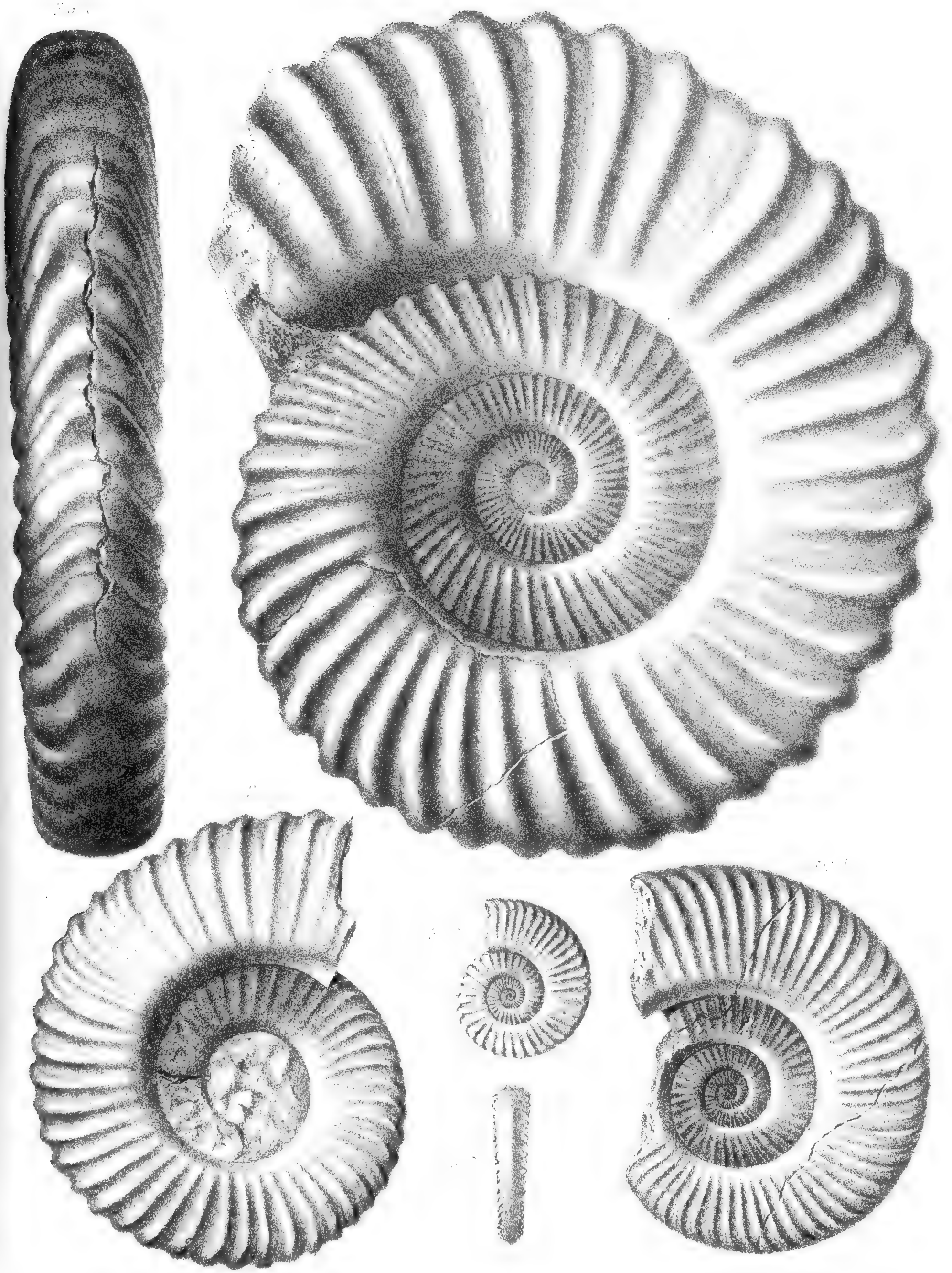


PLATE LII.

Zone of Aegoceras Jamesoni.

Fig. 1.	AEGOCERAS SAGITTARIUM, *Blake*.			Side view, two thirds natural size.
2.	—	—	—	Siphonal area of the shell, two thirds natural size. Collection of the Rev. J. E. Cross, F.G.S.
3.	—	—	—	Lobe-line, magnified.
4.	—	—	—	Side view of small shell, natural size.
5.	—	—	—	Siphonal area of do. do.

Fig 1

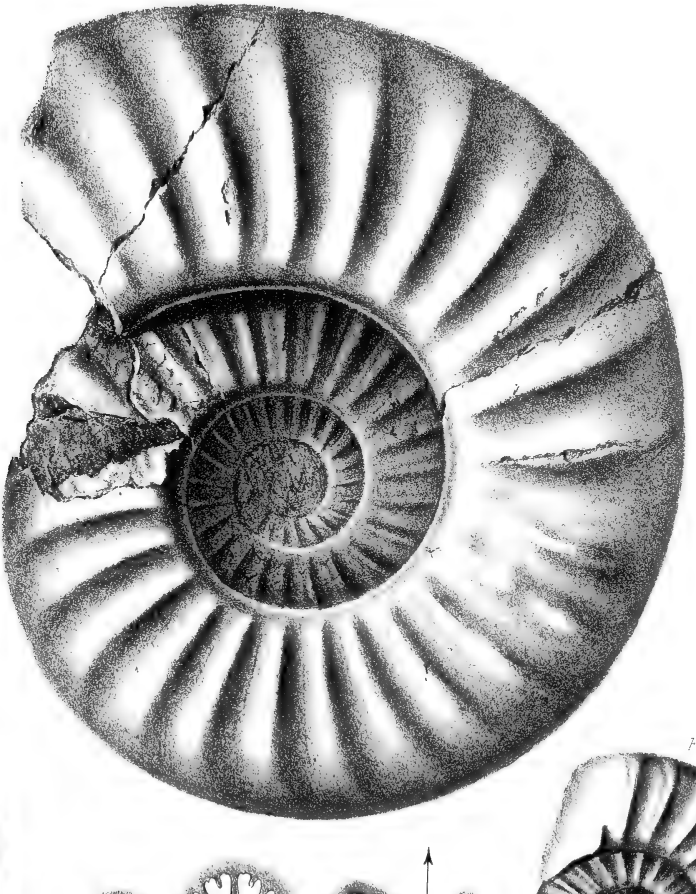


Fig 5

Fig 3.

Fig 4

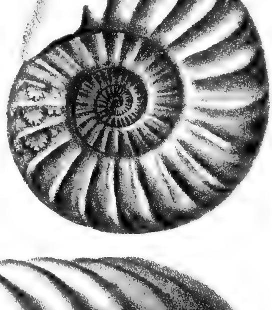


Fig 2

PLATE LII A.

Zone of Aegoceras Jamesoni.

Fig. 1.	AEGOCERAS SAGITTARIUM, *Blake.*			Side view, variety *a*, natural size.	My collection.
2.	—	—	—	Siphonal area, do. do.	
3.	—	—	—	Side view, natural size.	do.
4.	—	—	—	Front view, do.	
5.	—	—	—	Side view, do.	do.
6.	—	—	—	Siphonal area, do.	

