

PALÆONTOGRAPHICAL SOCIETY.
VOL. XXXVII.

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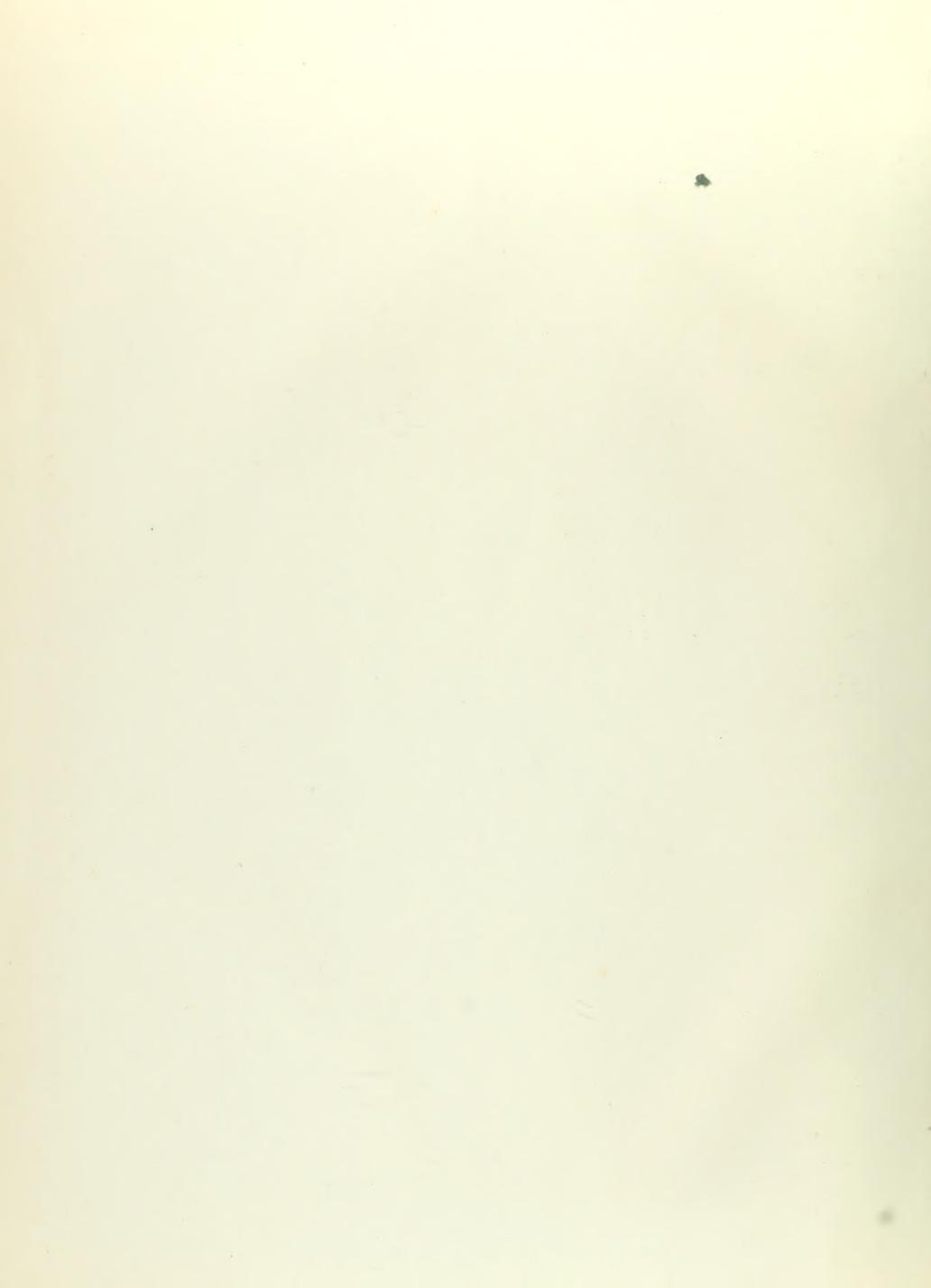
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PALÆONTOGRAPHICAL SOCIETY.

VOLUME XXXVII.

CONTAINING

- THE EOCENE FLORA. Vol. II, Part I. By Mr. GARDNER. Nine Plates.
- THE TRILOBITES OF THE CAMBRIAN, SILURIAN, AND DEVONIAN FORMATIONS. Part V
(*Conclusion*). By the late Mr. J. W. SALTER.
- THE CARBONIFEROUS TRILOBITES. Part I. By Dr. H. WOODWARD. Six Plates.
- SUPPLEMENT TO THE FOSSIL BRACHIOPODA. Vol. V, Part II (SILURIAN). By Dr. DAVIDSON.
Ten Plates.
- THE FOSSIL TRIGONIÆ. Supplement No. 2 (*Conclusion*). By the late Dr. LYCETT. Four Plates.
- THE LIAS AMMONITES. Part VI. By Dr. WRIGHT. Eight Plates.

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OCTOBER, 1883.

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- 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
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§ I. CATALOGUE OF WORKS

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THE PALÆONTOGRAPHICAL SOCIETY:

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 Lepadida, 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.

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|--------------------------------|-------|--|--|
| | | | <ul style="list-style-type: none"> 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. |
| Vol. VIII. Issued for the Year | | | <ul style="list-style-type: none"> The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Balanites and Verrucites, 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. |
| | *1854 | | |
| „ IX. „ | †1855 | | <ul style="list-style-type: none"> The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates. The Reptilia of the Wealden Formations, Part III, by Prof. Owen, 12 plates. The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards, 4 plates. The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates. The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates. The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright, 10 plates. |
| „ X. „ | 1856 | | <ul style="list-style-type: none"> The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright, 12 plates. The Fossil Crustacea, Part I, London Clay, by Prof. Bell, 11 plates. The Fossil Brachiopoda, Part IV, Permian, by Mr. Davidson, 4 plates. The Fossil Brachiopoda, Part V, No. 1, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part IV (Supplement No. 1), by Prof. Owen, 11 plates. The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen, 2 plates. |
| „ XI. „ | 1857 | | <ul style="list-style-type: none"> The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright, 14 plates. The Fossil Brachiopoda, Part V, No. 2, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen, 4 plates. The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen, 8 plates. The Polyzoa of the Crag, by Prof. Busk, 22 plates. |
| „ XII. „ | 1858 | | <ul style="list-style-type: none"> 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 | | <ul style="list-style-type: none"> 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 | | <ul style="list-style-type: none"> 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 Estheria, by Prof. Rupert Jones, 5 plates. The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell, 11 plates. |
| „ XV. „ | 1861 | | <ul style="list-style-type: none"> 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. |

* This Vol. is marked on the outside 1855.

† This Vol. is marked on the outside 1856.

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| 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. |
| „ XVII. | „ 1863 | { | The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter, 8 plates.
The Fossil Brachiopoda, Part VI, No. 2, Devonian, by Mr. Davidson, 11 plates.
The Belemnitidae, Part I, Introduction, by Prof. Phillips.
The Reptilia of the Liassic Formations, Part I, by Prof. Owen, 16 plates. |
| „ XVIII. | „ 1864 | { | The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright, 6 plates.
The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter, 11 plates.
The Belemnitidae, Part II, Liassic Belemnites, by Prof. Phillips, 7 plates.
The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford, 5 plates.
Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations. |
| „ XIX.* | „ 1865 | { | The Crag Foraminifera, Part I, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, 4 plates.
Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan, 10 plates.
The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward, 9 plates.
The Fossil Brachiopoda, Part VII, No. 1, Silurian, by Mr. Davidson, 12 plates. |
| „ XX.* | „ 1866 | { | Supplement to the Fossil Corals, Part IV, No. 1, Liassic, by Dr. Duncan, 11 plates.
The Trilobites of the Silurian, Devonian, &c., Formations, Part IV (Silurian), by Mr. J. W. Salter, 6 plates.
The Fossil Brachiopoda, Part VII, No. 2, Silurian, by Mr. Davidson, 10 plates.
The Belemnitidae, Part III, Liassic Belemnites, by Prof. Phillips, 13 plates. |
| „ XXI.* | „ 1867 | { | Flora of the Carboniferous Strata, Part I, by Mr. E. W. Binney, 6 plates.
Supplement to the Fossil Corals, Part IV, No. 2, Liassic, by Dr. Duncan, 6 plates.
The Fossil Echinodermata, Cretaceous, Vol. I, Part II, by Dr. Wright, 14 plates.
The Fishes of the Old Red Sandstone, Part I, by Messrs. J. Powrie and E. Ray Lankester, 5 plates.
The Pleistocene Mammalia, Part II, Felis spelæa, continued, by Messrs. W. Boyd Dawkins and W. A. Sanford, 14 plates. |
| „ XXII.* | „ 1868 | { | Supplement to the Fossil Corals, Part II, No. 1, Cretaceous, by Dr. Duncan, 9 plates.
The Fossil Merostomata, Part II, Pterygotus, by Mr. H. Woodward, 6 plates.
The Fossil Brachiopoda, Part VII, No. 3, Silurian, by Mr. Davidson, 15 plates.
The Belemnitidae, Part IV, Liassic and Oolitic Belemnites, by Prof. Phillips, 7 plates.
The Reptilia of the Kimmeridge Clay, No. 3, by Prof. Owen, 4 plates.
The Pleistocene Mammalia, Part III, Felis spelæa, concluded, with F. lynx, by Messrs. W. Boyd Dawkins and W. A. Sanford, 6 plates. |
| „ XXIII.* | „ 1869 | { | Supplement to the Fossil Corals, Part II, No. 2, Cretaceous, by Dr. Duncan, 6 plates.
The Fossil Echinodermata, Cretaceous, Vol. I, Part III, by Dr. Wright, 10 plates.
The Belemnitidae, Part V, Oxford Clay, &c., Belemnites, by Prof. Phillips, 9 plates.
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|-------------|--------------------------|--|
| Vol. XXIV.* | Issued for the Year 1870 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 Trigonie, No. I, by Dr. Lycett, 9 plates. |
| „ XXVII* „ | 1873 | <ul style="list-style-type: none"> 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 (Hylæochamps) No. VI, by Prof. Owen. The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen, 2 plates. |
| „ XXVIII* „ | 1874 | <ul style="list-style-type: none"> The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, 16 plates. The Carboniferous Entomostraca, Part I (Cyprinidnada), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady, 5 plates. The Fossil Trigonie, No. II, by Dr. Lycett, 10 plates. |
| „ XXIX* „ | 1875 | <ul style="list-style-type: none"> 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 Trigonie, No. III, by Dr. Lycett, 8 plates. The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen, 20 plates. |
| „ XXX* „ | 1876 | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates. The Fossil Trigonie, 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 (Palæoniscidae), 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. |

* 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.

CATALOGUE OF WORKS—Continued.

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| Vol. XXXII.* | Issued for the
Year 1878 | } | <p>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.</p> <p>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.</p> <p>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.</p> |
| „ XXXIII* | „ | 1879 | <p>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.</p> <p>The Fossil Trigonie, No. V (<i>Conclusion</i>), 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.</p> |
| „ XXXIV* | „ | 1880 | <p>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.</p> |
| „ XXXV* | „ | 1881 | <p>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 Trigonie (Supplement No. 1), by Dr. Lycett.</p> <p>The Lias Ammonites, Part IV, by Dr. Wright, 10 plates.
The Reptilia of the Liassic Formations, Part III (<i>Conclusion</i>), by Prof. Owen, 13 plates.
The Fossil Elephants (E. primigenius and E. meridionalis), Part III (<i>Conclusion</i>), by Prof. Leith Adams, 13 plates.</p> |
| „ XXXVI* | „ | 1882 | <p>The Eocene Flora, Vol. I, Part III (<i>Conclusion</i>), 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 (<i>Conclusion</i>), by Dr. Wright, 5 plates.</p> <p>Supplement to the Fossil Brachiopoda, Vol. IV, Part V (<i>Conclusion</i>), 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.</p> |
| „ XXXVII* | „ | 1883 | <p>The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner, 9 plates.
The Trilobites of the Silurian, Devonian, &c., Formations, Part V (<i>Conclusion</i>), by the late Mr. J. W. Salter.</p> <p>The Carboniferous Trilobites, Part I, by Dr. H. Woodward, 6 plates.
Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson, 10 plates.
The Fossil Trigonie (Supplement No. 2), by the late Dr. Lycett, 4 plates.
The Lias Ammonites, Part VI, by Dr. Wright, 8 plates.</p> |

* 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 1857.)*
- 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 Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter. *(Complete in the Volumes for the years 1862, 1863, 1864, 1866, and 1883. The Title-page and Index, with directions for the binding, will be found in the Volume for the year 1883.)*
- The Fossil Microstomata, 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 the 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 Trigonæ, 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.*)
- Supplement to the Fossil Trigonæ, by Dr. Lycett. (*Complete in the Volumes for the years 1881 and 1883. The Title-page, Index, with directions for the binding, will be found in the Volume for the year 1883.*)
- 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.*)

§ 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 Estherie, by Prof. T. Rupert Jones. *(Complete, with Title-page and Index, in the Volume for the year 1860.)*
- The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter. *(Complete in the Volumes for the years 1862, 1863, 1864, 1866, and 1883. The Title-page and Index, with directions for the binding, will be found in the Volume for the year 1883.)*
- 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 the 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 Trigonæ, 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.*)
- Supplement to the Fossil Trigonæ, by Dr. Lycett. (*Complete in the Volumes for the years 1881 and 1883. The Title-page, Index, with directions for the binding, will be found in the Volume for the year 1883.*)
- 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.*)

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, by Dr. H. Woodward.
- Supplement to the Fossil Brachiopoda, by Mr. T. Davidson.
- The Ammonites of the Lias, by Dr. Wright.

† 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.

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

- The Belemnites, by Professor Phillips.*
 The Sirenoid and Crossopterygian Ganoids, by Professor Miall.
 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.

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.
 The Cretaceous Asteroidea, by Dr. Wright.
 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 Rhaetic Mollusca, by Mr. R. Etheridge.
 The Carboniferous Bivalve Mollusca, by Mr. R. Etheridge, junr.
 The Silurian Fish Bed, by Dr. Harley.

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

† 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.
"	XXXVII	"	1883	"	"	"	October, 1883.

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (up to OCTOBER, 1893)—continued.

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years for which the volume containing the Monograph was issued.	III. Dates of the Years in which the Monograph was published.	IV. No. of Pages in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographs and Figures in each of Woodcuts.	VII. No. of Species described in the text.
The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter, COMPLETE	1862, 1863, 1864, 1866, 1883, 1884, 1865, 1866, 1867, 1883	BROUGHT FORWARD...	3387	443	7472	1452
The Carboniferous Trilobites, by Dr. H. Woodward, in course of completion	1883	1883	38	6	82	15
The Mesozoic 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
The 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 ^a , 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, Devonian and Silurian, in course of completion	1882, 1883	1882, 1883	242	17	943	76
The Fossil Trigonina, by Dr. Lyceet, COMPLETE	1872, 1874, 1875, 1877, 1879, 1881, 1883	1872, 1874, 1875, 1877, 1879, 1881, 1883	246	41	446	115
Supplement to the Fossil Trigonina, by Dr. Lyceet, COMPLETE	1847, 1855 ^b	1848, 1857	216	21	581	244
The Mollusca of the Crag, by Mr. S. V. Wood:— Vol. I. (Univalves), COMPLETE	1850, 1853, 1855, 1858 ^c	1851, 1853, 1857, 1861	344	31	691	253
Vol. II. (Bivalves), COMPLETE	1871, 1873, 1879	1872, 1874, 1879	322	18	517	232
Supplements to the Crag Mollusca, No. I and II, by Mr. S. V. Wood, COMPLETE	1882	1882	24	1	29	13
" No. III COMPLETE	1848, 1852, 1854, 1855, 1858, 1877	1849, 1852, 1855, 1857, 1861, 1877	361	34	625	275
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, continued by Mr. S. V. Wood, Vol. I, COMPLETE	1859, 1862, 1870	1861, 1864, 1871	182	25	531	194
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood, Vol. I, COMPLETE	1877	1877	24	2	66	30
Supplement to the Eocene Mollusca, by Mr. S. V. Wood (Bivalves), Vol. I, COMPLETE	1850, 1855, 1854	1850, 1853, 1855	282	30	846	419
The Great Oolite Mollusca, by Prof. Morris and Dr. Lyceet, COMPLETE	1861	1863	129	15	337	194
" Supplement by Dr. Lyceet, COMPLETE	1878, 1879, 1880, 1881, 1883, 1878, 1879, 1880, 1881, 1883	1880, 1881, 1883	440	80	637	84
" Supplement by Dr. Lyceet, COMPLETE	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	128	36	622	69
The Liassic Ammonites, by Dr. Wright, in course of completion	1861	1863	129	15	337	194
The Belemnites, by Prof. Phillips, in course of completion	1878, 1879, 1880, 1881, 1883, 1878, 1879, 1880, 1881, 1883	1880, 1881, 1883	440	80	637	84
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...	857	1070	23,500	4911

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (up to OCTOBER, 1883) — continued.

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years in which the Monograph was issued.	III. m. Dates of the Years in which the Monograph was published.	IV. No. of Plates in each Monograph.	V. No. of Librarians Figures and Woodcuts.	VI. No. of Species described in the Part.
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, COMPLETE.....	1853, 1854, 1855	BROUGHT FORWARD..	8857	23,500	4691
The Fossils of the Permian Formation, by Prof. King, COMPLETE	1849, 1854e	1863, 1865, 1867	67	319	79
The Sirenoid Gamoids, by Prof. Miall, in course of completion	1878	1878	297	511	138
The Fishes of the Carboniferous Formation, by Dr. Traquair, in course of completion	1877	1877	32	61	6
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, in course of completion	1867, 1869	1868, 1870	60	58	5
The Reptilia of the London Clay [and of the Blacklesham and other Tertiary Beds], by Prof. Owen and Bell, Vol. I, COMPLETE †.....	1848, 1849, 1856f	1849, 1850, 1859	150	304	39
" Vol. II, Part I, by Prof. Owen, in course of completion	1880	1880	4	4	1
The Reptilia of the Cretaceous Formations, by Prof. Owen, COMPLETE †.....	1851, 1857, 1858, 1862	1851, 1859, 1861, 1864	184	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	251	17
The Reptilia of the Wealden Formations (Supplements) in course of completion.....	1871, 1873, 1876, 1878, 1879	1872, 1874, 1876, 1878, 1879	81	175	15
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, in course of completion	1859, 1860, 1868	1861, 1863, 1869	16	23	3
The Reptilia of the Liassic Formations, by Prof. Owen, COMPLETE	1859, || 1863, || 1863, 1869, 1881a	1861, 1863, 1865, 1870, 1881	174	276	20
The Reptilia of the Mesozoic Formations, by Prof. Owen, in course of completion	1873, 1875, 1877	1874, 1875, 1877	97	165	17
The Crag Cetacea, by Prof. Owen, in course of completion	1869	1870	40	43	7
The Fossil Elephants, by Prof. Leith Adams, COMPLETE.....	1877, 1879, 1881a	1877, 1879, 1881	285	216	3
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and W. A. Sanford, in course of completion	1864, 1867, 1868, 1871, 1876	1866, 1868, 1869, 1872, 1878	304	253	7
The Mammalia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1870	1871	115	247	30
		TOTAL.....	10,450	27,210	5125

a Index. b Title-page to Univalves. c Note to Crag Molusca. 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. o Title-page and Index will be found in the 1861 Volume, or may be had separately. p Marked on outside label 'Reptilia of Oolitic Formations.'