Fig 5

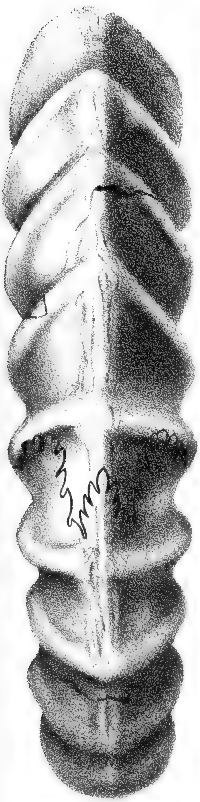
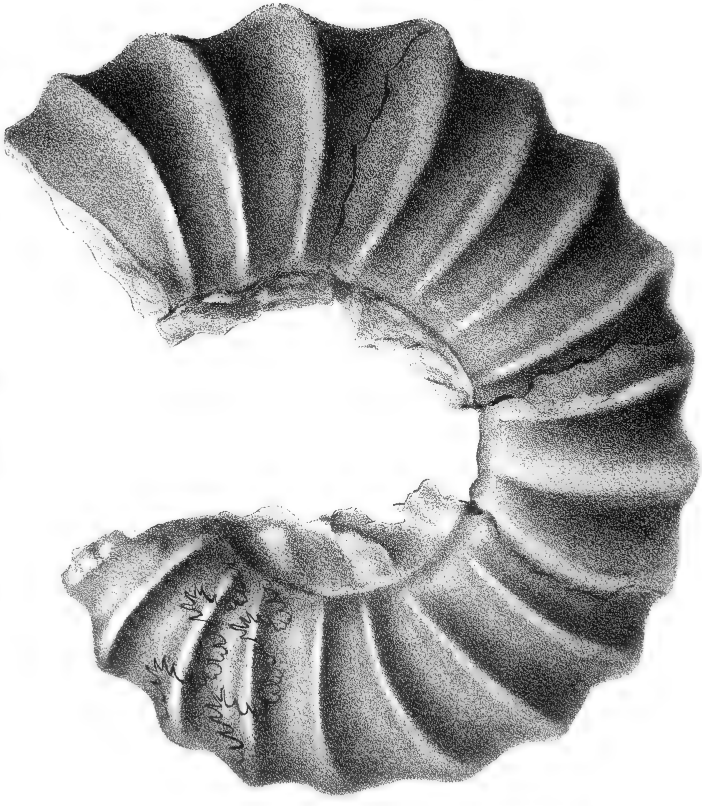


Fig 1



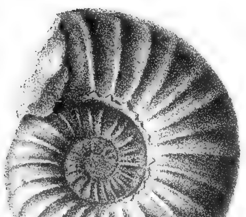


Fig 2

Fig 3

Fig 4

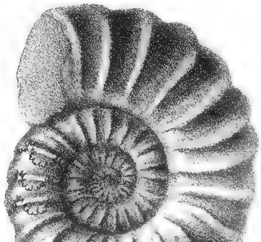


Fig 6

Mary Sift del et lith

Hanhart imp

PLATE LIII.

Zone of Amaltheus margaritatus.

Fig. 1. Amaltheus margaritatus, *Montfort.* Side view, natural size. My collection.

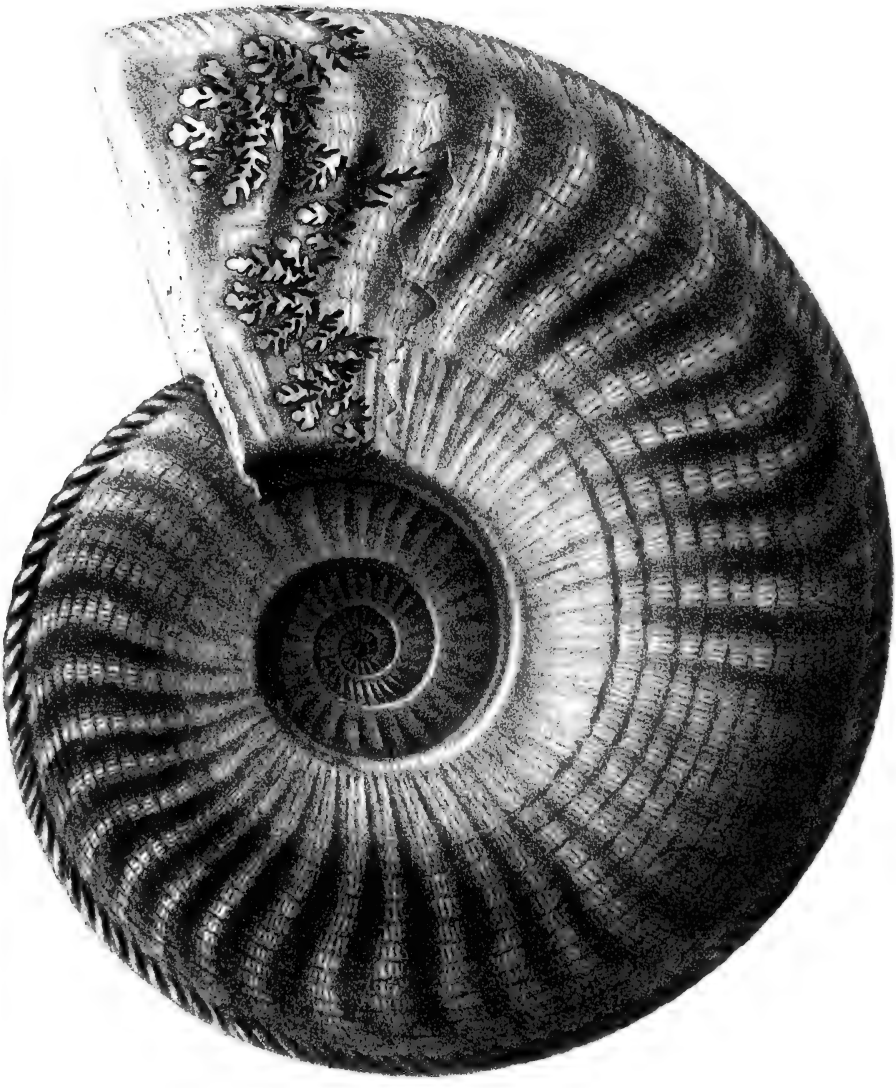


PLATE LIV.

Fig. 1.	AMALTHEUS MARGARITATUS, *Montfort*.	Front view, natural size.		My collection.
2.	— — —	Back view,	do.	
3.	— — —	Do. showing the imbrication of the keel.	do.	do.

Fig 1

Fig 2

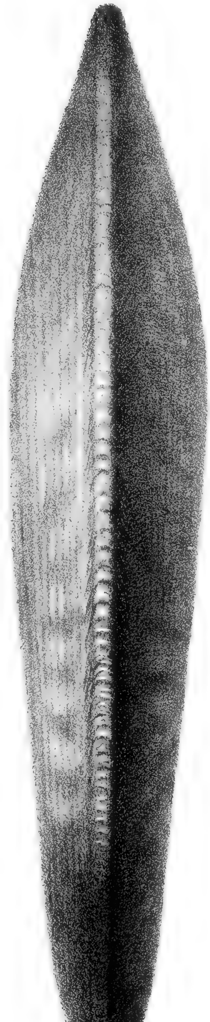


Fig 3

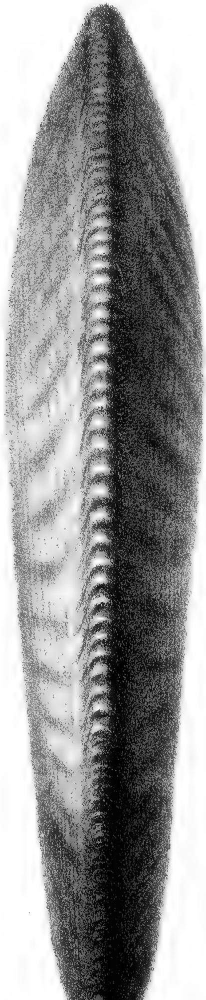


PLATE LV.

Zone of Amaltheus spinatus.

Fig. 1. Amaltheus spinatus, *Bruguiere*. Side view, natural size. My collection.

2. — — — Front view, showing the keel and spines. My collection.

PLATE LV

Fig 1

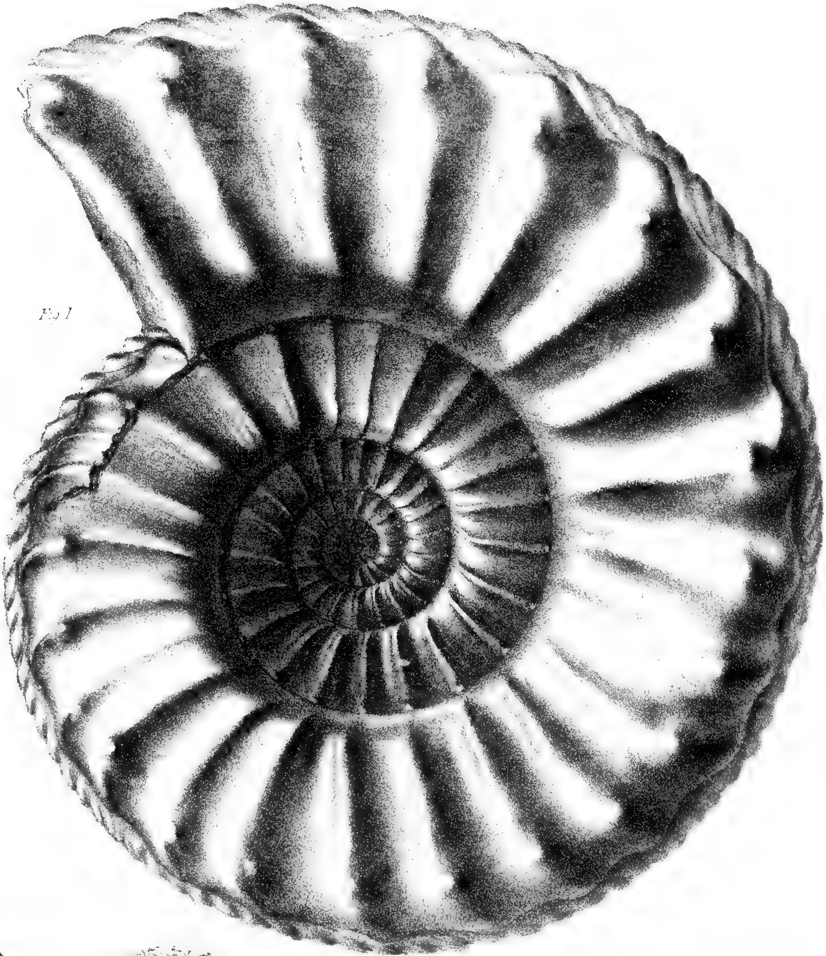


Fig 2

PLATE LVI.

Zone of Amaltheus spinatus.

Fig. 1. AMALTHEUS SPINATUS. Back view for keel and spines, natural size. My collection.
2. — — Side view, showing spines.
3. — — Front view, mouth aperture, and spines, and keel.
4. — — Lobe-line, magnified. My collection.
5. — — Front, showing aperture and position of siphuncle. do.

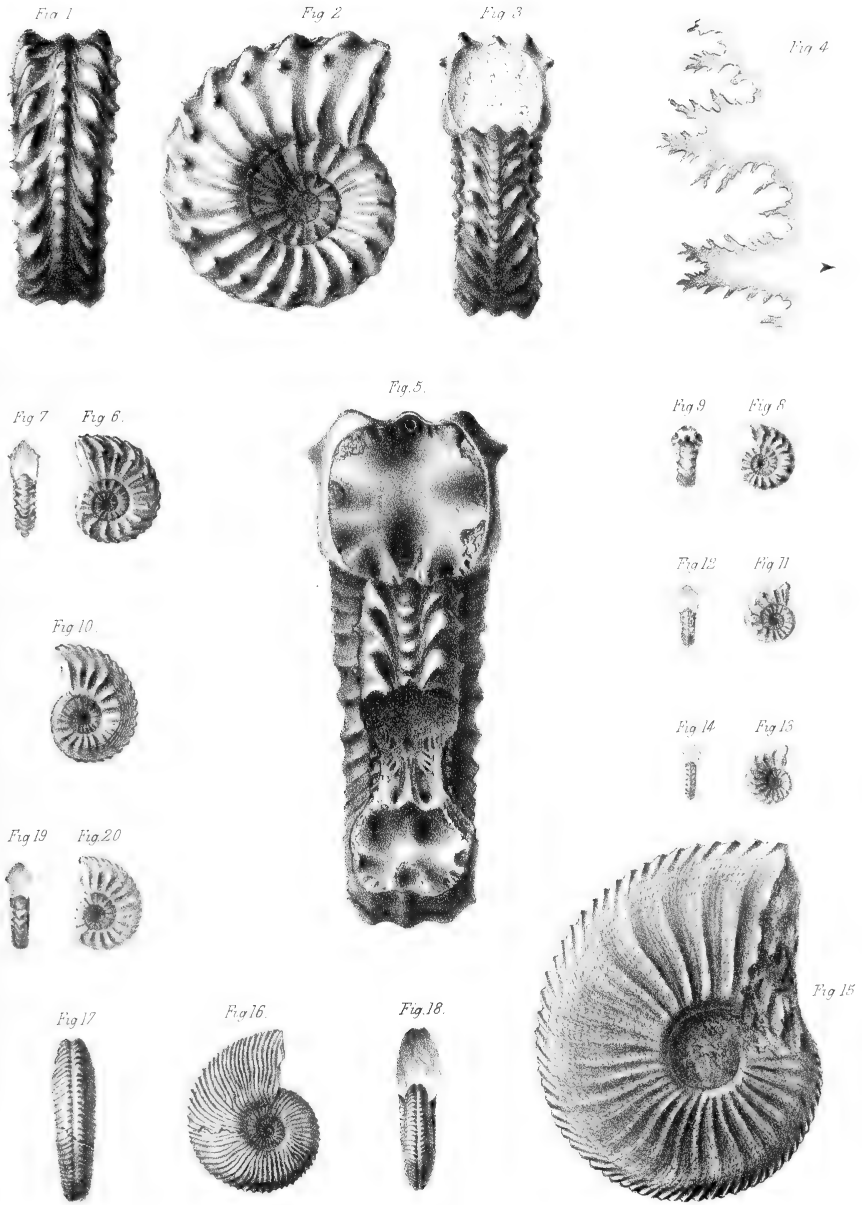
Zone of Amaltheus margaritatus.

6—14, 19, 20. AMALTHEUS MARGARITATUS. Shells of different ages showing the evolution of this species. My collection.
15. — — Type form of a young shell. do.

Zone of Amaltheus oxynotus.

16. AEGOCERAS LACUNATUM, *Buckman*. Side view, natural size. My collection.
17. — — — Siphonal area, showing furrow, natural size.
18. — — — Front view, do. do.

PLATE LVI

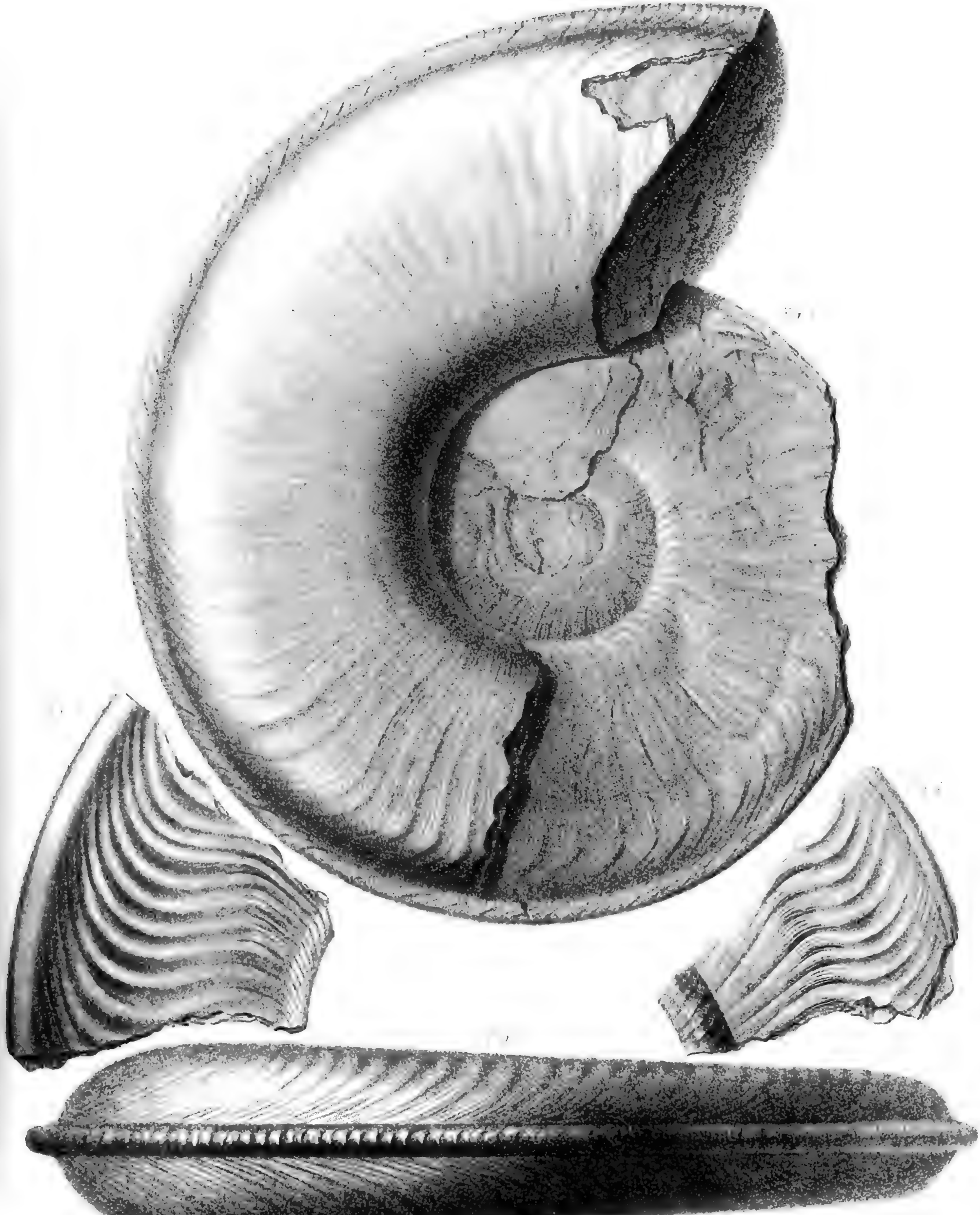


Hanhart imp

PLATE LVII.