§ V. STRATIGRAPHICAL TABLE exhibiting the BRITISH FOSSILS already figured and described in the ANNUAL VOLUMES (1847—1883) of the PALEONTOGRAPHICAL SOCIETY.

	P L A N T S.	PROTOZOA.		RADIATA.		ARTICULATA.					
		Sponges.	Foraminifera.	Corals.	Echinodermata.	Cirripedes.	Cyprides, Cytherines, &c.	Esteriace.	Merostomata.	Trilobites.	Malacostracous Crustacea.
Pleistocene .....	...	...	...	...	.....	.....	1874				
Crag .....	...	...	1865	1849	1852	{ 1851 1854 }					
Eocene	{ 1879 1880 1882 1883 }	...	...	{ 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 }	1883	
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—1883) 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 1852, 1854,	...	...	.....	{ 1869 1881
Eocene .....	...	{ 1852 1873 }	{ 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, 1883 }	{ 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, 1883 }	{ 1863, 1864, 1866, 1868, 1873, 1879, 1880, 1881, 1882, 1883 }	...	{ 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 1865, 1866, 1868, 1870,	.....	.....	{ 1867 1869 }		
Silurian .....	...	{ 1881, 1882, 1883 }					
Cambrian							

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

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

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A MONOGRAPH

OF THE

BRITISH EOCENE FLORA.

BY

JOHN STARKIE GARDNER, F.G.S., M.G.S. FRANCE, &c.

VOL. II. PART I.
GYMNOSPERMÆ.

PAGES 1—60; PLATES I—IX.

LONDON:
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1883.

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A MONOGRAPH
ON THE
BRITISH EOCENE FLORA.

INTRODUCTION.

THE study of Tertiary fossil floras appears hitherto to have had so few attractions that not one of the many competent British botanists has expressed a wish to undertake it. The material is fragmentary, and important organs are wanting, and they therefore consider the conclusions based upon them to be unsatisfactory. I would willingly have allowed, for my part, that my labour should have consisted in collecting specimens and accumulating facts for the use of men with more special knowledge, but on account of their silence, and lest the material should perish, I here venture to describe the British Eocene Coniferæ.

Such considerations have not weighed to the same extent abroad, and so large a number of works have been published on fossil plants that it seems strange that scientific speculation should have been so little influenced by them. The most ordinary inductions that these investigations might have given rise to have been overlooked, though they would often have facilitated the determination of the plants themselves.

The Marquis de Saporta, whose work takes the widest grasp, has almost alone seized the obvious inference that a flora within the Arctic circle must, in a period of decreasing temperature, have preceded the same flora in the latitude of Italy; and if the theory so ably argued by him, that a large proportion of the Miocene flora actually originated in the north, requires modification through more recent discoveries, it has at least served its purpose in rendering new departures possible. Any endeavour to connect the facts before us one with another, and render them intelligible, must add to their importance and enable geologists to follow with increased interest a study hitherto given over to specialists.

Our Eocene floras, from below the London Clay, for example, seem exceedingly homogeneous and present relatively few species. They are, as long since pointed out by Sir J. Hooker, in the case of fossil plants from Reading, of remarkably temperate aspect, the leaves and fruits of the Plane tree being conspicuous, among a number of undetermined prevailing types. This flora has sufficient leaves and fruit identical with

the Greenland plants in Mr. Whymper's collection, and which rarely occur in any other Tertiary floras, to show a close relationship. One inference from this is obviously that when the warmer Eocene period set in during the formation of the London Clay the older and more temperate Eocene flora was driven far north, where it probably remained until a gradual diminution of heat enabled it to come south again. The effect of the convergence on the land-areas of the Pole for so long a time of, perhaps, very dissimilar floras from different longitudes, consequent on this rise of temperature in the northern hemisphere in Eocene time, might naturally lead to a mingling to some extent of the floras of the three northern continents, so that they might have redescended enriched with a quantity of new forms. During all this lapse of time they were probably becoming modified in the direction of existing trees, and in that sense no doubt species did originate near the Pole as Saporta claims. When they reoccupied the temperate latitudes of Europe they constituted the Miocene flora. The discovery, which I have abundantly confirmed, of an Eocene temperate flora in the south of England—and consequently of a period when arctic conditions were probably not greatly dissimilar to those of the present—fully explains the break in the sequence between Cretaceous and Tertiary floras noticed all round the Arctic Circle; and is a considerable step towards a comprehension of the past, and even existing, plant distribution of the northern hemisphere, and one therefore whose ultimate bearings can as yet only be shadowed forth. The migrations, comparatively simple with regard to temperate floras, are infinitely complicated when those of the sub-tropics, which replaced them in Europe, are considered. The causes which led to the association together of types now characteristic of widely separated latitudes and longitudes in one area during the Middle Eocene must have been very varied, and seem, as yet, not to admit of any entirely satisfactory explanation.

These types, it is evident, are now to a great extent represented in areas as widely separated as tropical America, North-East Australia, and the East coast of Asia and adjacent isles. The plants from Mull and Antrim, described by some as Miocene, might, like those nearer the Pole, belong to any age between the beginning and the end of the warmer Eocene period; but they cannot be of earlier, and are unlikely to be of later date. Whether, and to what extent, the Cretaceous floras of Greenland and Dakota are connected with the older temperate Eocene floras, and what relationship the Aix-la-Chapelle flora bears to them and to still older Cretaceous floras, is as yet quite unknown and presents problems of deep interest.¹

¹ Towards the practical solution of such questions I have, during twelve years, collected plants from the British Eocenes. The results, although considerable, might have been greater had I found it possible to utilise assistance to any extent, but my experience has been that collections of fossil plants lose the greater part of their value when not directly made by those actually engaged in their study. I have further procured, where possible, collections from deposits of other countries, such as Sézanne, Gölinden, Céreste, and the Paris Basin, places whose Tertiary floras seemed likely to assimilate to those of Britain. Many collections of Tertiary plants have of late years come into the possession of the British Museum, and will, I hope, shortly be available for comparison.

When our British Eocene floras are compared with those of other countries we can hardly fail to observe that no Eocene or Oligocene fossils are described as occurring within upwards of two thousand miles of the Pole. All the fossil floras containing Dicotyledons within that radius have been in fact described as either Cretaceous or Miocene.

The correctness of this classification, which has been maintained and extended by Heer even in his latest works, is open to doubt, for there is no evidence in those regions of any break in the physical conditions which could have rendered unlikely the deposition of materials similarly adapted to the preservation of plant remains. Further, the supposed Miocene either rests directly upon, or is separated by not more than one thousand feet from the deposits described as Cretaceous. From the unquestioning way in which this classification has been generally received, we should expect to find it based upon well-nigh irresistible evidence. Instead of this, the Miocene hypothesis supposes that at least 25 per cent. of the forest trees and shrubs ranged at that period from Spitzbergen to Switzerland, and from Disco to Italy; a distribution without parallel at the present day. On the other hand, the temperature of the Eocene period would have been far more favorable to the growth of temperate floras in high latitudes; for the minimum estimated temperatures of our Middle Eocene and of the so-called Greenland Miocene differ by only 20° Fahr., or as nearly as possible one degree for each degree of latitude. At the present day the distance from England to Madeira produces an almost identical variation of temperature and a practically similar change in the flora. Setting aside, however, all other considerations, I believe I shall be able during the progress of this work to show that the evidence of the fossil plants themselves, relied upon by Heer, does not support the anomalies introduced by his classification, but, on the contrary, favours the view that deposition of sediment in which plants have been preserved did not cease in high latitudes during the Eocene period.

It is obvious, in such an inquiry, that floras from the south of England, supposed to be of the same age, are too widely separated in latitude from those of Greenland to permit of any useful comparison being made directly between their species. It would be almost tantamount to a person, totally unacquainted with the flora of the intervening American mainland, comparing the leaves of the forest trees of Cuba with those of Nova Scotia, in the hope of identifying them together. Their mutual relationship must chiefly be traced, and the problems contingent upon it solved, either through the older temperate Eocene floras, of which they may be supposed in part descendants, or through the deposits containing dicotyledonous plants preserved in intervening lands. Instances of the former are found at Reading, Newhaven, Bromley, &c., and of the latter in some of the western isles of Scotland, in Antrim County in Ireland, at several localities in Iceland, and possibly also in some of the many deposits of lignite in the Faroe Isles.

The specimens already obtained from Mull, though not very numerous, contain some striking forms of the English sub-tropical Middle Eocene, such as *Podocarpus*, mixed with

others common to Greenland. The newly-discovered deposit at Canna appears to have yielded only two species, both of which are also found at Mull. The Irish beds are generally admitted to be of the same age as those of Scotland, and have many species in common. They are especially interesting; for, while containing several species characteristic of our Middle and Lower Eocene, they also contain, like some of the Lower Eocene beds in France, Greenland species not yet recognised at Mull. As connecting links all these are therefore of the highest importance.

It is scarcely less important to obtain collections of plant remains from a series of beds of well-defined ages from as nearly the same latitude and longitude as possible, for a scale of temperatures, ranging from at least the Lower Eocene to the Pliocene, could be compiled from them. In England we have a probably unrivalled series of Eocene plants, whose relative ages, with the exception of those from Bovey-Tracy, are established on the most unequivocal palæontological and stratigraphical evidence. For the Lower Eocene group these are the floras from Newhaven, Reading, Dulwich, Bromley, Croydon, Lewisham, &c.; for the London Clay group, Sheppey, Herne Bay, Alum Bay, and Studland; for the Middle Eocene, Bournemouth and Bovey-Tracy; and for the Upper Eocene and Oligocene, Hordwell, Gurnett Bay, and Hempstead. From most of these localities collections may still be made, and some of them are remarkably prolific. Bournemouth has yielded a far larger number of distinct species of a Tertiary flora than any other locality; and I have received during the past two years nearly 20,000 fruits from Sheppey and Herne Bay.

In France the series of plant-bearing beds is even more complete. It commences, it is believed, at a lower stage, that called the "Paleocene" by Schimper, and extends upwards to the Upper Pliocene. The following list of localities from which floras have been obtained has been supplied by the Marquis de Saporta, who has at all times rendered me willing assistance. The Paleocene plants may to some extent, however, be equivalent to the Lower Eocenes of England. They are represented in the Paris Basin by the tuffs of Sézanne and the Grès de Belleu or Grès du Soissonais, in Belgium by the Gélinden limestone, and by the concretionary limestone of St. Gély (Hérault) in the South. The Calcaire-grossier stage is represented in the Paris Basin at the Trocadéro and by the Grès de Brives, and the Grès de Marne-et-Loire and of the Sarthe. It is, however, in Languedoc and Provence that the floras become of greatest interest, for there the sequence is uninterrupted from the Eocene, through the Tongrian or Oligocene, to the Mayencian stage of Heer. The exact sequence is:

Upper Eocene: Zone of Palæotherium.—Gypsum of Aix.

Lower Oligocene.—Gypsum of Garges.

Middle Oligocene.—*Calcaire marneux* of St. Zacharie.

Middle Oligocene.—*Calcaire marneux littoraux* of the Marseilles Basin.

Upper Oligocene.—Bonnieux and Céreste near Apt.

Newer Oligocene (*Oligocène récent*) or passage-beds to Aquitanian.—Armissan near Narbonne, and Brognon, Côte-d'Or.

Lower Aquitanian.—Lignites of Manosque (Basses Alpes).

Upper Aquitanian.—Clays of the Marseilles Basin and Schists of Gergovie.

Lower Miocene.—Ménat in the Auvergne.

Upper Miocene.—Mont Charray.

Newer Miocene (*Miocène récent*).—Flora of Théziers.

Lower Pliocene.—*Cinérîte du Cantal*, basaltic tufas of Auvergne, and tufas of Meximieux.

Middle Pliocene.—*Tufs de la Valentine* near Roquevaire (Bouches du Rhône), and *Marnes de Ceyssac*, Haute Loire.

Upper Pliocene.—*Marnes de Durfort* (Gard).

Twenty-three localities from which floras have been obtained are enumerated in this list. Those between the Gypsum of Aix and the Lower Miocene of the Auvergne form a practically homogeneous series in one locality, and are, therefore, of great value in tracing the gradual decrease in temperature, and the consequent departure or modification of the Tertiary plants of Europe.

Our British series is thus supplemented in France by both older and newer floras; and is repeated from the Middle Eocene upwards, but in a still more complete form, and seven degrees further to the South.

In America the conditions seem to be even more favorable, since a vast series of floras, ranging in age from Cretaceous to Pliocene, is known to exist in the Western Territories of the United States. If these can be connected, by the work of Principal Dawson, with those of the Arctic Circle, and if these floras and our own are ever studied with the same care that the Marquis de Saporta has bestowed on those of France, the results must be of most extreme value. A scale could then in time be constructed by which the ages of fossil floras of even remote countries might be determined, but which must otherwise remain doubtful. Such determinations are at present liable to error, as there are no recognised and fixed types from any latitude which are universally acknowledged to be characteristic of either the Cretaceous, Eocene, or Miocene systems.

In the first place, in determining the relative ages of fossil floras, the probability that temperature differed in somewhat the same degree as at present, in different latitudes and longitudes, seems seldom sufficiently considered, and an almost universally equable temperature in the Eocene and Miocene times has been assumed, without evidence that such was the case. The similarity between such widely separated fossil floras as those of Iceland and Italy renders it very improbable that they could be of the same age, especially if the causes which led to the increased warmth during the Eocene in high latitudes were purely terrestrial. Again, the probable nature of the station

in which the plants grew is rarely taken into account. It appears, for instance, that the floras of our Middle Eocene enjoyed an exceptionally favorable climate, moist and in close proximity to a very warm sea. Those of Aix, though so much farther south, had a dry and less favorable station, and therefore contrast with ours in point of luxuriance, for there moisture-loving plants seem to have been excluded until a later period. Other stations, such as Bovey-Tracey, eighty miles from Bournemouth, situated among hills which probably helped to furnish the materials of the Bournemouth deposits, may have stood considerably above the sea-level, and would present in consequence a slightly more temperate flora, which has been interpreted to be younger. In comparing American plants it should be remembered that the climate of the United States, even during the Eocene, was, latitude for latitude, cooler than that of Europe. Other examples might be instanced, but sufficient is stated to show that so far from it being possible to define the relative ages of fossil floras by their mere comparison, this class of palæontological evidence requires perhaps exceptionally philosophic treatment. A knowledge of the probable conditions under which Tertiary plants lived is an essential preliminary to their study, and a few considerations under this head will be of use.

The curves of the lines indicating the limits of trees towards the Pole, as well as of the isotherms, show very strikingly the cooling effects of descending Arctic currents upon the surrounding land. Wherever Arctic water penetrates in gulfs or bays, or finds egress, the limit of trees is deflected ten degrees south; while currents flowing northward carry the lines with them by fending ice off the shore. We need not seek farther than Iceland for an illustration of the changes in climate that a temporary diversion of an Arctic current will produce. In 1757 Greenland ice remained on the north shores of Iceland, and produced throughout the summer a cold equal to that of the depth of winter, which did not diminish under a mid-day sun, the air remained misty and snow fell frequently throughout May and part of June, preventing the growth of grass. The previous year snow fell to a depth of two feet on the 26th June, and continued to fall frequently during July and August with excessive cold. The ice left on the 28th August, and the snow then melted. A similar visitation in 1753 had destroyed nearly the whole of the cattle, and the ponies ate wood, peat, and flesh.

It seems from this example, and from the difference between the isotherms of Europe and America in the same latitudes, that ice-laden currents are of themselves capable of lowering temperatures by twenty or thirty degrees. It is a question whether the exclusion of ice altogether from the North Atlantic might not be sufficient to raise its temperature generally by some 20° Fahr. It is admitted that continuous land did exist during the Eocene period between Europe and America, in about latitude 70°, and this land must have completely excluded floating ice from seas to the South of it. If this cause were admitted to be capable of producing so great an effect, no other explanation of the presence of the floras that are met with in Greenland and in England would be required. The sudden rise seen in the temperature of the London-Clay period, both in

Europe and America, as well as the commencement of the warm Tertiary period in Greenland, might have been brought about by the completion of this land connection. Further, the universal gap in the Arctic plant series between the Upper Cretaceous of the Atane and the Eocene (the so-called Miocene) would also be explicable, since the plant-beds below the London Clay are filled with Plane and forms resembling Hazel and Lime, which represent a climate so nearly approximating to that of these latitudes at the present day that no forest of leafy trees could possibly have co-existed with them in the Arctic Circle.

There have been many attempts to restore the contour of Europe during Eocene and Miocene times. The principal difference appears in its central and southern parts, which were then to a large extent occupied by an extension of the Mediterranean Sea. India appears also to have been an island, and the chief mountain-ranges were hardly upraised. England was united to what then existed of France above water, and the two formed an isthmus which probably stretched towards Denmark and Scandinavia, and served to separate the waters of a then existing North Sea from a sea which extended south to the Mediterranean and Southern Atlantic. The present Eocene Basins of Hampshire and London seem to have formed part of one vast river-delta, which originally extended over portions of France as well; but, while the whole of our Eocenes are delta deposits, the plant-beds of Europe are almost exclusively lacustrine or tufaceous. Judged from the area and thickness of its deposits, the river which flowed from the west must have drained a land of continental dimensions, and it may well be that the then relatively small area of Europe, Asia, and a part of North Africa, was compensated by a vast stretch of land to the West, upon which the immensely varied Eocene forests, whose remains are to be described, must have succeeded each other. By some means or other there migrated to this continent, as the temperature increased, at first a flora whose predominating types seem to be Australian, and then a flora whose characteristics are essentially Neo-tropical. The latter, at least, were accompanied by a corresponding group of pulmonate Mollusca, a type of which, the gigantic *Bulimus* of the West Indies, swarms with its eggs in the Bembridge Limestone of the Isle of Wight. The Australian flora died out, or migrated South again, while the Neo-tropical flora passed across Europe, and seems to have reached finally the East Coast of Asia, where some of the Eocene species still appear to exist. The submarine ridges that have been mapped seem to furnish an explanation of the route that these migrations may have taken, and shadow precisely the connections which the plants independently prove to have existed; indeed it is difficult to imagine what the banks which traverse the ocean may signify if not either rising or sinking land. From beginning to end of the Tertiary Period the Western Continent, which, notwithstanding the prejudice that this name provokes, may as well be styled *Atlantis*, was diminishing while Europe was extending its area. Briefly sketched, these appear to have been the conditions under which the Eocene plant-world, to be described in these pages, existed. The

difference between deposition in flowing and in still water has, it will be seen, greatly influenced the relative characteristics of the floras.

Unfortunately authors when describing fossil plants have seldom given indications of the reasons which have led them to adopt one genus in preference to others with similar fruit or foliage; and they do not state why they have unhesitatingly attached generic and specific names to the most ordinary forms of leaf, whose bases or tops are wanting. If, for example, the suspicion communicated to me by a very distinguished botanist is well founded, that the oldest known dicotyledonous leaf is not *Populus*, and that the leaves determined as *Vitis*, from near the Arctic Circle, are not vines, all the theories built on their presence are valueless. The practice of identifying plants from different localities, by comparing them with lithographs, also very often leads to false assumptions; for, apart from inaccuracies introduced by artists and engravers, the finer variations, and, above all, the texture, are seldom represented; and single leaves especially can seldom be definitely identified without a comparison between actual specimens.

Although there are these difficulties, very valuable knowledge may be derived from the study, when the indefinite is omitted, and the same methods are used as in other branches of palæontology. It is fortunate that there are some fossil plants among those of the Tertiary Period which require no special ability to identify; others, however, require very careful consideration; and there are a few about which, in the present state of our knowledge, it would be unsafe to say anything, though it may be useful to record their existence. The relative value of these determinations should be made quite apparent and the indeterminate forms omitted entirely from all speculations.