Zone of Aegoceras Jamesoni.

Fig. 1.	Harpoceras	antiquum,	*Wright.*	Side view, natural size.	My collection.
2.	—	—	—	Siphonal area, do.	
3.	—	—	—	Flexure of ribbing and keel.	
4.	—	—	—	Do. do.	



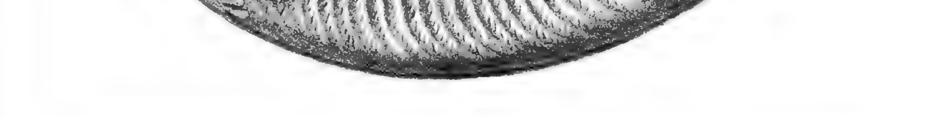
A. Gawan, del. et l.

PLATE LVIII.

Zone of Harpoceras serpentinum.

Fig. 1.	HARPOCERAS SERPENTINUM, *Schlotheim*.	Side view, natural size. My collection.
2.	— — —	Siphonal area and keel, natural size.
3.	— — —	Lobe-line, magnified.

Fig. 3



A Gawan del et lith

Hanhart imp

PLATE LIX.

Zone of Harpoceras bifrons.

Fig. 1.	HARPOCERAS BIFRONS, *Bruguiere.*	Side view, lobe-line aperture and lateral processes, natural size. My collection.
2.	— — —	Siphonal area with lobe-line do. do.
3.	— — —	Fragment of a small shell with groove.
4.	— — —	Do. do. do.

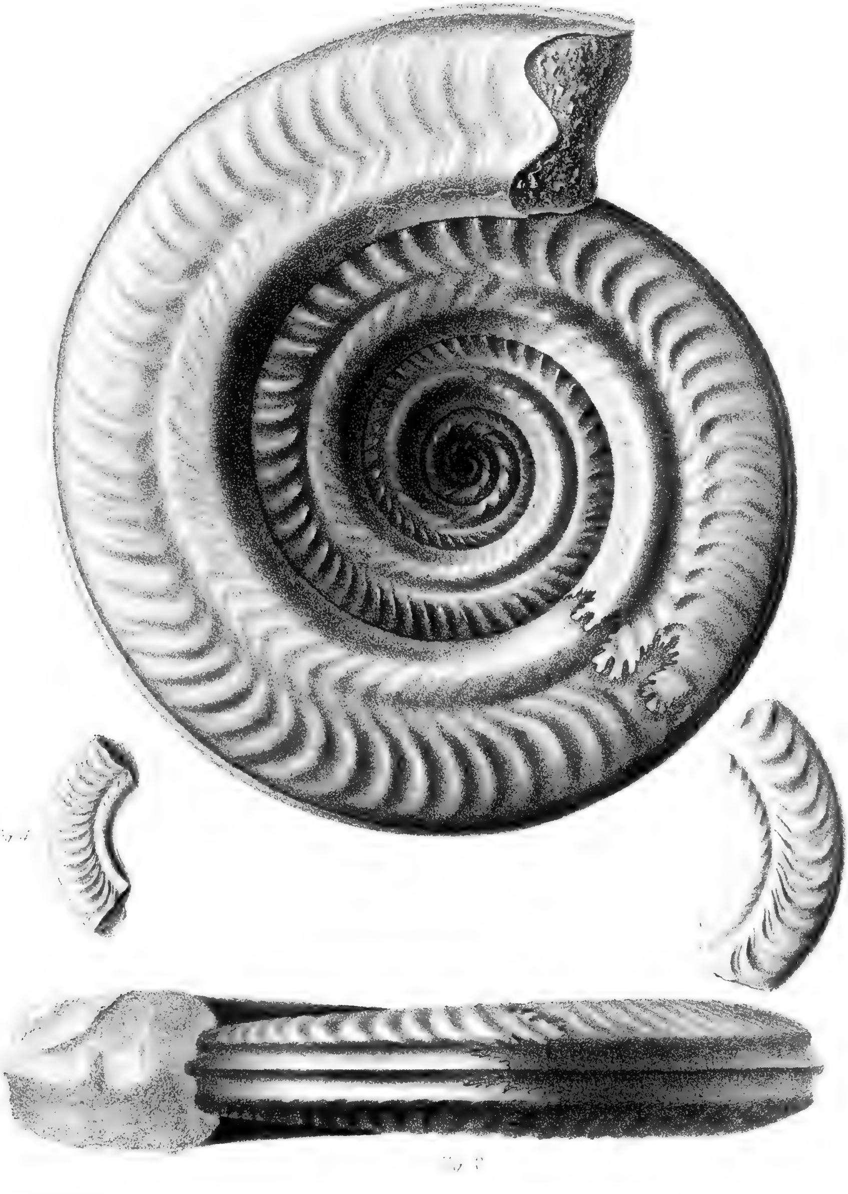


Fig. 4

Fig. 3

Fig. 2

Hanhart imp

PLATE LX.

Zone of Harpoceras bifrons.

Fig. 1. Harpoceras Levisoni, *Simpson.* Side view, natural size, showing side aperture, lobes, process, and lobe-line. My collection.

2. — — — Siphonal area and keel, natural size.

Fig. 1.

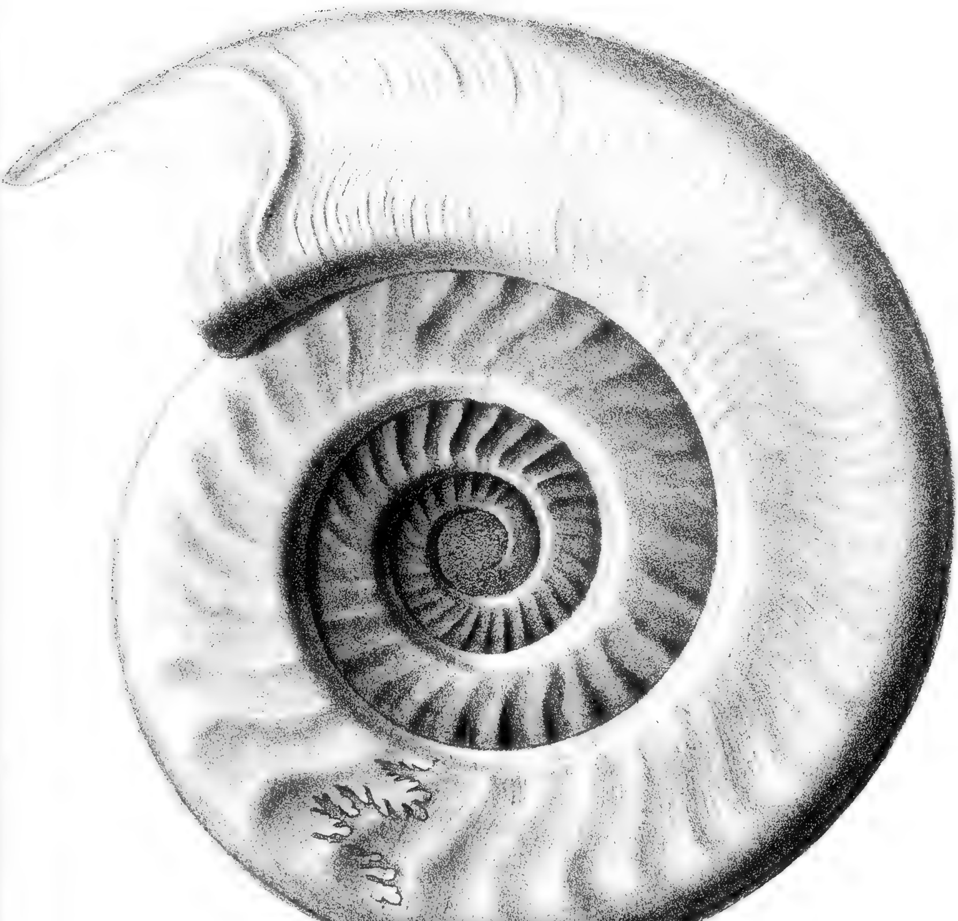


Fig. 2.

A. Gawan del et lith.

Hanhart imp.

PLATE LXI.

Zone of Harpoceras bifrons.

Fig. 1. Harpoceras Levisoni, *Simp.* Young condition with keel, bisulcations, and prominent ribs, natural size. Bath Museum.

2. — — — Side showing the lateral costæ, natural size.

3. — — — Lobe-line of a young costated shell.

4. — — — Another fragment with Aptychus. Bath Museum.

5. — — — Another specimen, side view of ribbing.

6. — — — Siphonal area and keel.

Fig. 1

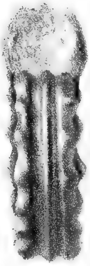


Fig. 3

Fig. 2

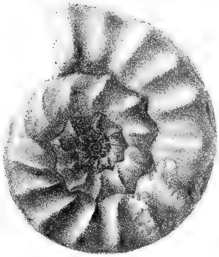


Fig. 4

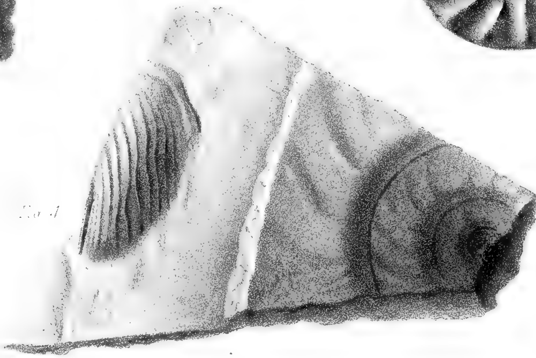


Fig. 5

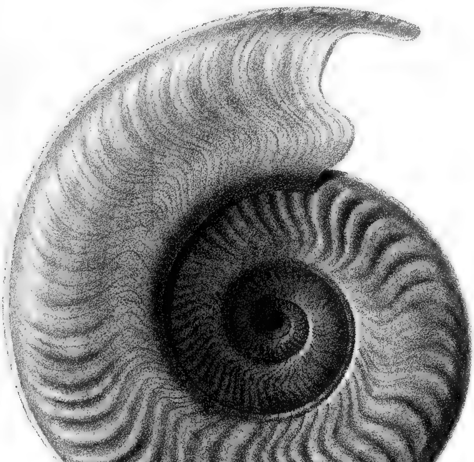
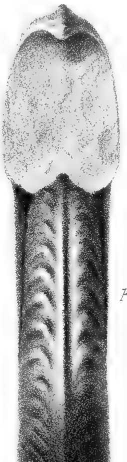


Fig. 6



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Hanhart imp

PLATE LXII.

Zone of Harpoceras serpentinum.

Fig. 1. HARPOCERAS EXARATUM, *Young* and *Bird*. Side view, natural size. My collection.

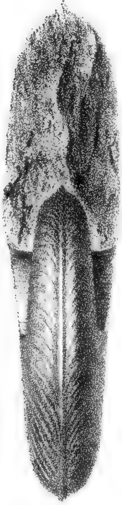
2. — — — Front view of do. do.

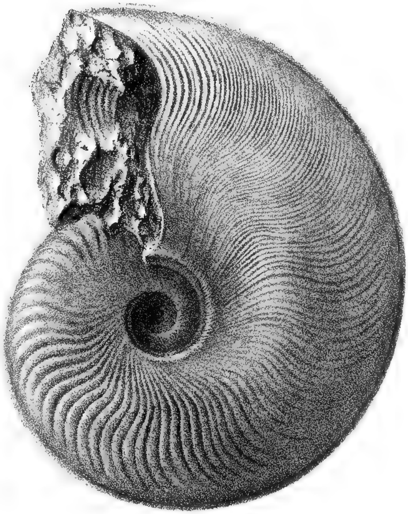
3. — — — Back view of do. do.

4. — LYTHENSE, — Side view, do. My collection.

5. — — — Back view of same, do.

6. — — — Front view do. do.





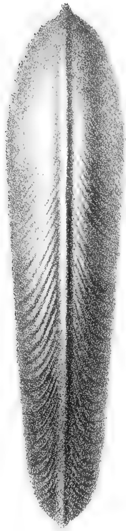


Fig.5

Fig 4

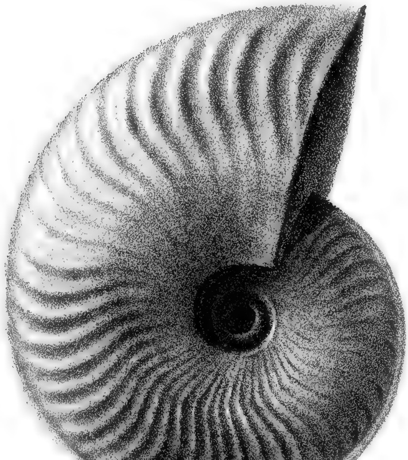
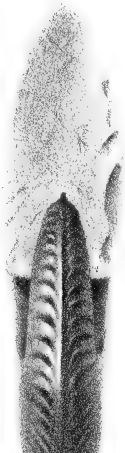


Fig.6.

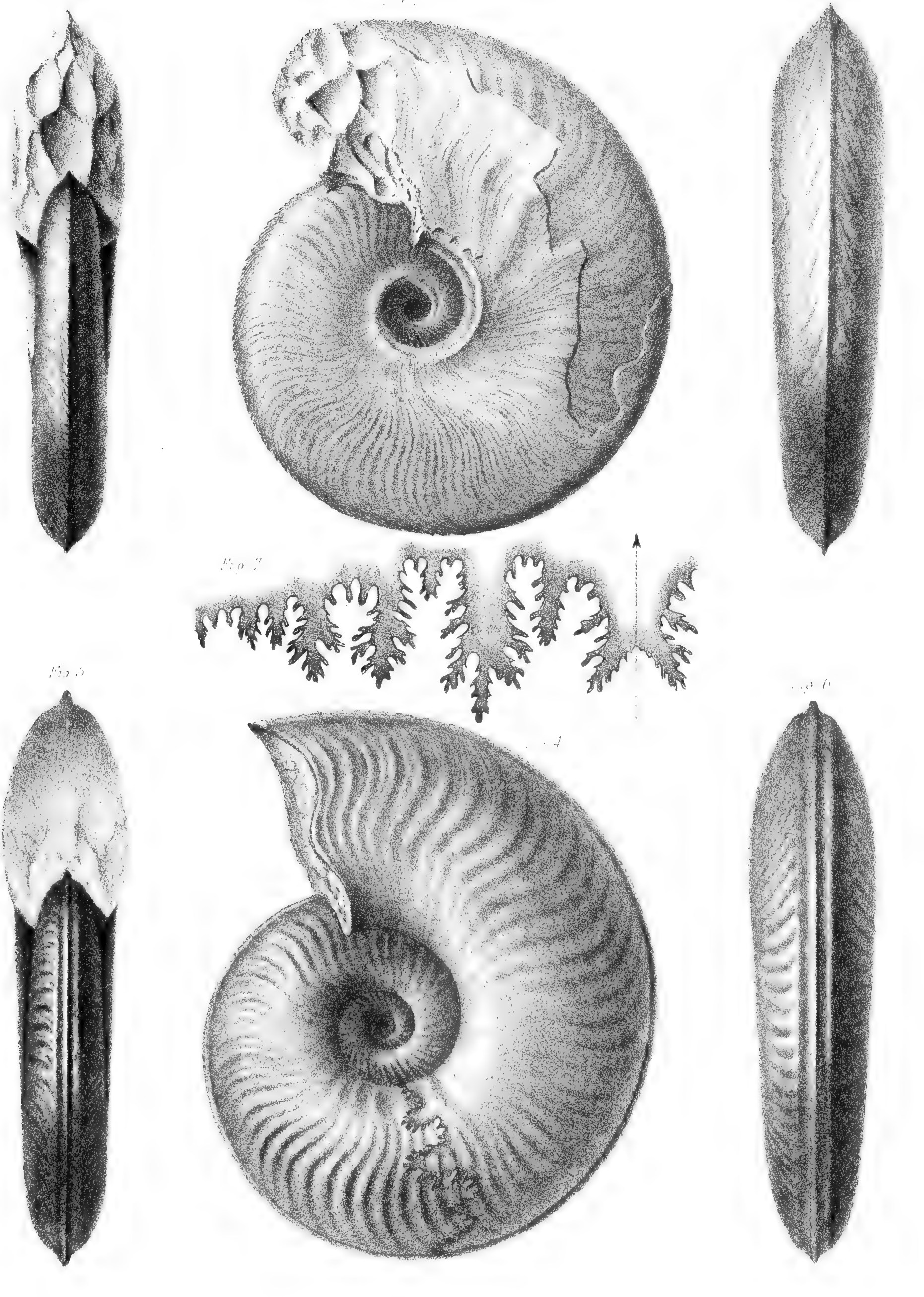


Hanhart imp

PLATE LXIII.