I now pass on to a review of the groups of vegetable forms revealed in the British Eocene deposits.

GYMNOSPERMÆ.

ALTHOUGH the Gymnospermæ are classed with Dicotyledons and with Exogens in many Botanical Classifications, and are therefore placed in a higher scale than Monocotyledons, no apology is needed in a palæontological treatise for introducing them next to the lowest class, the Cryptogams. Lindley, in 1833, recognising their somewhat anomalous characters, grouped the Cycadeæ, Coniferæ, and Taxineæ into a primary division, called by him Gymnospermæ, equal in value to the Exogens and Endogens, and placed next the Acrogens or higher Cryptogams. They have since been variously placed; but, whatever value may be attached to them in classifications as a primary division, they are now recognised to include the CYCADACEÆ, the CONIFERÆ, and the GNETACEÆ.

The Gymnosperms so far exceed in antiquity either the true Dicotyledons or the Monocotyledons, that it has long been felt that through them, if at all, the evolution of Phanerogams from Cryptogams would be traced. Notwithstanding, however, that the external resemblance of Cycads to Palms, and the similarity of certain Coniferæ to Ferns and Club-mosses, had led to much speculation as to their derivation, no satisfactory connection could be traced; and although they have been often claimed boldly as the connecting link between the highest and the lowest classes of plants, all the evidence, when sifted, has hitherto proved at best negative; and the early appearance in geological time of so highly specialised a type of plant has consequently been made use of by the opponents of evolution. Darwin, indeed, contrasted the direct fertilisation of the naked ovule by the pollen, with the admirably ingenious contrivances by which many other plants are fertilised by insect agency. "Can we consider," he says, "as equally perfect, the elaboration by our fir-trees of dense clouds of pollen, in order that a few granules may be wafted by a chance breeze on to the ovules?" Lindley also considered them analogous to reptiles in the animal kingdom; but it seems to be reserved to Saporta and Marion to bring to light the actual stages through which the evolution of the Gymnosperms has taken place; and as we have been led in their 'Evolution of Cryptogams' from the primeval Cellular Thallogen, step by step, through Vascular Cryptogams up to the Gymnosperm, so may we hope that their forthcoming volume will trace, as satisfactorily as they feel confident it will, the stages through which the

Phanerogam has become in its turn developed from the Gymnosperm.¹ To the present, however, the remains of former forests which have been found scattered, with wide intervals, through stratified rocks, have scarcely rendered it possible to trace the lines through which the evolution of any of the existing groups of plants has taken place. Still the known antiquity of completely differentiated Acrogens and Gymnosperms is such that we can only suppose the common ancestors of the spore-producing Lycopod and seed-producing Gymnosperm to be locked up in the form of graphite and other carbons in the estimated 70,000 feet of sedimentary strata comprised between the Laurentian and Devonian formations. Yet in a general way the development of the vegetable kingdom may be divided, as long since pointed out by Adolphe Brongniart, into three great periods—that of the Acrogens, of the Gymnosperms, and of the Angiosperms. In the oldest sedimentary rocks there are, as is well known, few recognisable plant remains; but in the Silurians, impressions ascribed to Cryptogams, and wood of a very anomalous and primitive character, are occasionally met with. In some of the Devonian rocks wood with the typical coniferous structure abruptly appears; but in other localities of the same age wood has been found with a structure tending to show that the Coniferæ were less completely differentiated. Angiosperms appear much later.

In 1831 Witham pointed out that the higher and more complex organisation of Coniferæ existed in the Carboniferous strata of Edinburgh and Newcastle. This was at one time believed to possess an Araucarian structure, and more recently to be nearer the Pines; but there is a complete absence of true cones in the Carboniferous; and the fruits, such as *Trigonocarpus* and *Neggerathia*, have been thought by Hooker and Saporta to be allied to Ginkgo. If the frequent reference of the earliest known Conifers to such types as *Araucaria* and Ginkgo should be confirmed by future discoveries, it would be a matter of considerable interest to find that the forms, which at the present day still closely approach in their foliage the Club-mosses and Ferns, are the older types. Ginkgo presents in its mode of seeding, according to Saporta and Marion, a nearer approach to Cryptogams than to any existing Phanerogam.

From the base of the Permian the Gymnosperms are more defined. *Voltzia*,

¹ The publication of that important work 'L'Evolution des Phanérogames' has been delayed owing to the desire of its authors to vindicate the determinations of Algæ in 'L'Evolution des Cryptogames,' and a comprehensive memoir on "Les Algues Fossiles" has appeared. In the meantime the Marquis de Saporta has favoured me with a note (29th November, 1882), in which he informs me that the parts treating of the *Progymnosperms*, *Gymnosperms*, and *Metagymnosperms* or *Gnetaceæ* are completed: "Nous nous basons pour tracer le mouvement évolutif des Phanérogames sur l'étude analytique de la structure des tiges ou plan caulinaire et aussi sur celle des parties intimes et essentielles de l'ovule, de manière à faire voir comment le passage organique a pu s'opérer sans effort et graduellement des types cryptogamiques de l'ordre le plus élevé vers les Phanérogames proprement dites. Il y a là une série de nuances dues au déplacement ou à la distribution relatives des diverses zones de tissus composant la tige, et aussi une série de modifications conduisant de la macrospore à l'ovule et du prothalle inclus vers le sac embryonnaire et les corpuscules, qui permettent de saisir le sens et la direction du mouvement évolutif d'où sont à la fin sorties les vraies Phanérogames, d'abord uniquement gymnospermiques."

formerly supposed to possess near affinities with *Araucaria* and *Cunninghamia*, has been thought by Saporta to belong to the *Taxodiæ*, the very distinct types of foliage included in the genus perhaps accounting for the divergent views. The widely-spread *Walchia* and *Ullmannia* have been generally supposed to be *Araucarian*, although the latter has also been placed in the *Cupressinæ*. The *Cycadacæ* were largely developed throughout the Permian and until the close of the Jurassic period.

In the Trias, besides some doubtful *Cupressinæ*, two prevailing types occur—a form of *Voltzia*, thought by Schimper to be related to the existing *Cryptomeria*, and *Albertia*, related to *Dammara*. Coniferous structure is abundant in the Lias, both the *Araucarian* and *Pine* structures having been partially recognised, and we meet with the names *Widdringtonites* and *Thuyites*. Four species of the latter are known from the Stonesfield slate besides *Araucaria*; and *Solenhofen* has been stated to have yielded *Pinus*, *Araucaria*, and *Arthrotaxites*. The Secondary Period has in fact been described as the age of *Gymnosperms*; and during the Jurassic especially they formed almost the entire forest vegetation. Schimper enumerates more than sixty species of *Cycadacæ*; the *Cupressinæ* and *Taxodinæ* are undoubtedly represented; and what appear to be cones of true *Araucaria* and *Pinus* have been met with in several localities at home and abroad. *Ginkgo digitata* is indistinguishable from the existing *Ginkgo*, and the *Pachyphyllum* from the middle estuarine series of Yorkshire bears a striking resemblance in its foliage to *Araucaria Cunninghami*, but possesses very much smaller and persistent cones.

The Wealden Flora scarcely differs from that of the Jurassic. The scanty British Cretaceous Flora, described by Carruthers, is almost entirely Coniferous; *Cedrus* having been met with in the Lower Greensand at Maidstone, Shanklin, and Folkestone; *Pinus* and *Amber* in the Gault, and *Sequoia* in the Gault and the Blackdown Beds. The Cretaceous Flora of Hainault is also entirely Coniferous, and is described by Coemans as containing links between the existing groups of *Abies* and *Cedrus*, *Strobos* and *Pinaster*, *Cembra* and *Strobos*. Germany is said to have yielded cones of *Dammara* and *Araucaria* from the Cretaceous. Cedar cones have also been found in the Wealden of the Ardennes; and Cedar and *Pine* cones occur in the Lower Cretaceous of Havre. Most of these cones have, however, been described from unique or almost unique specimens, and from external characters only. The Cretaceous Flora of Aix-la-Chapelle, in which both coniferous fruit and foliage are abundant, warns us that very unexpected internal characters may be combined, even in the later Cretaceous rocks, in a cone which appears outwardly to be of an existing genus. Thus a cone bearing every outward resemblance to *Sequoia* possesses under each scale a number of *Cupressineous*-like seeds, while the foliage approaches that of *Libocedrus*. The *Columbea*, or broad-leaved, and the *Eutassa*, or needle-leaved, types of *Araucarian* foliage, are both met with in great abundance at Aix-la-Chapelle and also in French localities; their constant association together suggesting that they may belong to a single dimorphic species. Several very anomalous Coniferæ, such as *Inolepis* and *Cyparissideum*, are met with in the Lower-Cretaceous *Komeschichten*

of Greenland, and elsewhere, in beds of the same age; the whole tending, perhaps, to show that the existing genera of Coniferæ were less completely differentiated previous to the Eocene time than has been generally supposed. For the Arctic Kome Heer claims *Pinus* and *Tsuga*, and *Pinus* and *Abies* for Atane; the leaves of *Pinus Credneri* are described as lying in thousands on some of the slabs; so that, even in Cretaceous times, forests of needle-leaved Coniferæ must have characterised northern latitudes. *Pinus* and *Sequoia* are also described from the North-American Cretaceous of Dakota.

In the Tertiaries the Gymnosperms are quite subordinate to the higher Phanerogams, yet in 1878 Lesquereux estimated that no fewer than 225 species were known from them.

Of the three orders of Gymnosperms two are recognizable in British Tertiary rocks, the Cycads being absent, and the Gnetaceæ only met with in the London Clay of Sheppey. Of the six orders of Coniferæ all seem more or less certainly represented.

Among the Cupressinæ, there is *Libocedrus* foliage from Bromley and from the London Clay perfect examples of fruits, apart from the doubtful species of Bowerbank, belonging to a section of *Callitris* met with in Australia; though only that now confined to Africa occurs in Ettingshausen's list of Sheppey fruits. But there is no ground for including *Callitris* or Cupressinites in the Alum-Bay flora. In the Tertiary swamp-clay of Bournemouth there are in places innumerable detached twigs, which precisely resemble those of *Sequoia Couttsiæ* at Bovey; but the few cones associated with them are distinctly Cupressineous. Types of *Libocedrus* and *Thuya* appear in the South of France in the Oligocene, and the North-African *Callitris* is found in the Eocene of Aix. A number of other Cupressinæ have been described from fragments scarcely deserving notice. Of the Taxodiæ we appear to have representatives of *Sequoia*, *Taxodium*, and perhaps *Athrotaxis*; but those in the Alum-Bay list are probably Podocarps of a single species. The *Sequoia Bowerbankii* of the Sheppey list by Ettingshausen, found only at Herne Bay, and in which four species of Bowerbank's *Petrophiloides* had been absorbed by Heer, is a cone of the Alder, and bears no resemblance to *Sequoia*. *S. Langsdorfi* may occur at Mull and Antrim, but the foliage only is known. *S. Couttsiæ* from Bovey is one of the oldest Eocene forms; and, unlike other species characteristic of the European Tertiaries, was not dimorphic. The Arctic species confounded with *S. Couttsiæ* is also found at Antrim. It is quite distinct, and might be fittingly named after Mr. Whymper, who brought many specimens from Greenland. *S. Sternerbergi* is, as originally described, an *Araucaria* allied to *A. Cunninghamsi*, but a distinct species of *Sequoia* has since been confused with it. The Arctic Cretaceous *Sequoiæ* were evidently polymorphous, and are divided into quite an unnecessary number of genera; as it is palpable in some cases that more care or good fortune in collecting would have shown that two or three supposed species grew on one branchlet. We have strong evidence of *Taxodium* and its sub-genus *Glyptostrobus* in England, foliage from Bournemouth belonging probably to the former as well as the latter. Both are represented in the Oligocenes and Miocenes of Europe and of Greenland, and are valuable indications of

temperature. Cones are of necessity associated with the fruits in most of the forms known definitely to belong to the Taxodiæ.

Of the Taxeæ, Ginkgo or Salisburia occurs in Ettingshausen's list of Sheppey plants; but it is just possible that the resemblance in the form of the seeds is accidental, for they appear to have a hilum, and are of much smaller size. Forms of Ginkgo are associated with nearly all the northern floras, from the Jurassic age onward, but seem absent in temperate Europe between the Jurassic and later Miocenes. The Podocarpeæ, again, are much more numerous than they appear in Ettingshausen's lists. At Bournemouth there are at least two types, one of which, with long articulated leaflets, extends north to Mull and Antrim, and is common in the Middle Eocene of Europe. There are Podocarp berries at Sheppey; and all the remains of Conifers from Alum Bay are now placed in a single species of Podocarp with dimorphic foliage.

Of the Araucariæ, Araucaria is certainly represented in our Eocene, and is confined to the upper part of the Bournemouth series. The former connection of this with the Australian region, indicated by this Conifer, is strengthened by Callitris and Podocarpus; while the remainder of the Coniferæ confirm the close connection with America and Eastern Asia, already rendered apparent by the Ferns. The Abietinæ have taught but little hitherto; but cones of Pinus have been found near Canterbury, at Herne Bay, the Isle of Sheppey, Bracklesham, Barton, Gurnet Bay, and Antrim. Ettingshausen believed that bodies resembling scales of cones from Alum Bay, and a pair of indistinct acicular impressions from Bournemouth, indicate the presence of Pinus in these floras. Strong evidence that all the freshwater deposits, whence floras are obtained in England, were deposited in running water is afforded by the fact that they are so devoid of remains of Pines; since it is certain, from their common occurrence in the marine formations, that they formed part of our flora throughout the whole Tertiary Period.

Sir Joseph Hooker has recently expressed the opinion that "Of all the orders of fossil plants of the formations referred to (the Cretaceous and Tertiary strata of North America), the Gymnosperms alone have, as a rule, yielded much trustworthy information; and this is due to their texture, to the peculiar character of their vegetative and reproductive organs, to the frequent adhesions of these to the branchlets, to their gregarious habits, to their wide distribution, and to their close affinity with existing species." But the study is, on the other hand, rendered difficult by the great similarity existing between the foliage of widely separated genera, and the rarity with which fruits are found associated with it, at least in deposits formed in flowing rivers. The relative persistence of the various fruits to the branchlets, the piecemeal manner in which so many cones are shed, and the greater length of time they float compared to the foliage, are points seldom taken into account. Just as we might infer when pinnæ of Ferns are found abundantly without any trace of sori that the fertile fronds were separate, so when cones are never mingled with foliage we might suppose that they were shed either piecemeal, or at a different time of year, or else possessed very different powers of flotation.

Order—CYCADACEÆ.

These are palm-like Gymnosperms with usually unbranched stems, often marked with lozenge-shaped leaf-scars, and bearing parallel-veined, hard, pinnate leaves. The wood is soft and pith-like, with the characteristic gymnospermous structure. The seeds are hard and woody, and borne on the edges of modified leaves, or in large cones, which are either sessile or pedunculate. They are generally low shrubs, but occasionally reach a height of thirty feet. They possess the general aspect of Palms combined with the fruit of the Coniferæ. There are two tribes, CYCADEÆ and ENCEPHALARTEÆ, with nine genera, and from 75 to 100 species, inhabiting intertropical or subtropical America, Asia, Australia, and the Cape.

For many years Cycads were believed to occur in the Carboniferous, but later investigation has not confirmed these views. They abounded in England during the Jurassics; and excellent illustrations of them are to be seen in Buckland's 'Bridgewater Treatise,' the 'Transactions of the Geological Society,' 2nd ser., vol. iv, and in Lindley and Hutton's 'Fossil Flora.' Carruthers has also published a monograph "on the Fossil Cycadean Stems from the Secondary Rocks of Britain," in which all the species are redescribed and figured.¹ They have also been met with in the Jurassic of Spitzbergen, and in great quantities in the Cretaceous Komeschichten of Greenland. They seem to become rare in the Newer Cretaceous of Atane, and disappear altogether in the Arctic Tertiaries. They migrated apparently from temperate Europe and America during the Tertiary Periods, and the few supposed remains of them found hitherto in the Tertiaries are in an unsatisfactory state of preservation.² None are known in our Eocenes.

Order—CONIFERÆ.

The Coniferæ form by far the most extensive of the Gymnospermous orders. As at present constituted, it consists of hard-wooded trees or shrubs, of exogenous growth, and with polycotyledonous embryos; but their woody structure is marked by discs, a peculiarity which renders it easily recognisable in almost every state of preservation. Their spiral vessels also are limited to the medullary sheath. They are both diœcious and monœcious; the female flower being either in cones or solitary, and the male flowers usually in deciduous catkins, composed of a number of scales, in the body

¹ 'Trans. Linn. Soc.', vol. xxvi, p. 675, 1870, (read June 18th, 1868). This appears by far the most important contribution to the history of Fossil Cycads, and is illustrated by ten very beautifully drawn plates. M. Renault, 'Cours de Botanique Fossile, Première année,' Paris, G. Masson, 1881, devotes the first six chapters to fossil Cycadaceæ.

² These are—a small fragment from the Miocene of Switzerland, named *Zamites tertiaris*, Heer; two fragments from Gélinden, named *Z. palæocenicus*, Saporta and Marion; a cycadaceous leaf and indistinct cone from Bonniueux, and the *Encephalartus* from Koumi, in Eubœa.

of which the pollen is contained (figs. 1 and 2). The name is derived from the cone or strobilus on which the great proportion of them produce their seeds (fig. 3). This is a fruit-spike, more or less elongated, and covered with scales or bracts, formed of metamorphosed leaves or branchlets; each scale has usually two seeds at its base, which are enveloped in a hard coriaceous integument, and often winged (fig. 4). The scales are sometimes united, as in the Cypress, and form a rounded mass, or become fleshy, as in the Juniper, where they unite to form a globular fruit or berry. In the *Taxæ* and



FIG. 1.—Male or Anther-bearing Catkin of Spruce Fir. Natural size.¹



FIG. 2.—Female or Ovule-bearing Catkin of Spruce Fir. Natural size.

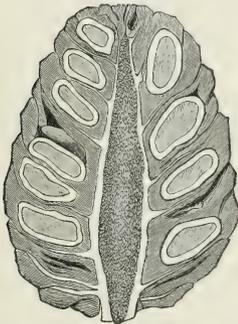


FIG. 3.—Longitudinal section of a cone of the Stone Pine (*Pinus pinea*), showing the relative position of the axis, scales, and seed. Two-thirds natural size.

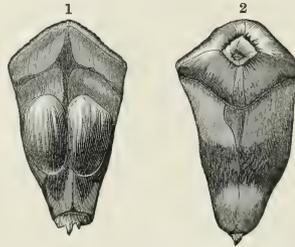


FIG. 4.—Scale of *Pinus pinea*, natural size. 1. Inner side with seeds. 2. Outer side, showing the swollen terminal portion called the *apophysis*, with its central protuberance.

Podocarpeæ the fruit is solitary and terminal, the external succulent covering being formed of modified bracts surrounding a naked seed. They are mostly trees or shrubs, with branched, resinous trunks, and abound in the temperate regions of both hemispheres.

Although they no longer play the chief part in forest vegetation, the *Coniferæ* still form a conspicuous feature in the physical geography of the earth. The needle-leaved Pines, Firs, Cedars, and Larches form enormous forests in the Northern Hemisphere;

¹ Figures 1 to 4 are from Veitch's 'Manual of the Coniferæ.'

and Araucarias, Podocarps, Dammaras, and Dacryds occupy corresponding tracts in the South. No genus inhabits the plains of the Tropics; they belong essentially to the Temperate and Subarctic Zones. In northern regions the members of this group outnumber the broad-leaved trees by ten to one; and even on the Pacific slopes of America extensive tracts are densely wooded by them, with scarcely any admixture of deciduous trees. The Pine-barrens of North America and the belt of Conifers in Northern Europe and Asia stretch almost continuously across the two continents, ceasing only with the limits of vegetation.