Zone of Harpoceras serpentinum.

Fig. 1.	HARPOCERAS ELEGANS, *Sowerby*.			Side view, natural size. My collection.
2.	—	—	—	Front view of same, do. do.
3.	—	—	—	Back view do. do. do.
4.	—	OVATUM, *Young* and *Bird*.		Side view do. do. do.
5.	—	—	—	Front view of same, do. do.
6.	—	—	—	Back view do. do.
7.	—	—	—	Lobe-line, magnified.



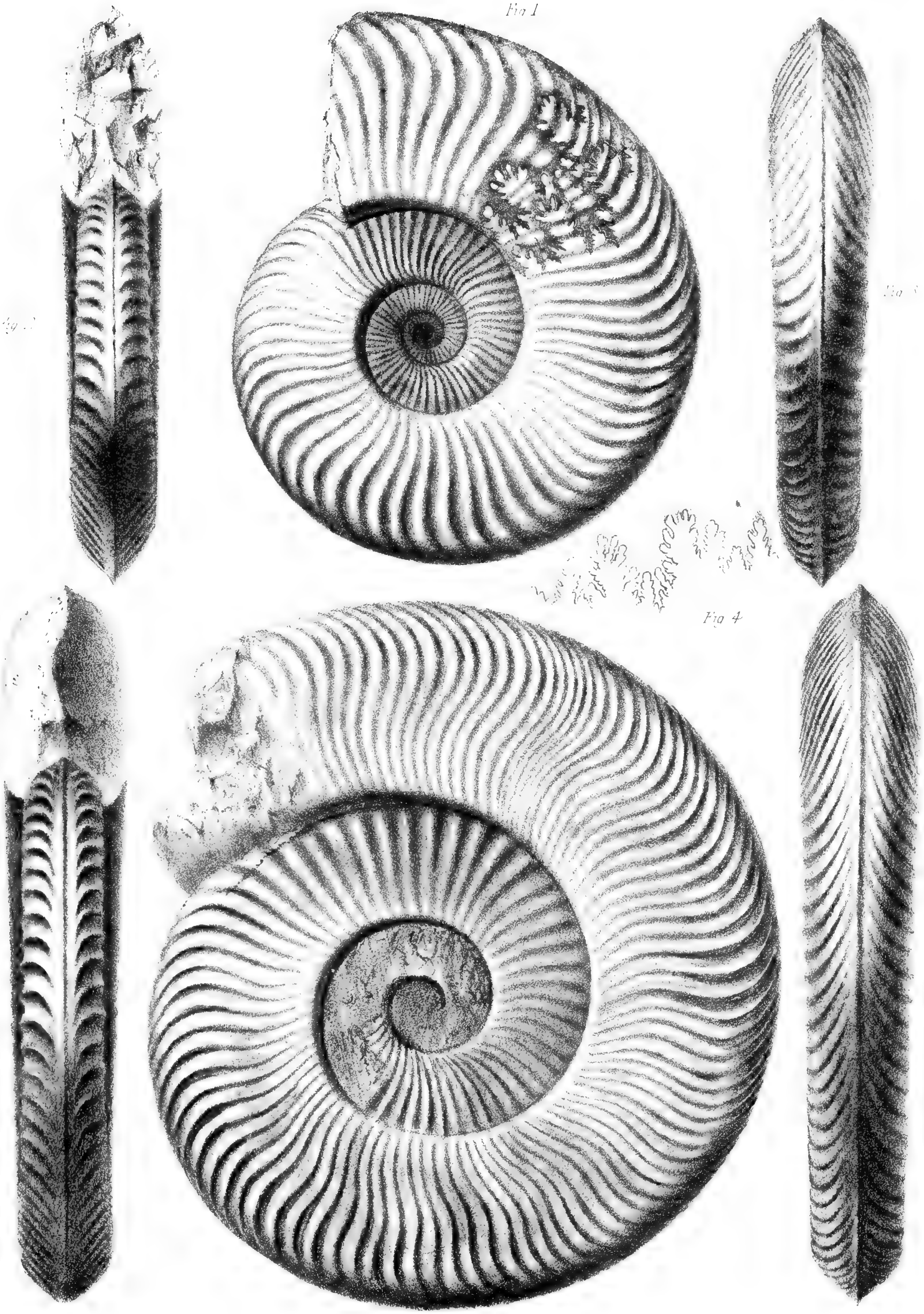
A.Gawan del et lith

Hanhart imp

PLATE LXIV.

Zone of Lytoceras Jurense.

Fig. 1.	Harpoceras radians,	*Schlotheim.*		Side view, natural size. My collection.
2.	—	—	—	Front view, do.
3.	—	—	—	Back view, do.
4.	—	—	—	Lobe-line, magnified.
5.	—	—	—	Another specimen, side view, do.
6.	—	—	—	Front view, do. do.
7.	—	—	—	Back view, do. do.



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Hanhart imp

PLATE LXV.

Zone of Lytoceras Jurense.

Fig. 1.	HARPOCERAS INSIGNE,	*Schubler.*		Side view, natural size. My collection.
2.	—	—	—	Front view, showing ribs and keel, natural size.
3.	—	—	—	Back view, do. do.
4.	—	—	—	Variety with spinous sides, do.
5.	—	—	—	Do., front view, do.
6.	—	—	—	Lobe-line, magnified, do.

Fig. 1

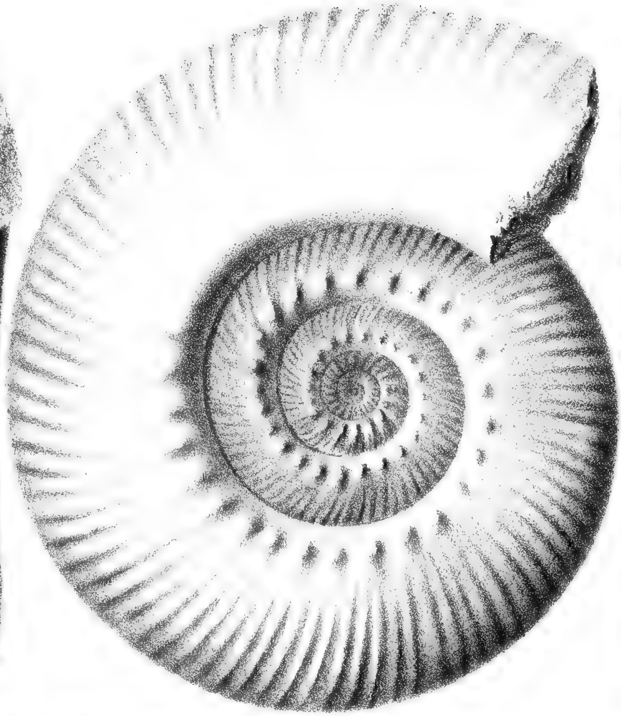
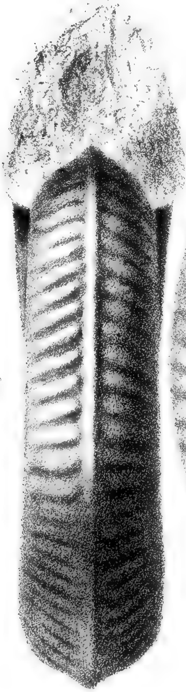