Notwithstanding the enormous areas still occupied by Coniferæ, instances are abundant of the areas of their growth and number of individuals becoming very sensibly lessened through contact with man or from changes of climate. The extinction of *Abies pectinata* and *A. excelsa* in England was probably due to a failure of heat. The diminution of *Taxus baccata* (the Yew) in England, and of many once common Pines and Firs in France, Switzerland, and Spain, the Cedars in Lebanon, and of the native Juniper and Yew in Madeira, are due to the agency of man. The limit at which Conifers cease to grow in Alpine forests in Switzerland is everywhere retreating towards the valleys, for Pines are not dwarfed there towards their superior limits, and do not creep as bushes to the verge of the snow-level as on other mountain ranges and towards the poles; but isolated and grand old Pines and Larches stand out in exceptional vigour beyond the rest. In many of these regions remains of large trees exist far above the limits of present forest vegetation; and the names of some now bare heights and valleys indicate their former wooded nature. In Siberia, on the other hand, the Larches seem to be creeping still farther north as trailing shrubs, and are now among the hardiest trees in existence.

Their majesty, symmetry, or fairy grace, their resinous fragrance, and their dry and open character give to Coniferous forests a charm seldom possessed by the often bare or dankly decaying forests of deciduous trees.

The stupendous size that individual Conifers attain has long excited wonder, though this is actually understated in text-books. Specimens have been seen of *Abies Douglasii* 309 feet in height, *A. Menziesii* 318 feet, *Picea grandis* 321 feet, *P. nobilis* about the same, *Pinus Lambertiana* 300 feet, and *Thuja gigantea* 325 feet; while the *Sequoias* are reputed to reach 400 feet, exceeding every forest tree in solid masses of timber. The Himalayan Pine and Deodar reach 200 feet; and some of the Podocarps of New Zealand also attain that height; while the Chilian Araucaria is said to exceed 260 feet. In Europe the extreme height recorded for any Conifer is 180 feet, the common Spruce and the Silver Fir both being stated by Selby to have attained these magnificent proportions. The age attained by some Coniferæ is no less astounding; a *Taxodium*, 117 feet in circumference, being inferred by De Candolle to exceed 5150 years in age, the *Sequoia* 4000, the Yew and Cypress about 2000, and Pines, Firs, Larches, and Cedars 300 to 500 years.

The economic value of the Coniferæ surpasses that of all other forest trees together,

supplying the largest proportion of useful timber, the importations of Coniferous wood into this country alone being of the value of £9,000,000 per annum. In India the Deodar takes the place of the Pine, and in the Southern Hemisphere the timbers of Araucarias and Dammaras are employed to a relatively equal extent. Many of the woods possess an intrinsic value for the manufacture of furniture, musical instruments, &c., tables made of the mottled butt-wood of the North-African *Callitris* having, according to Pliny, fetched £9000 or £10,000 each. The seeds of many Coniferæ are eaten or used for various purposes; and the annual importation of Coniferous tars and resins into England falls little short of £1,000,000 in value.

TRIBE I.—CUPRESSINEÆ.

These are large, very resinous trees or shrubs, with small scale-like leaves, and small globular cones, composed of from four to eight, or rarely ten, peltate, persistent scales, except in the Juniper, where they coalesce into a fleshy berry called a *galbulus*, with numerous small, compressed, frequently triangulated seeds, usually provided with membranous wings at the angles. Both fruit and foliage, from their resinous nature, appear exceptionally capable of resisting decay in water. Thirteen genera and 111 species are described in Gordon's 'Pinetum' (1880), but Bentham and Hooker have since reduced the genera to seven, with twelve subgenera or sections, and seventy-five species. These range from Australia, through India and South America, to the Arctic regions; and while many are fitted to thrive in the subtropics, others, as species of Juniper and Cypress, are among the hardiest shrubs in existence.

Their origin can be traced back to the Permian if *Ulmannia* be really Cupressineous; and they became during the Jurassic and Wealden a preponderating tribe. Some of the forms are of interest, among them being *Widdringtonia*, *Echinostrobus*, *Thuyites*, and *Thuyopsis*, but all are more or less imperfectly known, and the abundance of the tribe is chiefly inferred from the prevalence of wood called *Cupressinoxylon*.

In the Cretaceous deposits a number of very anomalous forms are met with, combining the imbricated foliage of the Cupressineæ with characters no longer met with in the tribe. A remarkable form from Aix-la-Chapelle combines a *Libocedrus*-like foliage¹ with a cone resembling that of *Sequoia gigantea*, but under each scale are a number of Cupressineous seeds. In the Komeschichten of Greenland an important genus, *Inolepis* of Heer, combining imbricated foliage with small oval cones, composed of some forty leathery, dorsally-carinated, scales, seems more nearly allied to the *Taxodiææ*. An equally abnormal Cretaceous genus is *Cyparissidium*, which also possesses imbricated slender foliage and small ovate cones, composed of eighteen to

¹ Dr. De Bey supposes the foliage to be dimorphic.

twenty overlapping, leathery, longitudinally-ribbed scales. *Sphenolepidium Kurrianum*, apparently common in the Portuguese Cretaceous, has very finely imbricated foliage, and cones apparently smaller, but not dissimilar to the last. It would thus appear that the Cupressineæ were not completely differentiated until the Eocene Period.

The tribe is not abundantly represented in European Tertiary strata until the Miocene age; but it appears even rarer in the great series of Arctic floras described by Heer,—a singular fact, as most of them are now only adapted to temperate climates of the Northern Hemisphere. The presence of *Libocedrus* is alone well ascertained there; *Thuaytes*, *Thuyopsis*, and *Widdringtonia* being founded on very fragmentary and almost unique twigs.

A few of the Cupressineæ, namely, some Cupresses and Junipers, inhabit swamps or places liable to inundation, while other species of the same genera seek out the loftiest mountains, and excel almost all other shrubs in hardiness, Juniper and Cypress being found in Central Asia at altitudes of 15,000 and 16,000 feet. The Juniper is the most hardy, creeping, as low scrub-bushes, on most mountain chains to far beyond the limits of trees, and occupying to the south the barren rocks of Cape Horn (*J. uvifera*), and to the north penetrating Labrador, Newfoundland, Hudson's Bay, and Greenland (*J. canadensis*). Some appear to adapt themselves to a great range of climate. *Fitzroya*, a stately tree 100 feet in height on the western slopes of the Patagonian mountains, dwindles to a small bush a few inches high on the confines of perpetual snow; and the Chilian *Libocedrus*, 100 feet high on the Cordilleras, dwarfs to a small bush in Magellan.

Although of relatively less bulk than the Sequoias and Pines, some species attain colossal dimensions, as the Oregon "Red Cedar" (*Thuja gigantea*), a plank of which was exhibited in the Philadelphia Exhibition from a tree 325 feet high and 22 feet in diameter; *Libocedrus decurrens* exceeds 200 feet; and the Himalayan *Cupressus torulosa* has been met with 150 feet in height.

The woods of several of the species are valuable;¹ and many of the gums, balsams, and resins are their products.

Of the seven genera² recognised in the 'Genera Plantarum,' FITZROYA alone has not yet been found fossil; and ACTINOSTROBUS is at present represented by a single cone from Sagor.³ The very extensive genus JUNIPERUS, present in every geographical

¹ The mottled butt-wood of *Callitris quadrivaleis*, the "Thuya" of Pliny and "Citrus" of Horace, commanded fabulous prices during the Roman Empire. Cicero is said to have paid a million sesterces (£9000) for a table made from this wood; and of two tables belonging to King Juba, and sold by auction, one fetched 1,200,000 sesterces, although the largest recorded diameter was only about fifty-four inches.

² *Widdringtonia*, *Frenela*, *Chamæcyparis*, and other generic names frequently made use of in works on fossil plants, are treated by Hooker and Bentham, whose classification is here followed, as subgenera.

³ The specimen described by Ettingshausen in 1859 is ignored by Schimper in his 'Palæontologie Végétale.'

region except the Australian, is divided into three sections. It is recorded as fossil from Aix, Häring, and the amber-beds of Prussia; but the small size of the fragments known, and the absence of fruit, render the determinations somewhat doubtful. The same species is supposed by Saporta to have persisted in Provence to the present day. A few fragments from the Upper Cretaceous of Greenland are known; and *J. rigida*, from the Tertiary of Spitzbergen, is based on an indistinct mutilated fragment, three quarters of an inch long. Its comparative rarity in the Arctic fossil floras is remarkable.

The foliage of THUYA is imbricated like that of Libocedrus but is less symmetric, and the cones are small, leathery, oblong, or oval, and of six to ten valvate unequal scales, persistent and gaping after shedding seed. The species are divided into five sections, and some attain gigantic dimensions. They inhabit principally North America, Japan, and China. No remains are known below the Tongrian beds of Armissan, where they are rare. Saporta, who has described them, believes the species *T. europæa* to be intermediate between *Thuyopsis dolabrata* and *T. borealis*, and from the identity of the foliage considers it the same as that which is included in the amber-beds in the north. Thuya, which formed vast forests on the Baltic during the latest Miocene, becomes plentiful to the south in the Pliocene deposits of Tuscany and Marseilles. *T. europæa* is claimed by Heer as an Arctic fossil on the strength of a terminal shoot, only three quarters of an inch long, from Atanekerdluk; and other species, *Thuyites Ehrenswærdi*, *T. Meriani*, and *T. Pfaffii*, are based upon no better material. Bowerbank supposed his *Cupressinites crassus* from Sheppey to be near *Thuya orientalis*. The widespread conifer, formerly known as *Chamæcyparis Hardtii*, of European Eocenes, is now recognised to be a *Sequoia*.

The three remaining genera are represented in the British Eocenes.

Genus—CALLITRIS.

Flowers monœcious or rarely diœcious, terminal. Cone globose or conical; valves three to six, rarely eight, even, or every alternate one larger, woody, persistent, dehiscent when ripe; seeds numerous, oblong, crustaceous, two to three-winged. Leaves scale-like and imbricated, or rarely acicular on the sterile branches.

The genus, as it now exists, is subdivided into four sub-genera, of which only certain characters need here be referred to.

1. PACHYLEPIS, or *Widdringtonia*, distinguished by thick woody cones, with four sub-equal valves. Confined to South Africa and Madagascar. Species 3.

2. TETRACLINIS, or true *Callitris*, cones with four valves. Confined to North Africa. Species 1.

3. *HEXACLINIS*, or *Frenela*, cones with six scales, three of which are smaller than the rest. Confined to Australia, except one New-Caledonian species. Species 9.

4. *OCTOCLINIS*, cones with eight valves. Limited to a single Australian species. Species 1.

The Eocene species seem to present much greater variation in the number of valves or scales than the existing species show; and Miller also has discovered in the Australian Miocene, a genus with large fruits, *Spondylostrobos*, in which the valves vary from four to six.

Callitris, at the present day, comprises, according to Bentham and Hooker, but fourteen species, though Gordon, in the 'Pinetum,' enumerates twenty-six. Many authors limit the genus to the *Tetraclinis* section as defined on the preceding page.

The genus does not appear to be older than the Tertiary Period. The earliest forms are from the London Clay of Sheppey, and the Calcaire-Grossier of the Paris Basin, and belong to the third or *Frenela* section. The *Tetraclinis* section appears almost contemporaneously, two very distinct types being known; one from the Eocenes of Aix and St. Zacharie, in Provence; the other from Switzerland, Bohemia, &c., where cones are very frequently found attached to the branches. *Widdringtonia* again occurs in the Amber of Samland.

A considerable number of supposed *Callitris* fruits from the London Clay of Sheppey were described by Bowerbank under the name of *Cupressinites*. A few of these seem to be true *Callitris*. The species are as follows:

Cupressinites globosus, Bow., 'Foss. Fruits and Seeds of the London Clay,' 1840, seems to be deficient in Cupressineous characters. Bowerbank describes it (op. cit., p. 52) as formed of an inner and an outer cupula, the outer being cup-shaped and fleshy, and the inner enveloping "the seed so closely as usually to leave but a very small portion of its apex visible through the triangular opening at the apex of the fruit." The inner cupula is composed of three valves, which are described as being cleft for only two thirds of their length. The specimens now in the British Museum, and others which I have since obtained, appear to present a rather thin tripartite husk, articulated to a cupula, and inclosing a single large fruit or seed. One specimen (op. cit., pl. x, fig. 14) is, however, very different to the rest, and might possibly belong to *Callitris*.

C. elongatus, Bow., op. cit., p. 54, is similar to the above.

C. recurvatus, Bow., op. cit., p. 55, appears to be another example of the fruit erroneously figured as *C. globosus*, pl. x, fig. 14, referred to above, and may equally be a *Callitris*. The original unfortunately no longer exists.

C. subfusiformis, Bow., op. cit., p. 56, possesses no Cupressineous characters. The original is still preserved in the British Museum.

C. curtus, Bow., op. cit., p. 56, is now described under *CALLITRIS*.

C. Comptonii, Bow., op. cit., p. 57, is included with the last.

C. crassus, Bow., op. cit., p. 59, is also included in the description of *Callitris*.

C. thujoides, Bow., op. cit., p. 58, with last.

C. subangulatus, Bow., op. cit., p. 60, is here described as *CALLITRIS*.

C. corrugatus, Bow., op. cit., p. 61 (*Solenostrobus*, Endlicher), is founded upon a very indistinct specimen (now in the British Museum), each valve of which seems subdivided. It has no distinctly Cupressineous character.

C. sulcatus, Bow., op. cit., p. 61 (*Solenostrobus*, Endl.), is a five-valved fruit, the original of which has not been identified. It suggests no Cupressineous affinity.

C. semiplotus, Bow., op. cit., p. 62 (*Solenostrobus*, Endl.). This somewhat resembles the preceding form, but cannot now be found.

C. tessellatus, Bow., op. cit., p. 63. The small specimen figured (pl. x, figs. 30 and 31) is very indistinct, but possesses five scales, articulated at the base, and with traces of a central plate. It does not appear to be Cupressineous; but figs. 26 and 27 of the same plate and species are here referred to under *Callitris curta*.

The cones in several of the existing species are exceedingly variable in size and appearance, so much so that it might even be possible that the two species to be described, totally unlike as they appear, may eventually have to be united.

1. *CALLITRIS CURTA*, *Bowerbank* sp. Plate IX, figs. 7—21.

CUPRESSINITES CURTUS, C. COMPTONII, C. THUJOIDES, C. CRASSUS, *Bowerbank*. Foss. Fruits and Seeds of the London Clay, pp. 56—59, pl. x, figs. 9, 20—23, 34, 1840.

CUPRESSITES CURTUS, &c., *Unger*. Synopsis Plant. foss., p. 192, 1845.

CALLITRITES CURTUS, C. COMPTONII, C. THUJOIDES, HYBOTHYA CRASSA, *Endlicher*. Synopsis Conif., pp. 274, 275; *Goepfert*, Monogr. der foss. Coniferen, pp. 170—180, 1850; *Unger*, Gen. et Spec. Plant. foss., p. 345, 1850.

CALLITRIS CURTA, C. COMPTONII, HYBOTHYA CRASSA, *Ettingshausen*. Proceed. Royal Society, vol. xxix, p. 392, 1879.

London Clay, Isle of Sheppey.

The cone is conical, and consists of four, five, or rarely six valvated scales. These valves are sometimes very unequal, but more often sub-equal, very thick and ligneous, more or less obtusely pointed, rugose, and somewhat keeled exteriorly, and apparently smooth and concave on the inside. No distinct umbo is preserved, but all are to some extent water-worn. All those preserved are dehiscent, and partly filled with pyrites, only one exhibiting the summit of the central column. The foot-stalk is thick. The cones are variable in size, the largest measuring two centimètres in diameter, and many are slightly distorted.

In spite of the varying number of scales I can see no characters by which those species described by *Bowerbank*, enumerated above, can be separated; for it is note-

worthy that nearly all fossil *Callitres* show a great amount of variability in this respect, relatively to recent species. Bowerbank's species were founded on unique specimens; but now that these are supplemented, the connection between them has become apparent. All those still preserved have gaped and shed their seed before fossilisation, but Bowerbank had before him an example in which the valves were still closed.¹

This type of *Callitris* belongs to the *Frenela* section, and is most nearly represented at the present day by *C. australis*, a tree growing sixty or seventy feet high, and found on the East Coast of New Holland and in Van Dieman's Land, and by *C. robusta*. I have observed many of these trees thoroughly acclimatised in Madeira, and find that the cones are very abundant, and in some species exceptionally persistent after shedding seed, remaining in rings or clusters on the thick branches, and even round the trunks, from which they can only be detached by aid of a sharp knife. None were lying under the trees, and only solitary cones on comparatively slender foot-stalks could possibly get removed, so that even in districts where the tree grows thickly no fruits of some of the species would be deposited amongst other vegetable remains. The normal number of six valves, three of which are almost always less developed, is not infrequently reduced to five.



FIG. 5.—*Callitris australis*.

These fruits are rare at Sheppey, about one in 2000; and their determination is so far satisfactory that they can be referred to no other section of the Coniferæ. Ettingshausen was mistaken ('Proceedings Roy. Soc.,' 1879), in supposing the species occurs at Alum Bay; the fruit accepted for it being oval, smooth, with only two valves, and on a slender, naked, dichotomous stem, and therefore quite unlike any fruit of the Cupressineæ. Fruits with three, four, and five valves are figured from Sheppey, the last being the most abundant.

CALLITRIS ETTINGSHAUSENI, sp. nov. Plate IX, figs. 1—6.

London Clay, Isle of Sheppey.

The cone is nearly globular, twelve to fifteen millimètres in diameter, composed of either six or eight valvate scales, every alternate one being oblong obtuse, and the rest short oval-lanceolate, and also obtuse, forming at the apex a tessellate cruciform design, which is striking and distinctive. The arrangement of the valves is identical with that of the closed cones of some species belonging to the section *Frenela*, and like no other known

¹ This, described as *C. Comptonii*, was from the Marquis of Northampton's collection, and, together with those formerly in the Canterbury Museum, no longer exists. All the other originals are in the British Museum.

fruits, so far as I can learn,¹ the resemblance being so complete in form and size as to render it certain that they are, if not the same, at least closely allied to the existing species. In comparing the characters of the fossil and the recent examples in detail, the condition of fossilisation has to be considered. When ligneous fruits occur fossil in the London Clay, the whole of the ligneous tissue is not replaced by pyrites, for an outer and sometimes several inner coats of lignitic matter remain, but the outer skin on drying bursts and rapidly peels off, so that it is rarely preserved in specimens picked from the beach, even when they have not been rolled by the sea.

The removal of this outer coat has left these specimens much smoother than the recent *Frenela* fruit, and in addition they have been water-worn. The outlines of the valves are marked by grooves, due to the greater thickness of the lignitic layer round their edges, corresponding with the thickening in recent *Frenelas*, and the small scars at



FIG. 6.—Cone of *Callitris Endlicheri*. Side.