Fig. 2



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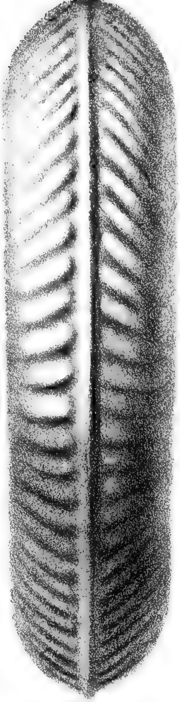


Fig. 4

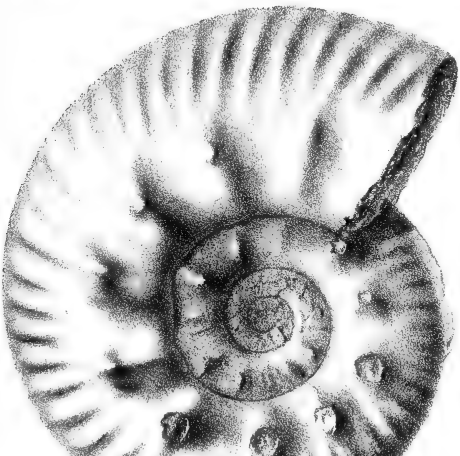
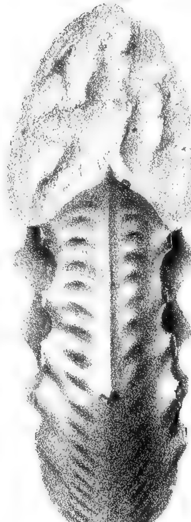


Fig. 6

Fig. 5



A. Gawan, del et lith

Hanhart imp

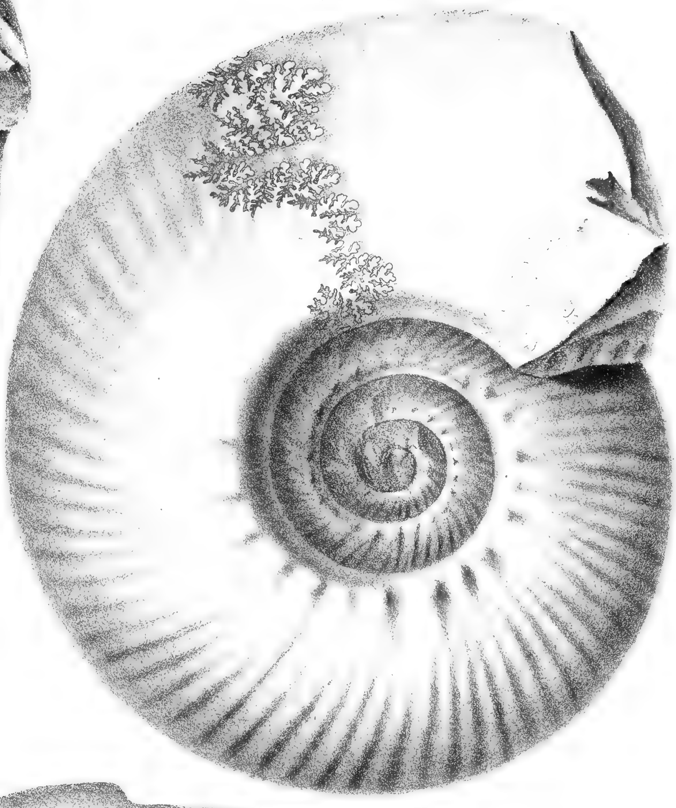
PLATE LXVI.

Zone of Lytoceras Jurense.

Fig. 1.	Harpoceras insigne, *Schubler*.	Side view, reduced half natural size.		
2.	— — —	Front view of this variety,		do.
3.	— — —	Back view,	do.	do.

This shell is contained in the Geneva Museum, and was collected in the Terrain Toarcien of Thouars, Deux-Sévres, France.

Fig. 1



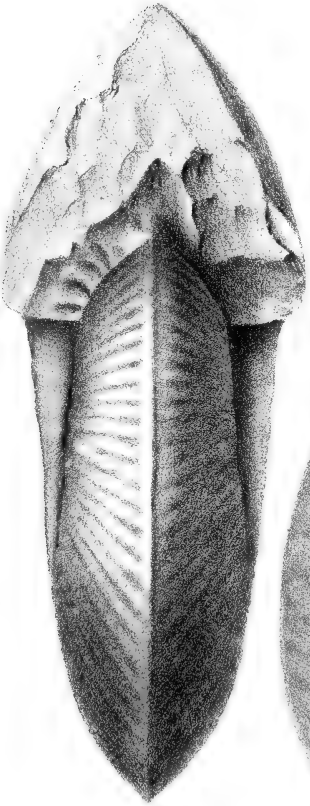


Fig. 2

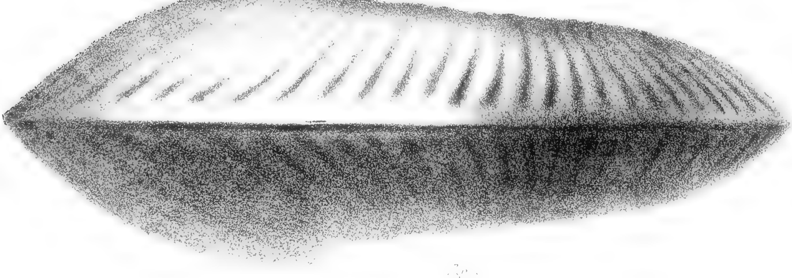


PLATE LXVII.

Zone of Lytoceras Jurense.

Fig. 1.	Harpoceras variabile, *d'Orbigny.*			Side view, natural size. My collection.
2.	—	—	—	Front view, showing siphuncle, do.
3—6.	—	—	—	Different forms of varieties of the species, do. My collection.

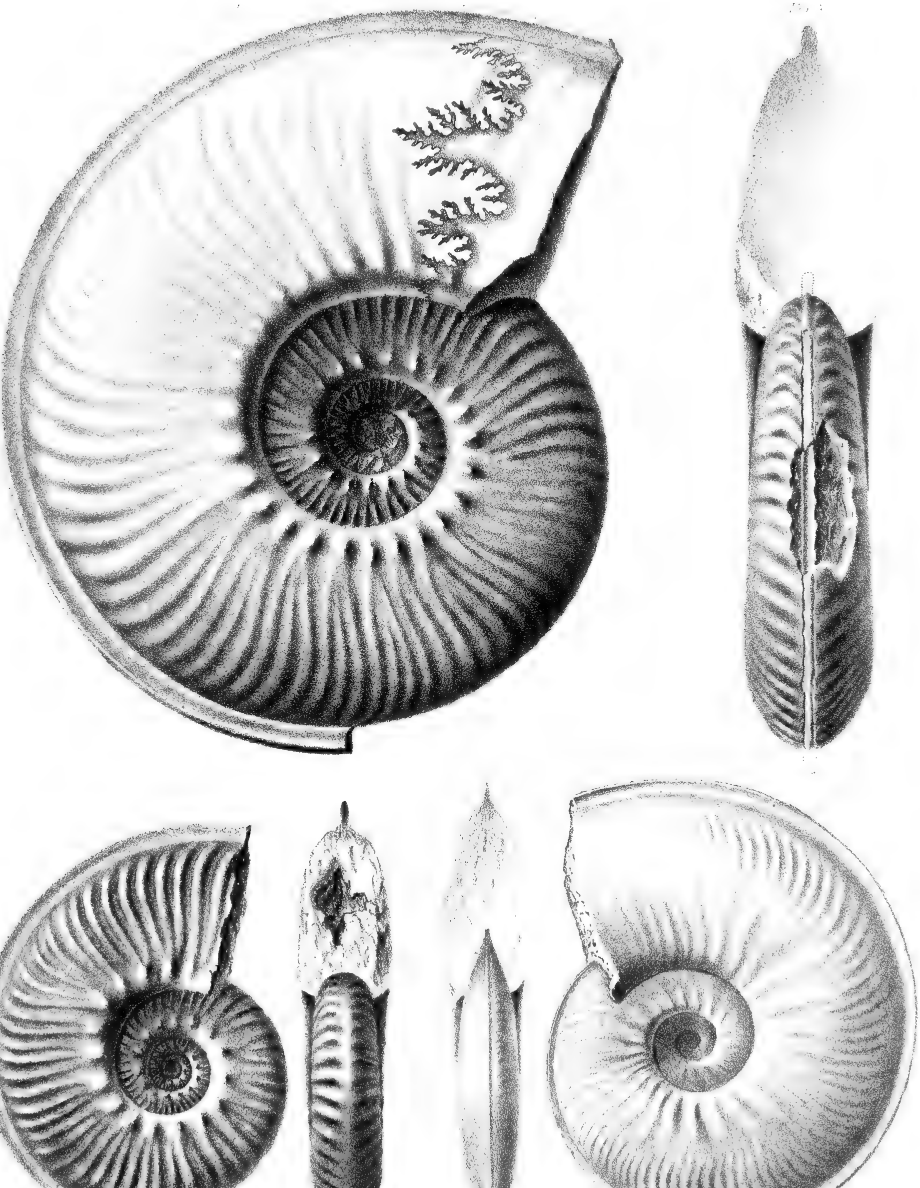


Fig. 5 Fig. 6 Fig. 3

Hanhart imp.

PLATE LXVIII.

Zone of Lytoceras Jurense.

Fig. 1. Harpoceras variabile, *d'Orbigny*. Grand specimen, natural size. My collection.

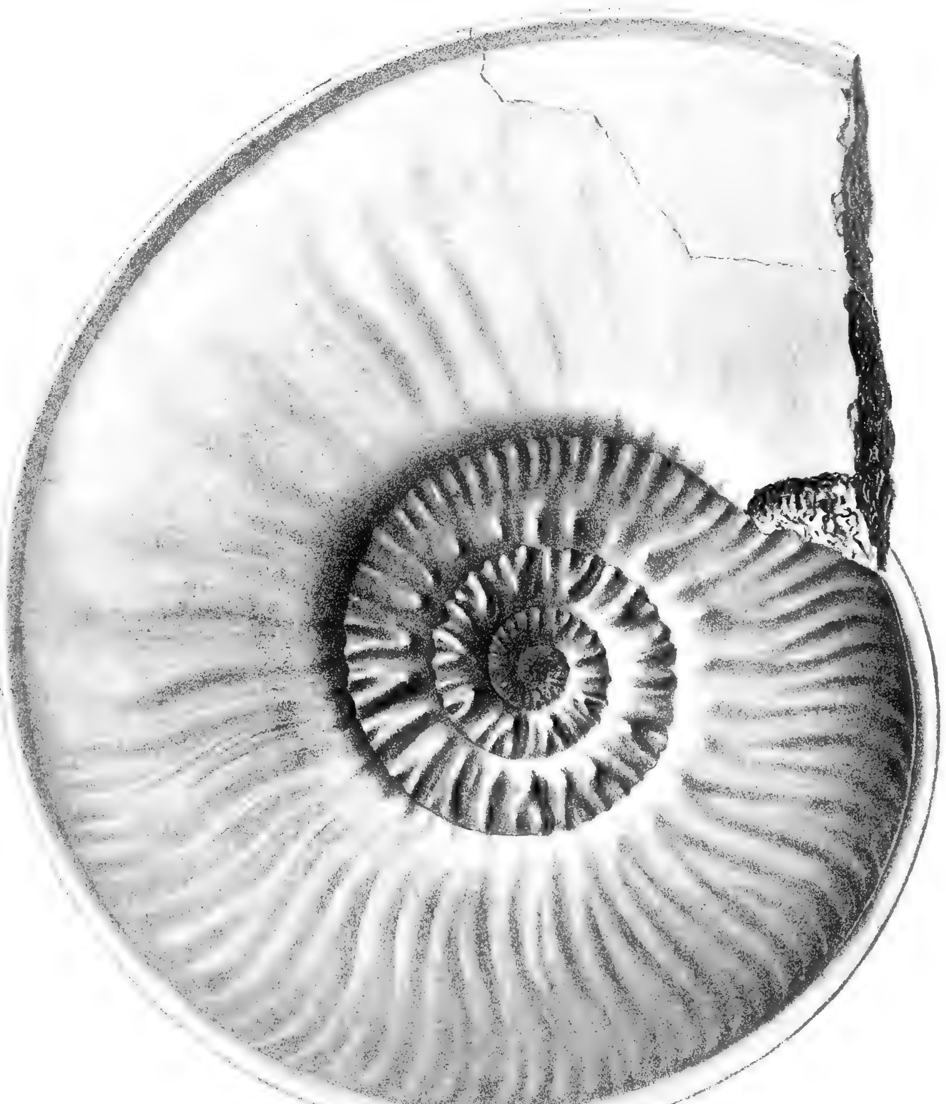


PLATE LXIX.

Zone of Aegoceras Henleyi.

Fig. 1. LYTOCERAS LINEATUM. Side, natural size. My collection.

Zone of Aegoceras Ibex.

2. AEGOCERAS VALDANI, *d'Orbigny*. Side view, natural size. My collection.
3. — — — Back view, do.
4. — — — Lobe-line, magnified.

Zone of Aegoceras Jamesoni.

5. — PETTOS, *Quenstedt*. Side view, natural size. My collection.
6. — — — Siphonal area and lobe-line, do.

Fig 1

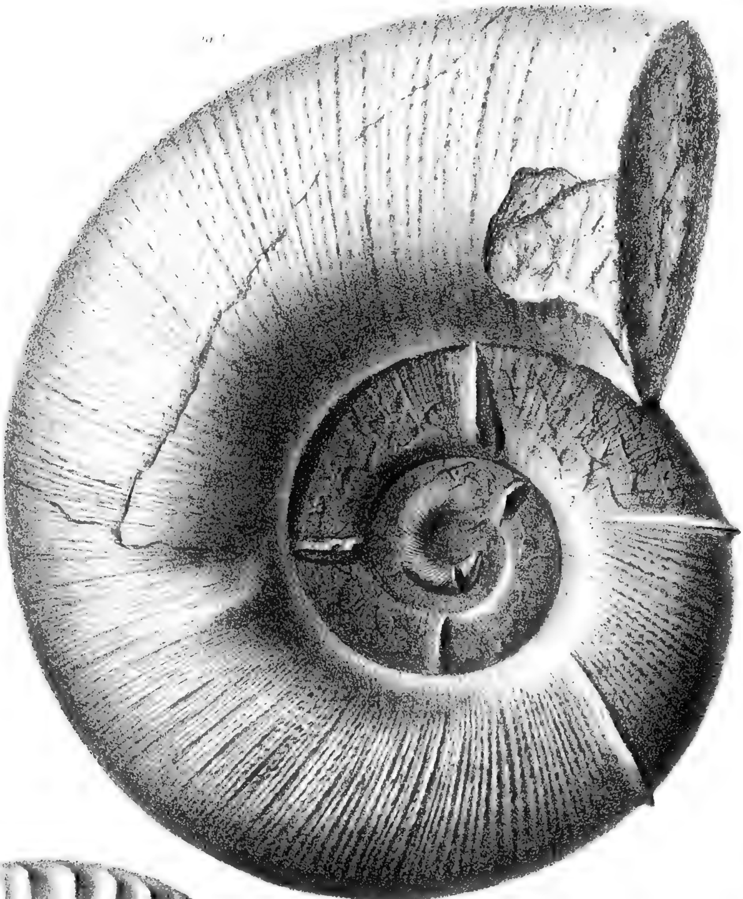


Fig 2

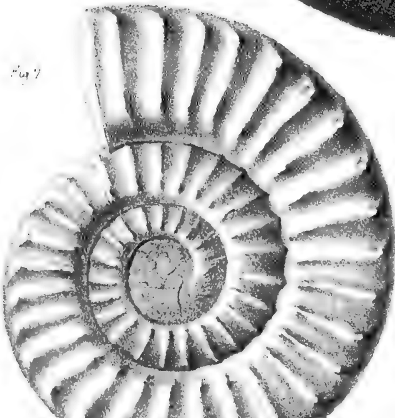
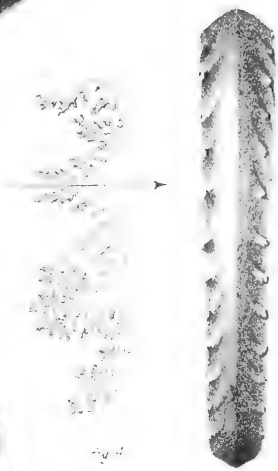


Fig 3

Fig 4



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