FIG. 7.—*Callitris Endlicheri*. Apex.

the base appear also to mark the dove-tailing of the valves into the axis, which is partially effected by two twin spur-like projections. The scar near the termination of the valves is similarly due to a small spur of woody tissue. The fruits seem partly hollow, and the seeds, with which the living fruit is filled, cannot be made out; but the rough division into four cavities, shown by the abrasion of the base in one of the specimens (Pl. IX, fig. 2), agrees fairly well with what would appear if a recent cone were infiltrated with pyrites. The removal of parts of the smooth surface from other specimens discloses an inner granular structure, which has probably replaced the seeds. The determination cannot be regarded otherwise than as satisfactory.

Callitris Endlicheri is perhaps the most closely related species, and is described as an evergreen bush, with loose subterete branches, crowded with somewhat slender three-edged branchlets, found in the interior of the eastern part of New Holland and about Port Jackson.

C. Eltingshauseni is rare in the London Clay of Sheppey, about one in 2000 specimens, and has not previously been recorded. The cones are closed, as are the greater number of those of the existing species that I have seen preserved in Herbaria. It presents another most interesting example of variation in the number of scales, in a species in which they do not appear to vary at the present day. Five specimens are figured.

The North-African type, which has been identified in great abundance in European Eocenes, especially towards the south, is not yet known to occur in England, though the foliage from Bromley, here referred to *Libocedrus*, bears a great resemblance to some of the foliage from other Eocene localities, referred to *Callitris*. There is a considerable

¹ The determination was approved by all the authorities at the Kew Herbarium, including Sir J. Hooker and Prof. Olliver, to whom I have submitted it. Other species of *Frenela* resemble it, but less closely.

difference in size between the Häring, Radaboj, and Armissan specimens of *C. Brongniarti*, and still smaller specimens from St. Zacharie are described as *C. Heerii*.

C. Brongniarti (Goeppert, 1836¹) is closely related to the existing *C. quadrivalvis*; and is highly characteristic of the later Eocenes and Oligocene of Central Europe, for it appears to have grown on all the shores of the Eocene Mediterranean Sea. Its area has, according to Saporta,² become more and more circumscribed, until at the present day it seems to have taken refuge only in the most southern portions of its former habitat, the existing species being now confined to the Mountains of Barbary and Mount Atlas. It loves rocky situations and a warm dry climate in proximity to the sea, and Saporta hence infers that the Eocene climatic conditions of Aix resembled those of Barbary or Abyssinia. There can hardly be a doubt but that the humidity of climate, evidenced by the flora, excluded it during the middle and later Eocene periods from the British area.

Genus—LIBOCEDRUS.

The genus LIBOCEDRUS is readily distinguished by its small, flattened, ovate, or oblong cone, composed of four to six hard leathery valves, very unequal, and in opposite pairs, not overlapping, and with small recurved terminal points. These cones are deciduous, and have not yet been met with fossil. The flowers are separate and terminal, and the seeds winged and samaroid, the valves of the cone remaining widely gaping. The foliage is no less characteristic, being thick and scale-like, and the leaves compressed in opposite pairs, and regularly imbricated in four rows. The genus, which occasionally forms very large trees, is widely distributed, two species being met with in Chili, two in New Zealand, and the rest in China, Japan, and California. Most of these grow at considerable altitudes, some even reaching the snow-line. Only three fossil species have been described, two of them from the Tertiaries. Of these *L. salicornioides*, a very characteristic species, has been met with in the Tongrian at Armissan, Ménat, &c., at Bilin, Radaboj, Schœnegg, Leoben in Styria, in Austro-Hungary, at Bonn, and in the amber-beds of Prussia, Monod in Switzerland, and Sinigaglia in Italy. It is compared to *L. chilensis*. Another species has been recognised by Heer in the Eocene of Spitzbergen, and appears to resemble *L. andina*, a tree confined to the cold valleys of the Andes. There is some evidence of a second and larger Arctic species, but the material is hardly satisfactory. The remaining species is from the Upper Cretaceous of Greenland, whence a very singular and apparently allied genus, *Moriconia*, has also been obtained.

¹ It first appears in the Calcaire Grossier of the Trocadero and Arcueil, near Paris, at Aix, St. Zacharie and Armissan (Saporta), and at Häring, Radaboj, Schossnitz, Sagor, Koumi; its most northerly range having been Salzhausen, in the Wetterau, latitude 51° 24'. The foliage in most localities is abundant, and the fruit often attached.

² "Révision des Flores d'Aix," 'Ann. des Sciences Nat.,' 5 série; 'Botanique,' vol. xv, 1872, pp. 39, 50—53.

LIBOCEDRUS ADPRESSA, sp. nov. Plate II, figs. 17—20.

Woolwich beds, Bromley.

The leaves are small, scale-formed, in alternate opposite pairs, compressed, adnate at the base, those on the margin clasping both sides, those on the upper and lower sides flat, and with more or less acute apices. The branching is irregular, and takes place by dichotomy similar to that in *Libocedrus decurrens*, the number of the leaves increasing to three or four pairs at the base of the forks. The longest leaves, 15 millimètres, are situate towards the bases of the branchlets, becoming shorter towards the buds.

The foliage appears to be identical in every respect, except that it is somewhat broader, with the existing *Libocedrus decurrens*. It differs from the more shortly imbricated species known as *L. salicornioides*, from Bilin, Armissan, Sinigaglia, &c., but bears a considerable resemblance on the other hand to some of the larger foliage ascribed to *Callitris Brongniarti*, from similar localities.

In the absence of any organs except foliage the determination of this fossil must be open to some doubt, for not very dissimilar foliage is met with in *Thuya*, *Cupressus*, *Callitris*, and even other genera. The strong resemblance, almost amounting to identity, between it and *Libocedrus decurrens* however, and the subordinate characters in the foliage of both, which serve to distinguish them from all other species of Coniferæ, induce me to place the fossil in *Libocedrus* with some confidence.

Libocedrus decurrens, or the Incense-cedar, is one of the giants of the Sierra Nevada. It is very generally distributed throughout the forests of the Yosemite, without exclusively occupying any area, or even making extensive groves. Its most congenial climate is on the warmer hill-sides, at elevations of 3000 to 4000 feet. The largest specimens are about 150 feet high, and 6 or 7 feet in diameter. The branches spread out horizontally, in beautifully fronded, ferny plumes, becoming erect at the summit and drooping towards the base of a singularly striking and regularly cone-shaped tree.

The foliage of *L. adpressa* is known only from Bromley, where, though not rare, it is very locally distributed.



FIG. 8.—*Libocedrus decurrens*. Nat. size.

GENUS—CUPRESSUS.

The genus *CUPRESSUS*, or Cypress, comprises twelve or more distinct species, with imbricated foliage, and small, woody, globular cones of six to ten peltate scales, armed with a central point or umbo. Most of the species are natives of comparatively warm climates,

and inhabit Southern Europe, China, California, Mexico, Guatemala, North America, and the East Indies. Some form stately trees, exceeding even 150 feet in height. Hitherto it has only been known fossil from two Miocene localities in Germany, and from Antrim and Italy; but in the latter cases especially the determinations appear founded on wholly insufficient material.

CUPRESSUS TAXIFORMIS, Unger, sp. Plate I, figs 1—13; Pl. V, figs. 13, 14; Pl. VII, fig. 8; Pl. IX, figs. 22—26, 28—30.

TAXITES ACICULARIS, *Ad. Brongn.* Prodrôme des plantes foss., Calc. gross., Descr. Env. de Paris, p. 362, 1828.

CUPRESSITES TAXIFORMIS, *Unger.* Chloris Protogœa, p. 18, pl. viii, figs. 1—3; pl. ix, figs. 1—4, 1847.

— — *De la Harpe.* Mem. Geol. Survey, Isle of Wight, p. 111, pl. v, fig. 2, 1862.

Middle Bagshot, Bournemouth.

The cones are ligneous and subglobose, broader than high, and 12 to 16 millimètres in diameter. The scales are eight in number, in four unequal pairs, subangular, four- or five-sided, depressed, and with strong wrinkles converging towards a sub-central mucro, and with slightly thickened and recurved edges. The four basal scales are sometimes trilobate and always coalesce into a single unequal quatrefoil round the foot-stalk, one pair, however, being relatively shortened. The next pair are opposite and five-sided, and the uppermost pair rather smaller, quadrate, and sometimes soldered together.

The foliage is polymorphic. In the young and barren shoots it is spiral, but with two lateral rows of leaflets expanded, and the rest decurrent and relatively undeveloped. The expanded leaflets are linear, rarely linear-lanceolate, from 3 millimètres to 15 millimètres in length, opposite or alternate, seldom crowded or overlapping, with acute, sometimes mucronate, symmetric, or more often asymmetric apex and indistinct midrib. This type, though generally separate, occasionally passes into the ordinary imbricated foliage on the same shoot. The scale-like foliage is loosely imbricated and of various shapes, spiral, in apparently six rows, sometimes short and acute or obtuse-pointed, or longer, adpressed, and decurrent, awl-shaped, blunt, or acutely pointed, and occasionally spinous.

The leaflets are very persistent to the stem, less expanded than in *Sequoia polymorpha*, more pointed, and of more delicate texture, more regular and expanded than in *Glyptostrobus*, and less crowded than in the Alum Bay Podocarp. The shoots or branchlets were shed simple, for among many I have rarely seen one compound. The longest is 12 centimètres in length, but the average is only from 4 to 6 centimètres.

These characters enable the foliage at Bournemouth to be distinguished with some certainty, though it would be less easy to identify it from distant localities.¹

The evidence favouring its reference to *Cupressus* is that cones, identical except in some minor characters, with cones of an existing species are found in the Marine Beds at Bournemouth with the same foliage; an identical cone and other fragments of cones (Pl. IX, figs. 28, 29; Pl. V, fig. 14) being also associated with the foliage in the fluviatile beds. The imbricated foliage is thus absolutely connected with true Cypress cones. The more leafy foliage is seen on several of the figured specimens (Pl. I) to be joined to this, and their constant association together, in at least all the freshwater beds in which either occur, would alone render it far more probable that they belong to the same than to different conifers.

Male flowers, probably of this species, are figured (Pl. I, fig. 12, and enlarged at 12 a), and small pellets of amber are frequently associated with the twigs.

The species is not met with at Bournemouth lower than the horizon of rolled blocks marked *i* in the Coast Section ('Quart. Journ. Geol. Soc.,' vol. xxxviii, p. 4, 1882, "Description of the Bournemouth Beds," part 2), in some of which it occurs abundantly mixed with broken cones, the distichous foliage being finer and (Pl. V, fig. 13) more sharply pointed in these than at higher horizons. It is quite absent from the beds called Gleichenia-beds in the section, and from all the "Lower Coastguard-beds," but suddenly reappears in great abundance in the highest bed immediately under, and continues throughout the "Black Bed." Here, wherever the clay is fissile, large sheets may be obtained thickly sprinkled with its shoots, mingled with much macerated leaf matter, seeds, &c. (Pl. I, figs. 1 and 2).

De la Harpe figured a specimen in the 'Geological Survey Memoir on the Isle of Wight,' identifying it with Unger's *Cupressites taxiformis* from Häring, in the Tyrol. Some of the foliage from other parts of Europe, determined as *Sequoia Hardtii*, &c., may not improbably belong to this species.

The cones are so distinctly those of the Cypress,² that no doubt whatever as to their genus can be entertained. Their wrinkled mucronate surface and rectangular form, together with their base formed of four scales soldered together, is reproduced in such well-known species as *C. sempervirens*, *C. torulosa*, *C. macrocarpa*, and *C. funebris*. The latter species, indeed, further resembles our fossil in the possession of not dissimilar dimorphic foliage. This character appears, as in the Taxodiæ, rarer in existing than in fossil species, and is only shared by two species of *Callitris* and some imperfectly known



FIG. 9.—Cone of Cypress (*Cupressus sempervirens*).

¹ The fig. 1 D of *S. polymorpha* on pl. ii of the second part of Saporta's 'Études sur la Végétation,' seems to be of this species, for not only is the foliage identical in the minutest details, but the cone attached is represented with the peculiar trefoil-shaped scale at its base, and with the number and arrangement of scales characteristic of this Cupressus.

² Fig. 27, pl. xi, is apparently another species, and more resembles some of the *Sequoia Couttsiæ* from Bovey.

Widdringtonias and Cupresses in Mr. Gordon's collection, recently purchased and presented to the Kew Herbarium by Sir J. Hooker.

The only genus resembling Cupressus is the closely-allied Thuya. The cones, however, are generally smaller and are more leathery, except in the section Chamæcyparis or Retinospora, in which they are woody and only distinguishable in size from those of Cupressus. All the Thuyas have imbricated foliage except the section Biota, in which it is sometimes partially expanded.



FIG. 10.—*Retinospora filifera*.—From Veitch's 'Manual of the Coniferae', p. 244.

Cupressus funebris, or the funeral cypress, is when full grown a graceful tree, with erect stem and drooping branches, reaching a height of fifty or sixty feet. The young plant is of erect habit, and is clothed with needle-like leaves, which are succeeded as it becomes older by others which are scale-like, closely adpressed, and imbricated. It is a native of the north-east provinces of China, and frequently appears in clumps on the sides of hills. The other species to which the fossil has been compared, on account of the similarity in the cones, are natives of eastern Europe, the Himalayas, and California.

TRIBE II.—THE TAXODIÆ.

The genera are *Cryptomeria*, *Taxodium*, *Sequoia*, *Athrotaxis*, and *Cephalotaxus*, possessing spiral or distichous foliage, and smooth, woody, or leathery, more or less ornamented cones, except in the last which bears a drupe. All the genera are alike remarkable for the paucity of their living species, which in no case exceed four, and for the restricted areas which these occupy. It would appear from this, and their much wider range in the Tertiaries, that they are survivals from older floras. All are natives of temperate North America, or China and Japan, except the Tasmanian *Athrotaxis*.

The Permian *Ullmannia* is the oldest genus ascribed to the Taxodiæ, but its true affinities are still somewhat doubtful. A specimen with cones attached, from Solenhofen, was originally described as *Athrotaxis*, but was transferred by Schimper to the Jurassic genus, *Echinostrobus*. Other Jurassic and imperfectly known genera, *Brachyphyllum* and *Leptostrobus*, have been placed in this tribe. Its first definite appearance seems to date from the Middle Cretaceous, cones with at least the outward semblance of *Sequoia* having been obtained in the Gault and Greensand. From the Greenland Komeschichten, besides *Sequoia*, a genus *Inolepis*, with imbricated foliage and cones of some forty leathery, dorsally-carinated scales, which are very like the male cones of *Sequoia* (fig. 13, p. 33), is abundant, and has been, I believe, erroneously placed in the Cupressinæ instead of near to *Glyptostrobus*. Another remarkable form from Patorfik and the Upper Cretaceous of Europe, especially Portugal, and which should also be placed in this tribe, is *Cyparissidium*, also possessing imbricated foliage, and small ovate cones of eighteen or twenty overlapping, leathery, and longitudinally-ribbed scales. A single but very characteristic scale of *Glyptostrobus* from the beds at Patorfik suffices to carry that genus back to the Cretaceous. The Wealden *Sphenolepidium* appears somewhat remotely allied to *Cryptomeria*, and the Cretaceous *Geinitzia* to *Sequoia*. The existing genus CEPHALOTAXUS may probably be represented in the Arctic Eocenes by *Taxites Olriki*. CRYPTOMERIA, which forms a tenth part of the forests clothing the three large islands of Japan, is at present unknown in the Tertiaries. The genera *Taxodium*, *Sequoia*, and possibly *Athrotaxis*, are represented in British Eocenes.

Genus—TAXODIUM.

In this genus the flowers are monœcious, the cones globular and ligneous, and persistent after shedding the seed, the scales spirally disposed, imbricated, with an expanded ligneous, mucronated or unbonated apex, and tuberculated or embossed margin. The foliage is deciduous or sub-persistent, distichous, or small and scale-formed. There are

three existing species, *T. distichum*, or the deciduous Cypress, *T. mexicanum*, which flourishes on the high plateau of Mexico at from 5750 to 7670 feet above the sea, forming trees 120 feet in height and 25 to 40 feet in girth,¹ and the smaller *Glyptostrobus* of Japan.

The *Glyptostrobus* section of *Taxodium* is said to occur in the Tertiaries of Atanerdluk in Greenland, and of the Mackenzie River, Spitzbergen, and Alaska. Of two species described, one has only imbricated and the other imbricated and distichous foliage, but no trace of the cones of *Glyptostrobus* has yet been obtained with either. There is, indeed, no direct evidence that any of the foliage so described from the Arctic Tertiaries does not belong to the Sequoias, whose fruits are so constantly associated with it. The nearly invariably polymorphic growth of the ancient Sequoias has not been sufficiently recognised, and hence every polymorphic twig has been placed in the genus *Glyptostrobus*.

The inflorescence ('Fl. Foss. Arctica,' vol. iv, pl. 11, fig. 8), also determined as that of *Glyptostrobus*, is indistinguishable from that of *Sequoia*. The species had a very extensive range in Europe, principally from the Upper Eocene period to the close of the Tertiaries; for it is recorded from Greece, Italy, Austria, Switzerland, France, Germany, and as far north as the Baltic provinces. Foliage alone would be scarcely satisfactory evidence of its range, but cones accompany it at Koumi, in Eubœa, Hungary, Oeningen, Manosque, and the Prussian shores of the Baltic.

It finally disappears from Europe with the Pliocene of the Val d'Arno.

TAXODIUM EUROPÆUM, *Brongnt.* Plate III, figs. 1—9; and Plate IV, figs. 1—8.

TAXODIUM EUROPÆUM, *Brongnt.* Ann. des Sciences Nat., 1st series, vol. xxx, p. 175, 1833.

— CENINGENSE, *Al. Braun.* In Leonh. and Bronn., Jahrbuch, 1845.

CUPRESSITES RACEMOSUS, *Gœpp.* Monogr. Conif., p. 184, pl. 19, 1850.

TAXODITES EUROPÆUS, *Gœpp.* Ibid., p. 192, pl. 22, fig. 1, 1850.

GLYPTOSTROBUS EUROPÆUS, *Heer.* Fl. Tert. Helv., vol. i, p. 51, pls. 19 and 20, fig. 1, 1859.

Middle Bagshot, Bournemouth.

The foliage is usually imbricated, sometimes closely adpressed and decurrent, the leaflets of various shapes, alternate, some scale-like, small, ovate, acute or obtuse-pointed, others near the base of the shoots frequently very short and scale-like, somewhat triangular and compressed, increasing towards the points of the shoots to rather long, awl-shaped, and recurved, and even expanding into flat linear leaflets, tapering to a sharp point. The branchlets appear to have been alternate, somewhat crowded, and repeatedly forking, and the shoots frequently seem to terminate in a male flower or bud.

¹ Humboldt, 'Cosmos,' p. 326.

No trace of the fruit has been met with at Bournemouth, the branchlets to which the cones were attached having probably been floated farther out towards the sea. In their absence there is obviously no absolutely certain evidence as to the genus to which the foliage belongs, but the very great likeness it bears, not only to fossil foliage positively known to belong to *Glyptostrobus*, but to that of the existing species, renders it in a high degree improbable that the determination is incorrect.

The Bournemouth specimens are the oldest Eocene representatives of the genus, and most nearly resemble the form described by Ettingshausen as *G. bilinicus* from Bilin, a form subsequently incorporated by Heer in his species, *G. Ungerii*. Its discovery is interesting as it unites to some extent the species with decidedly polymorphic foliage (*G. Ungerii*) with the true *G. europæus*, in which the foliage is described as wholly imbricated. Foliage from a large number of localities has been ascribed to *G. europæus*, often apparently on a superficial comparison. Some imbricated foliage from the newest stage of the American Lignitic has been referred by Lesquereux to this genus.

Its remains are very abundant in the "Lygodium-and-Laurel-beds" at Bournemouth, whence a considerable branch (Pl. IV, fig. 1) has been obtained. It is also not unfrequent in the "Willow-bed," where it seems to put on a freer and less imbricated character (Pl. III, figs. 1—9). I have never yet met with it in any of the series of Leaf-beds at Bournemouth east of this point, nor in any other British Eocene formation.

The frequently branching character of the specimens enables this species to be distinguished easily from the other Coniferæ at Bournemouth.

The existing *Taxodium* (*Glyptostrobus*) *heterophyllum* is a small tree with an erect stem, growing from eight to ten feet high, confined to parts of China, and inhabiting preferably places liable to inundation or the banks of rivers. It has leaves of various forms, and is almost evergreen.

TAXODIUM EOCÆNUM, sp. nov. Plate VII, figs. 1—8.

Middle Bagshot, Bournemouth.

The foliage is usually minute, somewhat scale-like, but occasionally approaches a distichous arrangement. As in the last form, the expanded leaflets seem confined to young plants or shoots, and they are very slender, linear, and taper to an acute point. The more abundant foliage is imbricated spirally, the leaflets long and decurrent for some distance, and terminating in a more or less ovate and acute point. The branchlets were shed either in dense tufts, twelve to fourteen inches in length, or singly. The tufted branchlets probably formed the apex of the branches, and the simple branchlets, which reach seven or eight inches in length, were shed from the more woody regions. The immature fruits figured (Pl. VII, fig. 6) have the appearance of berries covered with small scales, and closely resemble some preserved in the Kew Herbarium from New Orleans. The

very delicate and partly distichous foliage shown in fig. 3 is also occasionally met with in the existing species.

The fossil differs very considerably from the ordinary forms of *Taxodium distichum*, but strangely resembles, even in very minute particulars, the variety *T. imbricataria*, Mett., which inhabits, as an inscription in the Kew collection states, "ponds in the pine forests of Florida." The length and slenderness of the branches in both cases suggest a somewhat pendulous habit, and the texture of the fossil leads to the belief that it was not very leathery, and of probably a brightish green.

Taxodium distichum forms very extensive forests. The Deciduous Cypress, as it is called, is described as towering over all the vegetation of the Great Dismal Swamp, with its top spreading in full leaf in the season when the sun's rays are hottest, and when, if not intercepted by a screen of foliage, they might soon cause the fallen leaves and dead foliage to decompose, instead of contributing to the peaty mass. The White Cedar, *Thuja spheroides*, forms a dense undergrowth, firmly supported by its long tap-roots in the softest part of the quagmire, whose surface is carpeted with Ferns and Reeds. The association of this with a Cypress in the "Coastguard-beds" at Bournemouth, and with many Ferns of the sub-tropics of North America, shows that it may have grown there in not altogether dissimilar stations.

While the most heat- and moisture-loving of all the forms of *Taxodium distichum* has never been met with elsewhere, and is, even at Bournemouth, limited to a single bed, other varieties of the same species are very abundant in European Tertiaries. The most familiar type of *Taxodium distichum* with distichous and deciduous leaves, that which withstands our own climate at the present day, has been met with fossil in the Tertiaries of Atanekrdluk, in Greenland, of Alaska, and Spitzbergen. Further south magnificent specimens have been obtained from the Miocene of the Baltic Coast, and figured by Heer as *T. distichum miocænum*. Two other varieties are met with, one of them, a Spitzbergen form named *T. angustifolium*, approaching nearer, according to Heer, to *T. mexicanum*. Foliage assigned to the Miocene *Taxodium distichum* is also stated to have been found at numerous localities, especially in the newer Miocenes of Austria, Italy, Switzerland, the South of France, and the United States; but, as cones are, in scarcely any instance, associated with the foliage some doubt about it still exists. There can, however, be no doubt that the temperate type of the species, after flourishing in the Arctic regions during the Eocene, descended, as temperatures decreased towards the close of the Miocene, as far as Central Europe and to the United States. That type is quite unknown in any Eocene deposit of temperate Europe, though *Glyptostrobus* is very universal. Sir Joseph Hooker¹ looked upon it as the most interesting of the Arctic fossils.

The Bournemouth species is wholly confined to the uppermost of the "Coastguard-beds" below the Black Bed, where it is associated with a luxuriant Flora.

¹ 'Ann. Add. Royal Society,' 1877, p. 10.

Genus—SEQUIOIA.

The Sequoiæ are monœcious. Their cones are ovate, ligneous, persistent, and terminal on the branchlets, one to two inches in length, composed of sixteen to thirty-five wedge-shaped scales, with a wrinkled and depressed, transversely oblong, nail-like head, mucronated in the centre. In existing species they are solitary, but clustered in several fossil species. The foliage is distichous and yew-like in *S. sempervirens*, and spirally imbricated in *S. gigantea*, though both occasionally foliate in the opposite way. These are the only existing species of a genus which was widely spread during the Tertiary

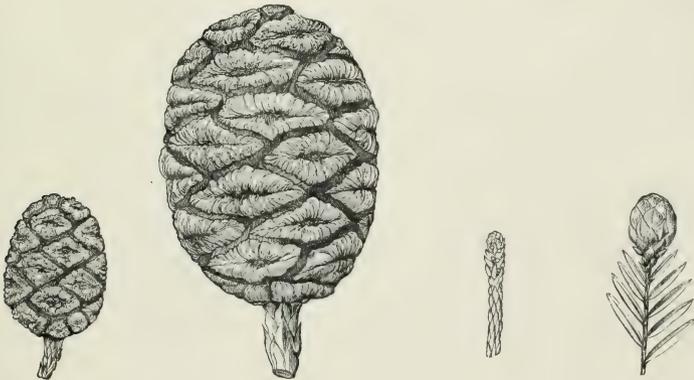


FIG. 11.—Cone of *Sequoia sempervirens*. (Figs. 11—14 are from Veitch's 'Manual of the Coniferae'.)

FIG. 12.—Cone of *Sequoia gigantea*.

FIG. 13.—Male flowers, *Seq. gigantea*.

FIG. 14.—Male flowers, *S. sempervirens*.

period. The former, better known as the Red-wood, occupies the Coast Range, a sandy ridge rising to a height of 2000 feet, and forms dense forests, twenty to thirty miles in width, from a little south of Santa Cruz to the southern borders of Oregon, following the coast-line for some 350 to 500 miles; its distribution depending according to Professor Bolander, upon the sandstone and oceanic fogs. The second species, *S. gigantea*, extends at intervals along the western slope of the Sierra Nevada for nearly 200 miles, and at elevations of from 5000 to 8000 feet. "Towards the north the trees occur as very small, isolated, remote groves of a few hundreds each, most of them old, and interspersed amongst gigantic pines, spruces, and firs, which appear as if encroaching upon them. Such are the groves visited by tourists (Calaveras, Mariposa, &c.). To the south, on the contrary, the Big-trees form a colossal forest forty miles long, and three to ten broad, whose continuity is broken only by the deep sheer-walled cañons that intersect

the mountains; here they displace all other trees, and are described as rearing to the sky their massy crowns; whilst seen from a distance the forest presents the appearance of waves of vegetation, gracefully following the complicated topography of the ridges and river-basins which it clothes."¹

The oldest Sequoias known are those described by Carruthers from the Blackdown beds and the Folkestone Gault. Schimper speculates upon their derivation from some much older Araucarian form, and the character of the foliage associated with them in Cretaceous rocks certainly seems to point in that direction. Saporta regards the Chalk period as the Golden Age of Sequoia. The best Cretaceous specimens seem to have been obtained in the far north, and are illustrated in the 'Flora fossilis arctica.' Saporta speaks of Pattorfik as a Sequoia wood carpeted with Ferns, and Ekkorfat as a forest composed of Cycads, Sequoias, and Firs. It is quite apparent that in these Arctic forms the distichous and imbricated types of foliage were united in the same species; a character not only preserved in many of the Eocene species, but in the nearly allied Taxodium, and even to some extent in the surviving Sequoias. Heer, through overlooking this



FIG. 15.—*a, b. Sequoia Reichenbachii*; *c. S. Smithiana*. (Koueschichten, 'Flora foss. arctica,' vol. iii, pl. xxi, fig. 7.)

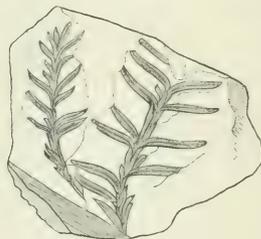


FIG. 16.—*S. rigida*. (Ibid., pl. xxii, fig. 11a.)



FIG. 17.—*S. Reichenbachii*. (Ibid., pl. xx, fig. 8.)

character, has been led to make a number of species which cannot be sustained, the pieces so separated being in some cases evidently from the same branch. The truth of this statement is obvious even from the few figures here reproduced. Similar distinctions are made in the forms from the Ataneschichten, named *S. fastigiata*, *S. subulata*, &c. Another very interesting characteristic, also unmentioned by Heer, is that the distichous arrangement was produced in the Cretaceous species, if the drawings can be

¹ Sir J. Hooker, Lecture to Royal Institution, April 12th, 1878.

trusted, rather by the shortening, almost to abortion, of the upper and under leaves, than through their being narrowed at the base and twisted, as at present, towards the sides of the branchlets.

The Arctic Tertiaries have yielded no foliage of the *S. gigantea* type, except that referred erroneously to *S. Coultisia*, which I distinguish as *S. Whymeri*.¹ The *S. sempervirens* type, on the contrary, was exceedingly abundant; *S. Langsdorffi* being, in fact, the prevailing fossil in the Greenland Tertiaries, for scarcely any stones with leaf impressions are without some traces of it. The branchlets seem to have been shed simple or singly, rarely forking, and would thus perhaps appear to have had but a short season of growth, an adaptation possibly to Arctic conditions. *S. Langsdorffi* again appears in the Miocene of the Baltic, in Mull, in the Mayencian or Lower-Miocene stage in Switzerland and Germany, and in Italy in the latest Miocene period. Its course southward from the Arctic Eocenes to Italy, as the temperatures gradually decreased in the Miocenes, is therefore indicated, like that of so many other Coniferæ. The branchlets from the more southern deposits, it is curious to notice, are sometimes compound. Another Spitzbergen species is distinguished by smaller, more tender foliage, and narrower leaflets set at a more acute angle with the stem.

The Eocenes of France have yielded two well-marked species, one very distinctly, and the other to a less degree dimorphic. Another extremely dimorphic form, *S. Hardtii*,¹ is abundant at Steiermark and Häring in Austria. *S. Whymeri* seems certainly to have been dimorphic, and to have descended south towards the Miocene. *S. brevifolia* is not dimorphic in Greenland, but becomes so in the American Eocene, and even in the most persistent of the distichous types, *S. Langsdorffi* the fruit-bearing branches are imbricated to a greater extent than is usual in *S. sempervirens* at the present day, though in trees cultivated in warmer climates, as Madeira, the imbricated foliage is relatively much developed.

The purely imbricated type is rare in the Tertiaries. After mature consideration the so-called *S. Sternbergi* of Bournemouth is placed in *Araucaria*, and I have failed to discover any reasons why the greater part of the similar foliage so widely spread in mid-European Eocenes should not also be transferred back to the same genus. In some cases it might belong to *Sequoia*, but no *Sequoia* cones have yet been found with it, and until some better evidence is forthcoming it is preferable to consider all the Eocene foliage of this kind as belonging to one genus. In the Iceland Tertiaries, however, there is an unusually large-foliaged *Sequoia*, confounded with *S. Sternbergi*, though it is very distinct in character from the typical form. This reappears in the Superga of Turin, being in both cases associated with cones, and apparently also at Sinigaglia (*Pinites cryptomerioides*, Mass.), and in the Great Lignitic of America (*S. acuminata*, Lesq.).

The striking difference in the form of the foliage belonging respectively to the two recent species is seen to have been far less pronounced in the past; even now *S. sem-*

¹ See *S. Coultisia*, p. 39.

² Long known as *Chamæcyperites Hardtii*.

pervirens preserves the spiral, scale-like leaves for a longer or shorter distance, according to climate, at the base of each branchlet, while *S. gigantea* sometimes assumes the distichous arrangement. But besides this, the leaflets are not in two rows as they are in *Taxodium*, for their bases are decurrent and spirally arranged round the stem, becoming a short distance from their attachment twisted to one side, flat, and expanded, and crowded into two lateral rows, apparently in order that their surfaces may be exposed as fully as possible to sun or moisture; and with frequently an additional row lying centrally along the upper surface.

It has been surmised that the genus became well-nigh exterminated during the Glacial Epoch, and has been most strangely preserved in two isolated spots, perhaps outside its original range, where the moderating influence of the Pacific had permitted it to survive upon lofty spurs of mountains, while the valleys were filled with glaciers. Fixed on exceptionally favorable stations and with congenial soil, the existing species may have slowly adapted themselves to a temperature far more genial than that supported by their ancestors.¹ In adapting themselves since the Glacial Period to ever increasingly favorable conditions, they may possibly have acquired that stupendous habit of growth which makes them the giants of vegetation.

Sequoia is thus seen to be a genus which apparently first became differentiated during the Cretaceous, and widely spread and adapted to a great range of climate during the Tertiary, when it contained species which differed greatly from those that have survived. The needle-leaved type is the most ancient, but this became dimorphic during the Cretaceous in high northern latitudes, where it was finally superseded by the distichous type. The latter appears even now to grow more imbricated in warmer temperatures. The former ranged from hot to quite temperate climates during the Tertiaries, but not into such northern countries as Greenland and Spitzbergen.

SEQUOIA COUTTSIÆ, *Heer*. Pl. VI, except fig. 18.

SEQUOIA COUTTSIÆ. Lignite of Bovey-Tracey, *Heer* and *Pengelly*, *Phil. Trans.*, 1863.

TAXODIUM DUBIUM. *Fossile Flora von Bilin, Ettingshausen*, p. 34, pl. x, 1866.

NON S. COUTTSIÆ, *Heer*. *Flora fossilis arctica, and Miocäne baltische Flora*; *Baily*, 2nd Report on Antrim Flora, *British Association Reports*, 1880.

Bovey-Tracey, Bournemouth, Hempstead, and Gurnet Bay.

The leaves are alternate, spirally arranged, short and imbricated, keeled exteriorly, concave on the inner surface, decurrent at base, with the apex free and frequently

¹ In estimating the minimum temperature required by the fossil *Sequoia* we may be misled through relying too exclusively on the data furnished by existing species.

acutely pointed, and either divergent or falcate. On the older branchlets the leaves are more obtuse, regularly imbricated, and adpressed. In these and other characters the fossil resembles young shoots of the adult *S. gigantea*, but differs in the smaller size of its foliage. The branchlets, however, seem to be more thickened at the base, and the scars left by them are so distinct that they must have readily become disarticulated. The cones are very different to those of *S. gigantea* (figs. 12 and 18), being shortly ovate and globose,



FIG. 18.—Fertile branch of *S. gigantea*, grown in Linton Park. Natural size. (From Veitch's 'Manual of the Coniferæ'.)

averaging apparently but two thirds of an inch in length, but in size, form, number, and arrangement of scales, they approach those of *S. sempervirens* (fig. 11). The chief difference is in the less deeply wrinkled surface and sunk centre of the face of the scale. At Bovey the cones are very much compressed and often distorted, and at Hempstead the

scales are generally detached and scattered. They were doubtless shed, as in existing Sequoias, with the scales gaping after losing the seed, but still attached to the branchlets. Several seeds were stated by Heer to have left their impressions under the scales, and there were probably three to five under each scale, as in *S. sempervirens*. They are variously shaped, ovate, flattened, denticulated at the apex, emarginated at the base, and winged laterally. The best of the cones from Bovey and Hempstead remaining in our national museums are figured on Pl. VI. None of these appear to be exactly those figured by Heer, which, though collected at the same time, appear to have been since lost. The restoration at pl. x, 'Phil. Trans.,' l. c., was pieced together from a number of fragments; and, while delineating the different characteristics of the foliage, can hardly be thought to convey the mode of growth, which was probably free and graceful, dense, and somewhat pendulous. The remains still existing, and which are figured, do not conclusively establish the accuracy of its reference to Sequoia. Its station, from its constant association with remains of a marsh-loving *Osmunda*, was evidently swampy; and this is at variance with the habits of either existing species.

A large number of remains from the Tertiaries of other countries have been referred to *S. Couttsia*. Many of these, however, clearly belong to another species.

The foliage from Disco and from the whole northern regions is, even where smallest, more than double the size of that of *S. Couttsia*, while the average terminal branchlets from Bovey require magnifying four or five times to equal those collected by Whymp¹ or those deposited in the British Museum by McClintock. The cones also are considerably larger, exceeding an inch and a quarter in length; and, although making the difference appear less, Heer says, "This greater length certainly arises from the scales having partly separated from their axis," most of the Bovey cones are in a similar condition, and it is difficult, if not impossible, to lengthen those of recent Sequoias, by compression. In Plate VI, I have figured for comparison the largest foliage of *S. Couttsia* from Bovey (fig. 7), and the smallest of that called *S. Couttsia* from Greenland (fig. 18). The figures in the 'Miocene baltische Flora,' pl. xiii, also by Heer, are, with one exception, equally large, and the seeds scattered on the slabs with the foliage are two or three times larger than those from Bovey. The supposed *S. Couttsia* of Antrim is presumably the same as the Greenland species.

The very beautiful remains from Armissan, which Saporta has figured and described under the name of *S. Couttsia*, var. *polymorpha*, possess decided characters which imply more than a variety. Heer determined certain incomplete fragments from this locality as *S. Couttsia*, but the fine specimens described by Saporta² show that these are widely distinct. At the base of each shoot there is, as in *S. sempervirens*, a region of short, closely imbricated, scale-like leaves; the remaining leaves are long and linear, decurrent at the base, and then free and slightly falcate. This is a growth unknown in the typical *S.*

¹ 'Phil. Trans.,' 1869, pl. xli, figs. 1—9; xlii, fig. 1, p. 464.

² 'Le Sud-est de la France à l'époque Tertiaire,' 2nd part, p. 193, pl. ii, fig. 2.

Couttsia, and in the Armissan form even the imbricated regions are shorter and more densely clothed than any of the corresponding parts in the Bovey species. The cones figured are smaller and seated upon thicker stems, and their general resemblance does not seem sufficient to outweigh the distinctions seen in the foliage.

It therefore appears that the forms included under the name of *Sequoia Couttsia* represent at least two, and possibly three species.

The first, *S. Couttsia*, distinguished by the exceptional delicacy of its foliage, which in this respect, resembles certain species of *Cupressus*.¹ It ranges in England from the Bournemouth beds, where it is rare, through the Bembridge to the Hempstead series. This species has not hitherto been met with out of England except at Bilin.

The second and more robust northern form, I should propose to name after Mr. Whymper, from whose specimens it was described. *S. Whymperi* approaches more closely to the existing *S. gigantea*, and possessed foliage, cones, and seeds, of approximately double the size of those of *S. Couttsia*. It is abundant in the Tertiaries of Greenland, Spitzbergen, the Mackenzie, and Baltic. Some portions of foliage, which seem clearly to belong to it, are separated as *Glyptostrobus Ungerii*. These, while usually associated with Sequoia cones, are never accompanied by any trace of the persistent and very distinct cones of *Glyptostrobus*, and the inflorescence, said to be of *Glyptostrobus*,² is absolutely indistinguishable from that figured as Sequoia in the 'Flora of Bovey,' pl. ix, fig. 43. *S. Whymperi* appears in fact to be another instance, like *S. polymorpha*, of a wide-spread species with so-called dimorphic foliage; and, besides the supposed *Glyptostrobus Ungerii*, I should also feel inclined to unite with it the *S. Langsdorffii* figured in the 'Flora Arctica,' vol. 1, pl. xlvi, fig. 3, and vol. 2, pl. xlv, fig. 2, the *A. Sternbergii* from Oeningen,³ Sinigaglia, and Turin, and from the newest stage of the Lignitic series of America. It is, and must always be, impossible to describe the extinct Sequoias satisfactorily without first realising that the now nearly completely separated types of foliage were formerly very generally united in the same species; and also that constant and accentuated differences, though perhaps unimportant relative to living trees, when met with and found to be persistent in fossil species, mark clearly either a difference in age between deposits, and therefore a stage in evolution, or else a change in temperature or other physical conditions, and must therefore be recorded and distinguished by the palæontologist.

The third, *Sequoia polymorpha* of Saporta, seems principally confined to the Oligocene of the south-east of France.

These species may have lived contemporaneously, yet in different regions; the northern form certainly descended as far south in the later Miocene periods as Central Europe.

¹ *C. sempervirens*, *C. funebris*, *C. torulosa*, *C. macrocarpa*, &c.

² 'Fl. Arct.,' vol. iv, pl. xi, fig. 8.

³ 'Fl. Tert. Helv.,' vol. i, pl. xxi, fig. 5.

S. Coultisia is rare in the dark clays and "Marine beds" of Bournemouth and the concretionary ledges of Gurnet Bay, but very abundant at Bovey-Tracey and Hempstead.

SEQUOIA TOURNALII, *Brongt.* (sp.). Plate V, figs. 1—12.

TAXITES TOURNALII, *Brngt.* Prodr., pp. 188, 214, 1828.

CHAMÆCYPARITES HARDTII, *Ettingsh.* Flora von Häring, 1855.

SEQUOIA HARDTII, *Heer.* Lignite of Bovey-Tracey, p. 35, 1863.

TOURNALII, *Saporta.* Études sur la Végétation du S.-E. de Fr. à l'Époque Tert., part 2, p. 196, 1866.

Middle Bagshot, Bournemouth.

The foliage in this species appears to have been distichous on the barren, and closely imbricated on the fertile branchlets. The distichous foliage is like that of the *Cupressus* from the same locality, but much larger, coarser, more irregular, and of thicker substance. The longest leaflets measure twenty-two millimètres, are nearly parallel-sided, and terminate in a bluntly mucronate point. They are not in opposite pairs, and are irregular in size, an occasional leaflet appearing almost aborted. The specimens show that the distichous foliage did not continue uninterruptedly for any considerable distance, but frequently alternated with the imbricated type, resembling in this respect many existing Coniferæ, and especially *S. sempervirens*. The imbricated shoots figured (Pl. V) seem entire and articulated at the base, and are as large as any yet met with. They are densely clothed with short, closely imbricated leaflets, either falcate or spinous at the apex, and are preserved as deeply and sharply imprinted hollow casts, from which every vestige of colour has disappeared. They present perfect intaglio impressions, which are in some respects more satisfactory than those whose substance is partly preserved, for in these the stem frequently splits in two, and an inaccurate idea of the foliage is thereby conveyed. Fig. 1 shows the arrangement of the branchlets to have been irregular. These, unlike those of the *Cupressus* of the same beds, were often shed compound.

There is no direct evidence to connect this Conifer with any particular tribe, but it more nearly resembles the living *Sequoia sempervirens* than any other species, and seems indistinguishable from foliage met with at Aix, in Provence, to which well-preserved *Sequoia* cones are attached. There can be no doubt but that the small imbricated shoot on fig. 3 is actually attached to the branchlet, and fig. 1 also shows imbricated foliage at its base; and this evidence is confirmatory of the view that the two kinds, which are found together, belong to the same species, while *Saporta* has found far more perfect specimens at Aix (a flora exhibiting the greatest affinity to ours), which exhibit the same combination.

Saporta considers *S. Tournalii* to approach the most nearly of any fossil species to the existing *S. sempervirens*. Short and simple branchlets, appearing naturally detached, are often found at Armissan, covered with the same loosely squamiform leaves, but terminating in short ramifications, or rather peduncles of cones which have been shed. These were in clusters of three to seven, or more rarely singly or in twos, while the cones of the existing *Sequoia* always occur singly. In the river-deposits of Bournemouth the cones must have been floated away by the moving water and deposited elsewhere, for no trace of them has yet been discovered.

All the specimens figured, except 9 and 12, are from the uppermost "Coastguard-beds." Fig. 12 is from the "Myrica-bed," and fig. 9 from near Poole.

SEQUOIA LANGSDORFII, *Brongn.* (sp.). Plate X, figs. 1, 1 a.

TAXITES LANGSDORFII, *Brong.* Prodr., pp. 108, 208, 1828.

TAXITES? CAMPBELLII, *Forbes.* Quart. Journ. Geol. Soc., vol. vii, p. 103, pl. ii, fig. 1 a, b, 1851.

SEQUOIA LANGSDORFII, *Heer.* Fl. Tert. Helv., vol. i, p. 54, pl. xx, fig. 2; xxi, fig. 4, 1859.

Eocene, Isle of Mull.

The branchlets are irregularly alternate, rather distant, about three centimètres broad and nine centimètres long. The stem of the branch is clothed with very long, distant, scale-like leaflets, closely adpressed for two thirds of their length, and then looser, shortly acute or falciform. The base of each branchlet is clothed for a short distance with somewhat crowded, small, scale-like leaflets; on the rest of the branchlets, the leaflets become for the greater part of their length linear-lanceolate, pointed, rather distant, flat, nearly straight, with a distichous arrangement. The apex of the branchlet is in no case quite preserved, but the termination seems to have been abrupt or truncated, and in a sort of leaf-bud. The expanded portions of the leaflets measure six to nine millimètres in length, and their texture seems to have been leathery and the midrib well defined.

Although the figure of this specimen, described as *Taxites? Campbellii*, represents small, undeveloped, scale-like decurrent leaflets lying along the stem between the expanded leaflets, none can be now recognised in the specimen. The enlargement shows that every leaflet is fully developed and twisted either to the right or left, every third or fifth having its base in the centre of the stem, and its blade pressed to one side or the other. The pressure during fossilisation has led to the appearance of a secondary growth of undeveloped leaves, and the black and coaly consistence of the fossil has helped to mislead the artist of the plate in question. It is remarkable that all the Coniferæ from Alum Bay and Bournemouth with similar foliage possess the very characteristics attri-

buted in error to the Mull fossil, so much so that this appears one of the readiest means of distinguishing them. (Pls. I, V, VIII.)

Although no fruit of *Sequoia* has been found in the Isle of Mull Leaf-bed, the characters of the foliage agree in their minute details with those of *Sequoia sempervirens*, though the general form appears to have been more regularly branching. The reference of the species to that genus seems fully justifiable.

There can be little doubt respecting its identity with some of the foliage of the Swiss Tertiaries, attributed to *S. Langsdorfi*, nor with some determined from the Italian Miocene by Massalongho, and the German Miocenes by Weber and Heer. The foliage from the Tertiaries of Greenland and Alaska, undoubtedly belonging to *Sequoia*, also resembles it very closely, and connects it with a longer and more crowded, distichous, *Sequoia* foliage from Spitzbergen. Very little of the English, French, or Austrian Eocene *Sequoia* foliage can be safely united with it, though a branch in the British Museum, from Leoben, in Styria, can in no respect be distinguished from it. Again, *S. brevifolia*, Heer, from the lowest stage of the North-American Tertiary lignites and from Greenland may be but an ordinary variation in foliage, such as can be seen in almost any tree of *S. sempervirens* at the present day. The species, as might be inferred from its almost perfect identity with the living one, had a northern range during the Eocene, Mull apparently having been its southern limit, for, instead of abounding there as in other localities, it is exceedingly rare, and has never been found in Antrim. It seems only to have descended south towards the close of the Tertiary period in company with *Ginkgo*, *Taxodium distichum*, and so many other northern plants which, after traversing Europe during the Miocene or Brown-coal period, finally appear in the newer Miocene of North Italy. Its place was occupied to the south during the Eocene by the dimorphic *S. Tournalii* and *S. Hardtii*, and it is not a little interesting to find that *S. sempervirens* under cultivation at Madeira, in a warmer climate than is natural to it, has, even in the few years since its introduction, taken on a strong tendency towards a dimorphic habit.¹

Sequoia sempervirens, or the Red-wood tree, is a lofty evergreen, growing from 200 to 300 feet high, and from twenty to thirty feet in circumference, one tree even measuring fifty-five feet in girth, six feet from the ground. It grows abundantly on the mountains of Santa Cruz and the Sierras of primeval California. In the very heart of these immense pine-belts the Red-wood forms, in company with the Sugar-pine, the Douglas spruce, and Incense-cedar, superb columns towering 200 feet, in inviting woods of sunny colonnades and park-like openings.

The original specimen, which illustrated the Duke of Argyle's paper "On the Leaf-Beds of Ardtun Head, in Mull," remains unique, and is in the Museum of Practical Geology at Jermyn Street. I have, however, seen indistinct and scattered leaflets from Uig, in Skye.

¹ The imbricated growth possibly takes place in winter or in spring, and is therefore more prolonged in a warm than in a rigorous climate.

Genus—ATHROTAXIS.

This is a small genus of three to four species, nearly allied to *Sequoia*, and inhabiting Van-Diemen's Land. They bear small ovate or globular and woody cones of many scales, of about the size of a hazel nut; and scale-formed, either closely inlaid or open and incurved leaflets. They are small trees, growing near to water, and are tolerably hardy. They are known as Jointed Yews, from their jointed branchlets, and are restricted to a few localities and occur only in limited numbers.

Athrotaxis (?) *subulata*, sp. nov. Pl. XI, except fig. 1.

London Clay, Isle of Sheppey.

The leaflets are spiral in eight rows, thick, scale-formed, closely inlaid, broadly triangular, falcate, keeled on the back, and concave on the inner face. The branchlets fork irregularly, and are from five to ten millimètres in diameter. The cones are solitary on the ends of the branchlets. The only fruiting specimen known is almost globular and measures but little more than ten millimètres in diameter by twelve millimètres in length, and it is composed of over twenty imbricated scales.

Fragments of stems clothed with leaflets are occasionally met with, washed out of the Sheppey cliffs. These resemble branchlets of the existing *Athrotaxis selaginoides*, but the determination rests almost entirely upon a single small cone, which in its form, appears to approach much more nearly to *Athrotaxis* than to any other genus of Coniferæ. Carruthers concurs in the view that with the material no other determination is possible. The foliage also resembles, but more distantly, that of *Dacrydium balansæ*, certain *Araucarias*, &c.

TRIBE III.—TAXEÆ.

The Taxeæ comprise *Taxus*, *Torreya*, *Ginkgo*, *Phyllocladus*, *Dacrydium*, and *Pharosphaera*. They are distinguished by their seeds not being collected into cones, each ovule growing singly and being protected by a fleshy disk, or forming a drupe. The leaves are narrow and veinless, or expanded, with the forked venation of Ferns. They are occasionally large, even gigantic, trees, as *Dacrydium taxifolium*, and occur in the milder climates of both hemispheres, extending on elevated regions across the tropics.

Lindley considered the Taxeæ a more primitive type than the cone-bearing Conifers,

and they can, in fact, be traced with almost certainty to the Carboniferous through ancestral forms of Ginkgo. No other Taxads are known of greater age than the Cretaceous. *Torreli*¹ of the Tertiary of Alaska possesses long, narrow, leathery leaves, rounded at the end, and with forked venation, conjectured to be coniferous from the base of the leaf being articulated. Distichous twigs have been described frequently from Cretaceous and Tertiary beds as "*Taxites*," but in most instances later discoveries have led to a different interpretation.

There is no conclusive evidence of the presence of TAXUS, or the Yew, in any Eocenes, though a few berries are ascribed to it from the Wetterau. It contains about seven species, all hardy, and confined to temperate Europe, Asia, and America. *Taxus baccata* is one of the three Conifers indigenous to Great Britain, and grows in most parts of Europe at heights of from 1000 to 4000 feet. The species generally resemble each other, the most remarkable being *T. Wallichiana* of Northern India, which forms vast forests at elevations of from 8000 to 10,000 feet, and even ascends in Bhotan as a dwarfed form to 11,800 feet.

TORREYA has not been found fossil in the Eocenes of temperate Europe. Two species are described by Heer (vol. iii, 'Flor. Arctica') from the Cretaceous of Kome, from foliage and a small detached globose nut; *Taxites microphyllus*, from Alaska, may represent another species. Saporta connects them with *T. nucifera* of China and Japan, through *Taxites validus*, Hr., of the Baltic Miocene. The leaves seem not to have been distichous but in opposite pairs, and their real affinities may still perhaps be doubted. *Torreya nucifera brevifolia* from the Pliocene of Meximieux is, however, scarcely to be distinguished by any character from the Japanese species; and Saporta also believes that a branchlet from Bilin, figured by Ettingshausen as *Sequoia Langsdorffi*, is a representative of *T. taxifolia* of Florida. There now exist but three or four species, all natives of North America, Japan, and China. The fruit is plum-like, containing a single seed enclosed in a hard shell, and the leaves linear and subspiral or distichous. It presents another instance of a Conifer existing in the Arctic Circle during the Eocene, and only spreading over Europe and America towards the later Miocene.

The genus PHYLLOCLADUS, or Celery-leaved Pines, contains trees of moderate growth, which are natives of New Zealand, Borneo, and Tasmania. The branchlets are leaf-like and feather-nerved; the leaves themselves are reduced to minute, scale-like bodies on the margins of the branchlets. The only fossil referred to the genus is from the Upper Cretaceous of Spitzbergen, but even this possesses hardly the most slender character connecting it with Phyllocladus. PHEROSPHERA, a genus with small scale-like foliage and solitary fleshy fruit, contains but a single species from Tasmania. DACRYDIUM contains some ten species, natives of the Malays, Fiji, New Caledonia, New Zealand, Tasmania, and Chili. One, *D. cupressinum*, is said to reach 200 feet in height, and *D. elatum* and *D. Franklinii* are also very lofty trees, while, on the other hand, *D. taxifolium*

¹ Heer; not to be confounded with the existing *Torreya*.

barely attains three feet when full grown. The fruits somewhat resemble those of Podocarp. No fossil has been referred to it, though some fossil foliage bears a great resemblance to it. GINKGO is the only genus that has been recorded from the British Eocene.

Genus—GINKGO.

The genus, better known as *Salisburia*, possesses a single species. Its leaves are adiantoid, leathery, very variably lobed, and of all sizes up to an extreme of five inches across, and deciduous. The fruit, about an inch in diameter, is drupaceous, on a slender foot-stalk, composed externally of a fleshy layer, and internally of a hard light-coloured shell, somewhat unsymmetrical owing to the abortion of one of the seeds. The foliage, though like that of the maidenhair fern, may when fossil be recognised by its stout petiole, often three inches long and distinctly articulated at the base. Again, however irregularly the leaf may be lobed, its primary bilobation is discernible.

Though so singularly restricted a genus now, its ancestry is perhaps more venerable than that of any other forest tree. The Carboniferous fruits, *Trigonocarpum* and *Noeggerathia*, are believed by both Hooker and Saporta to have belonged to some allied form. *Psygmyphyllum* of Schimper approaches nearly to Ginkgo, and even true Ginkgo has been said to be found in the Carboniferous. *Baieria*, beyond doubt a close ally, appears in the Permian, and the bilobate *Jeanpaulia* of the Rhætic of Bayreuth is probably a true Ginkgo; but an even more definite species has been found in the same system in Australia. The group, however, did not reach its maximum development until the Jurassic period. Heer's 'Jurassic Flora of Eastern Siberia'¹ contains a most important contribution to their past history. Five genera are placed in the group:—*Ginkgo*, *Baieria*, *Trichopitys*, *Phœnicopsis*, and *Czekanowskia*, the two latter of which seem, however, to have little affinity with Ginkgo. The most aberrant form, obviously belonging to the group, is *Trichopitys* of Saporta, in which the parenchyma is reduced to a narrow expansion bordering the veins, yet with the characteristic bilobation and petiole preserved. Its affinity is best traced through *G. concinna*, which is similar, but the segments of the leaves are more expanded and receive two or three veins each.

The Arctic Ginkgos have been subdivided by Heer into too many species: the leaves of the existing species are so excessively variable under different conditions of growth that their varieties would more than embrace all the supposed Jurassic species. The second genus, *Baieria*, possesses a larger and more palm-like leaf averaging nearly five inches in radius, its bilobation and venation connecting it closely with Ginkgo. The persistence, throughout the whole group, of characters which would hardly have been suspected to possess a morphologic value is a peculiarly interesting fact.

¹ 'Flor. Foss. Arctica,' vol. iv.

There is a marked diminution in the group in the Cretaceous. Baieria from the Komeschichten is limited to vestiges, of stunted form, described as Ferns, while Ginkgo appears in a starved species with small leaves and short thick petiole, described as *Adiantum formosum*, and by fragments from the Ataneschichten, inappropriately named *G. primordialis*. In the Arctic Tertiaries, Ginkgo is met with sparingly in Greenland only, where it so much resembles *G. adiantoides* of the Italian Miocenes that Heer almost directly abandoned his specific name *primordialis*, and became doubtful even whether both should not be united with the existing species. Coming south there are small and doubtful fragments from the Baltic Miocene, and it is only again met with in the later Miocenes and Pliocenes of Italy and the South of France. It is completely unknown in either the Eocene or Oligocene in temperate Europe, with the one exception of Ettingshausen's *Salisburia eocenica* of Sheppey, about which there is some room for doubt.

GINKGO (?) EOCENICA, Ett. and Gard. Plate IX, figs. 31—34.

SALISBURIA EOCENICA, E. and G. Proceed. Roy. Soc., vol. xxix, p. 392, 1879.

London Clay, Sheppey.

The fruits or seeds are entirely pyritized, irregularly ovate, and variable in form. The largest measure some eleven millimètres in height by about nine millimètres in breadth, but they are occasionally wider than high, and more or less compressed, varying from seven to barely four millimètres in thickness. They are sharply keeled, the keel is sinuous and the seeds consequently not symmetrical. There is a small truncated projection at one extremity, greatly resembling that seen in the existing seed of Ginkgo, but at the other end of the seed there appears a trace apparently of a scar of attachment.

They are perfectly smooth, and are probably interior casts of the shell filled with amorphous pyrites. They are much smaller and more sharply keeled than in Ginkgo, which they otherwise resemble in general form; but if the slight scar which they present is truly one of attachment, it would point to a leguminous origin. A great variability in the form of the seed is also seen in the existing species. Several of these seeds are preserved in the Bowerbank Collection in the British Museum. They are now difficult to obtain, being either very rare or overlooked by collectors at Sheppey.

The sole existing representative of the genus is the gigantic *G. biloba*, apparently indigenous to Northern China, for it is only met with in the immediate vicinity of



FIG. 19.—Seed of *Ginkgo biloba*.



FIG. 20.—Edge view of same.

temples and is unknown in a wild state, the aboriginal stock having possibly become extinct.¹

Imported into England about 1754, it thence found its way to the Continent, and now flourishes and bears fruit abundantly in Padua, Avignon, Montpellier, &c., and has even been known (1853) to fruit at Versailles. It is sterile at Geneva and almost everywhere to the north, and the isotherm best fitted to it would therefore seem that of the Corea or even a little to the north of that point. It requires a considerable summer heat.

Although fossil species of the Jurassic period have been met with so far south as Yorkshire, it appears to have been an essentially northern genus, for it disappears from temperate Europe thenceforward with slight exception until the Pliocene age. It is everywhere unknown, except from polar regions, during the older Tertiaries; a supposed species from the Mississippi having proved to be a fragment of *Lygodium*, and it therefore seems somewhat unlikely that the high temperature in which vegetation flourished late in the London-Clay time would have been favorable to its growth. The doubt which must exist, in the absence of any foliage of the genus in other Eocene deposits, whether the resemblance which these seeds bear to Ginkgo may not be accidental, is at least shared by Saporta.

TRIBE IV.—PODOCARPEÆ.

The tribe contains, according to the *Genera plantarum*, but three genera. Two of these, MICROCACHRYS, a small shrub confined to Tasmania, and SAXE-GOTHEA, a larger bush confined to the mountains of Patagonia, are each represented by a single existing species, nothing yet being known of their ancestry. The seeds in both are contained in small fleshy cones. The third genus, PODOCARPUS, is widely distributed throughout the Eocenes of Southern Europe.

Genus—PODOCARPUS.

The flowers are dioecious or rarely monœcious; the fruit is either drupaceous or nut-like, and inverted; the seeds are hard, with a crustaceous integument; the leaves coriaceous, and either opposite, alternate, or scattered, linear or oblong, with a single median nerve, or more rarely with a dicotyledonous venation. The genus contains fifty-nine species, according to Gordon, many of which, however, are so little known that Hooker and Bentham believe them capable of reduction to forty. These are divided into four sections:—*Nageia*, with opposite or alternate many-veined leaves and round

¹ Masters, 'Linn. Soc. Journal,' vol. viii, p. 481, "On the Conifere of Japan."

drupaceous fruit, comprising according to Gordon, eight species which inhabit from New Caledonia to Japan, one being the only Conifer indigenous to Hindustan. *Eupodocarpus*, in which the leaves are linear, with one nerve, and the fruit solitary, with a fleshy receptacle, comprising forty-six species according to Gordon. *Stachycarpus*, with linear single-nerved leaves, alternate or in two rows, and fruits born on spikes without the fleshy receptacle, possessing but two species. *Dacrycarpus*, with squamiform spiral leaves on the fertile branches, flat and distichous leaves on the barren, and fruit similar to, but smaller than in *Eupodocarpus*, comprising four species.

The Podocarps vary from mere shrubs to colossal trees, and are widely spread over the Southern Hemisphere. They are well represented in the Oriental, Ethiopian, Australian, Neotropical, Palæarctic, and China—Japan provinces; and in the Nearctic province by a single Californian species.

Notwithstanding this almost world-wide distribution, and the evidence of antiquity which the genus presents, scarcely anything is known of their past history. In most cases the foliage when detached has little to distinguish it from that of better known Coniferæ, and the fruits, in the fossil condition, seldom present anything by which their Gymnospermous nature can be detected. Except a doubtful and undescribed species from Aix-la-Chapelle, no Podocarp is known of earlier age than Eocene, when they at once appear with a wide distribution over temperate Europe, again as suddenly disappearing with the Oligocene. No Podocarp has



FIG. 21.—Fruit of *Podocarpus elata*.



FIG. 22.—Apex of the same.

been made known from either the Arctic or the American Cretaceous or Tertiary series, and therefore, either the distribution of existing species must have been accomplished prior to the Cretaceous period, or, in order to explain their presence in Chili and other parts of South America, we are forced to admit a land connection far to the south of that relied upon by Wallace and those who share his opinions.

The fossil Podocarps that are only known from their foliage may be conveniently classified under two heads, those that have shed their leaves separately, and those in which they remain adhering to branchlets. Both sections are represented in our British Eocenes.

PODOCARPUS EOCÆNICA, Unger. Plate II, fig. 6—15.

UNGER. Fossile Flora von Sotzka, p. 28, pl. ii, figs. 11—16, 1850.

— Sylloge Plantarum Fossilium, pl. 31, pp. 10—12, 1860, &c.

Middle Bagshot, Bournemouth; Lower Bagshot, Alum Bay; Upper Bagshot, Hordwell; Middle Eocene (?), Mull, and Antrim.

The Bournemouth specimens are linear-lanceolate, the margins being parallel for nearly the entire length; the apex is acute and the base broadened and sessile. No venation is discernible except the midrib, which shows more strongly on the back of the leaf than on the face. Their condition of preservation betrays a very coriaceous consistence. Figs. 9 and 10, both representing imperfect leaves, exhibit a total length of over three inches, with a breadth of only three-sixteenths of an inch, but these may possibly be neither the same species as the other leaves, nor even Coniferous. A fine and perfect typical example of true Podocarpus is delineated in fig. 7. The length of the leaf is seven millimètres, the breadth barely three millimètres; the apex is sharply pointed and mucronate, the base sessile, about one millimètre broad; the midrib strong and distinct, and the colour a deep brown. The leaves from Mull are identical with it in every respect, save colour, and apparently also a half leaf from Antrim. This is the more remarkable since at Bournemouth the species is strictly confined to the Uppermost "Coastguard Bed," and has never been met with in any of the other numerous beds, from which large collections have been made. The remaining specimens from Bournemouth agree well with it, except fig. 8, which is a much smaller leaf, becoming broader towards the apex, with a slender, petiolated base, and thin and sharply defined midrib. Our species differs materially in its broadly sessile and articulated base, and narrow linear form with parallel margins, from all the many similar Podocarp leaves described from the Continental Eocenes. It bears the greatest resemblance to *P. gracilis*, Sap., from Aix, and *P. Peyriacensis*, Sap., from Peyriac, yet differs from these in the sessile base and mucronated apex.

The single leaf known from Alum Bay (fig. 15) has a different character, tapering to an apparently petiolated base and a pointed, but not mucronated, apex. This measures seven centimètres in length and six millimètres in breadth; and while agreeing closely with *P. plana*, Wat., *P. proxima*, Sap., and *P. eocænica*, Ung., differs very markedly from the Bournemouth type. No venation is discernible, except the strongly marked midrib, and the leaf was obviously coriaceous. Figs. 13 and 14 represent much smaller, and also very coriaceous, leaves from Hordwell, which, if referable to Podocarpus, would probably belong to another species.

Unger,¹ who first described them, explains the microscopic leaf-structure of Podocarpus in great detail, as well as that of the wood, which he also met with fossil. More than a dozen extinct species have been made from the Tertiary leaves of this type, and though Heer has united several, such as *P. mucronulata*, Ett., *P. haringiana*, Ett., and *P. taxites*, Ung., about eight species remain. Some of these can perhaps scarcely be regarded as satisfactory; and it does not appear, in the present state of our knowledge, that any useful purpose can be served by adding further to them. The broad fact is of

¹ 'Sylloge plantarum fossilium,' pl. 31, pp. 10—12. The specimens were from the Wetterau. He considered the arrangement of stomata, which he represents magnified 100 and 360 diameters, to be most like that existing in *P. nubigena* of Chili.

great interest that Podocarps with foliage very similar to such forms as *P. andina*, *P. chilina*, *P. elongata*, *P. falcata*, *P. novæcaledoniæ*, and others belonging to the Eupodocarpous or Stachycarpous divisions, were widely spread over Europe during at least the Middle-Eocene period. They range in time from the Suessonian to the lowest stage of the Aquitanian, and thus form a group essentially characteristic of the Eocene in Central Europe. They seem soon after to have migrated, for, except in Italy, they are totally unknown in the Miocene. The chief localities in which they have hitherto been met with are Sotzka, Häring, Bilin, Ralligen, the oldest Tertiary plant-bearing formations in Switzerland, the Grès du Soissonais, Grès de la Sarthe, Aix, Armissan and Peyriac in France, Koumi in Eubœa, Bournemouth, Alum Bay, &c.

They are thus known to have occurred in Western Europe during the Eocene, from Aix, lat. 43° to about lat. 48°. Their presence, therefore, so much farther north in Antrim and in Mull, lat. 56·30°, emphasises the importance of the results to be expected from a careful examination of our British Eocene Floras.

Although no fruits belonging to this species have been recorded, and it would be difficult to find any essential characters by which to recognise them when detached, the leaves, which appear undoubtedly Coniferous, could from their size belong to no other genera. The only other genera with at all similar foliage, are *Cephalotaxus*, *Taxus*, and *Torreya*.

The number and great range of the existing species with similar foliage, and the varied temperatures which these different species sustain, render it unlikely that they will afford safe data for estimating past temperatures, but from their somewhat limited vertical range in time and changing forms, they may, with other plants, become valuable data in ascertaining the relative ages of Tertiary plant-beds in Europe.

PODOCARPUS ELEGANS, De-la-Harpe (sp.). Plate VIII, figs. 1—16.

CUPRESSITES ELEGANS, *De-la-Harpe*. Mem. Geol. Survey, Isle of Wight, p. 111, pl. v
figs. 1—3, 1862.

GLYPTOSTROBUS EUROPEUS, SEQUOIA LANGSDORFII, S. COUTTSIÆ, *Ettingshausen*.
Fossil Flora of Alum Bay, Proceed. Royal Society,
vol. xxx, p. 231, 1880.

Lower Bagshot, Alum Bay.

The leaflets are opposite, narrow, linear, spreading, and in two rows; or three-sided, awl-shaped, and acute, and in five rows; their size varying in the first form from very small to almost twelve millimètres in length, and two millimètres in breadth. They are coriaceous, finely parallel-veined, with inconspicuous midrib, and a surface irregularly dotted with pits just visible without a lens; and they either taper to a point or are

bluntly rounded. The angle formed by the leaflets, which are often crowded and overlap, averages about 20° , and their bases, as in many recent Conifers, are decurrent on the stem until overlapped by the succeeding leaflet. The basis of their arrangement seems spiral, though only the lateral leaflets are expanded, the rest being narrow and closely pressed to the branchlets. In the smaller terminal shoots they are less in size, more tapered and acute, and therefore to a slight extent intermediate between the expanded and the imbricated foliage. This latter is loosely imbricated, spinous, recurved, or falcate, often approaching the distichous type.

An example of what is apparently the fruit of the species is shown in fig. 16; in which case it must have been a small solitary berry on a short pendant stalk, as in *P. andina* and some other Podocarps, and not terminal. Though rather crushed, the characteristic footstalk seems to ally it to the section Dacrycarpus.

Although by no means closely related to any known existing species, the specimens recall *P. cupressina*, of Java and the Philippine Isles; particularly fig. 11, which agrees most closely with it in the relative positions of the broad and scale-leaved shoots. It also resembles *P. tenuifolia* of New Caledonia, and other species, and the foliage bears a general resemblance to that of *Taxodium*, but is more coriaceous.

While there can be no reasonable doubt about most of the figured specimens belonging to one species, some of them may belong to quite other Conifers,¹ though they do not afford characters which enable them to be definitely separated. None of the foliage has been met with except at Alum Bay, and it differs from any of the similar kinds of foliage from Bournemouth; yet it is difficult to formulate any well-marked distinctions, which would allow of isolated pieces being immediately recognised, when met with elsewhere. The richer parts of the Alum Bay leaf-beds have now been washed away; and the two specimens with fruit were almost the last fossils obtained from it.

The only fossil resembling it is *P. taxiformis*, Sap., from Armissan.

De-la-Harpe² mentioned the occurrence of branches of Coniferæ at Alum Bay, resembling *Cupressites taxiformis*, Ung., and *Taxites Rosthorni*, Ung. They were described at greater length in the 'Memoirs of the Geological Survey, Isle of Wight,' 1862, p. 111, by the same author, as *Taxites*, sp., and *Cupressites elegans*, De-la-H. The separation is made on slender characters, and the latter type is compared to *Dacrydium cupressifolium*.³

¹ A large drupe, since discovered, seems to indicate a second Podocarpous species.

² 'Bull. Soc. Vaudoise des Sc. Nat.,' 1856.

³ Ettingshausen, in his "Report on the Fossil Flora of Alum Bay to the Royal Society" ('Proceed. Roy. Soc.,' 1880) introduced six species of Coniferæ into his list, three of which were founded on material now figured in the accompanying plate, two others on fragments which seem to be of a doubtful coniferous character, while the sixth has been here mentioned, p. 49, under *Podocarpus eocanica*.

PODOCARPUS ARGILLE-LONDINENSIS, sp. nov. Pl. IX, figs. 35 and 36.

London Clay, Sheppey.

Fruit compressed, globose, nearly as long (sixteen millimètres) as wide (fifteen millimètres), deeply and finely wrinkled; apex small, not central, slightly produced and recurved; basal-scar a small pit, subcentral, and inclining to the same side as the apex. The external wrinkled coat of the fossil represents the desiccated integument, while the next layer, probably the bony shell of the seed, is somewhat rough and pitted, and the nut, visible inside, is smooth.

This fruit very strikingly resembles that of *P. elata* of Queensland, (fig. 21, 22, p. 48) the determination resting entirely, in fact, upon the exceedingly strong likeness which the two bear to each other. It is very rare at Sheppey, the specimen sent to me by Mr. Shrubsole, F.G.S., being unique.

PODOCARPUS (?) INCERTA, sp. nov. Pl. II, figs. 1—5.

Middle Bagshot, Bournemouth.

Foliage distichous, opposite, or alternate; leaflets long, linear-lanceolate, bluntly pointed, parallel-sided, constricted at the base, and thence decurrent on the stem, the largest measuring three centimètres in length by five millimètres in breadth, with five parallel veins and inconspicuous midrib. As in many other Coniferæ the leaflets are occasionally abortive, and in addition to those expanded in two rows the stems are clothed with narrow, decurrent, scale-like leaflets. In texture and venation the leaflets somewhat resemble those of Cycads, but their arrangement shows the species to be undoubtedly coniferous. The foliage is more like that of some of the Podocarps than of any other species of existing genera, but it possesses no character which would altogether preclude its reference to other Tribes of the Coniferæ.

It is the largest of all the Yew-like Eocene foliage, and is easily distinguishable by its fine parallel venation, with an absence of midrib, smooth or glossy surface, and blunt terminations. It is confined to the "Gleichenia-beds" at Bournemouth, where it is relatively rare.

TRIBE V.—ARAUCARIEÆ.

The genera recognised in Bentham and Hooker's 'Genera Plantarum' are *Cunninghamia*, *Agathis*, *Araucaria*, and *Sciadopitys*. They are distinguished by their cones, composed of exceedingly numerous spirally imbricated scales, and wingless or marginally-

winged seeds. The two principle genera are entirely confined to the Southern Hemisphere; the others have each a single species, and are natives the one of Japan and the other of China.

The earliest traces of distinctly Gymnospermous wood were for years supposed to present the Araucarian structure. The foliation of the Permian genus *Walchia* and the Triassic *Voltzia* resembles that of *Araucaria*, but the latter possesses an abnormal cone, consisting apparently of altered and expanded leaves, a peculiarity which is even more striking in the allied *Glyptolepis*. Another protean genus, *Palissya*, seems to approach *Cunninghamia*. These remote genera are probably, however, extinct types, ancestral perhaps to several existing tribes of the Coniferae. The first distinctly Araucarian genus *Pachyphyllum* is met with in the Lias, and believed by Saporta to combine characters of *Agathis*, *Cunninghamia*, and *Araucaria*. In the Stonesfield, Somersetshire, and Yorkshire Oolites, cones with every character of true *Araucaria* make their appearance,¹ and have been described by Carruthers; and from Solenhofen by Th. Dyer; while forms agreeing closely with these have also been found in the Jurassic rocks of India. It is not yet known from Cretaceous rocks, for the larger fossil cone figured by Heer as *Araucarites Nordenskiöldi*, from the Upper Cretaceous of Spitzbergen, is a very indistinct coaly mass, and, as he suggests, probably Cycadaceous.²

Small Araucaria-like foliage, both of the imbricated and needle-leaved types, is very abundant in the Cretaceous series of Aix-la-Chapelle, and is also met with in several localities on the same horizon in France. It appears probable, from the constant association of the two types of foliage together in so many places, that they may have belonged to the same plant.

Of the other existing genera, CUNNINGHAMIA, a native of China, has been described from German Cretaceous rocks as *Cunninghamites*, and a fragment has even been determined from the Miocene. No fossil representative of the Japanese SCIADOPITYS is known, except from the Amber-beds of Samland, in Prussia.

Genus—AGATHIS.

The flowers are monœcious or diœcious, cones globose, scales numerous and persistent, the seeds unattached, solitary, or rarely in twos, and occasionally winged on one or both margins; leaves sub-opposite, ovately oblong or rarely lanceolate, leathery, and finely parallel-veined.

¹ Lesquereux believes that cones of true *Araucaria* occur in America as far back as the Trias.

² 'Flora foss. Arctica,' vol. iii, pl. xxxvii, p. 126. Heer acknowledges the figure to be much too distinct, and that the position and arrangement of the scales can only be made out with the greatest trouble. Restored as it is, it possesses no distinctly Araucarian characters, and while no branches of *Araucaria* are found Cycadaceous foliage abounds in most Cretaceous rocks in high latitudes.

The existing species, eight to ten in number, better known by the name of *Dammara*, are natives of Australia, New Zealand, the Malayan and Fiji Isles, New Caledonia, and New Hebrides. The best known species are the Amboyna and the Kauri Pine, both trees exceeding 100 and even 180 feet in height. The latter is the most beautiful and celebrated of all the New Zealand Conifers, and except *Athrotaxis*, the only one bearing cones. Its range is limited to the long and slender North-Western peninsula of the North Island. The range of the tree depends upon the moist sea breeze and stiff clay soil which are there united, for the Kauri loves to be near the sea, and the richest forests and most luxuriant timber are found along the shores of Kaipara Harbour and its affluents upon the coast of the peninsula. It grows in groups of trees of approximately the same age, and thus clumps of 100, 200, 400, or 500 year¹ old trees are met with. Extensive districts formerly covered with the Kauri Pine are now destitute of them, and half-decayed giant stems and the gum which the natives dig are, according to Hochstetter,² the only indications of the former extension of the woods over many large and barren tracts. Its final extinction is feared to be as certain, and will probably be accomplished as speedily, as that of the Natives of New Zealand.

Two cones from the Cretaceous have been described as *Dammarites*, which Schimper believes, however, may be Cycadeous.

There is slender evidence suggesting that an *Agathis* near to *A. robusta* of Queensland, or to some of the Malayan species, formed part of the Bournemouth Eocene Flora. The leaf figured (Pl. II, fig. 16) seems to have possessed the peculiar leathery texture and silky face, with the very fine parallel venation, and twist at the base, characteristic of *Agathis*, and fig. 21 represents a scale in no way dissimilar to a detached scale from the cone of the same species. Saporta also is now convinced that an *Agathis* with the foliage of *Araucaria Cunninghami* existed side by side with species of *Abies* down to a very late Miocene period.

Genus—ARAUCARIA.

The Araucarias are diocious, the pollen- and the ovule-bearing catkins being produced on different trees, or rarely monocious. The cones are globular, terminal, and erect, with very numerous scales disposed in spiral rows, and, more or less deciduous. The seed-scales and the bract-scales are firmly soldered together, the combined scale presenting a distinct double apex. The seeds are large, firmly adherent, and more or less laterally winged. The leaves are coriaceous, spirally disposed, and persistent for many years. In the division *Columbea* they are broad and scale like, and in *Eutassa* lanceolate and acute.

The Araucarias are lofty evergreen trees, natives of the Southern Hemisphere, with

¹ Individuals are supposed to reach an age of 700 or 800 years.

² 'New Zealand,' Hochstetter, English edition, 1867, p. 143.

perfectly erect trunks and horizontal or decumbent branches in whorls. They present a singular and unmistakably archaic appearance, and are divided into two distinct sections: Columbea, or true, and Eutassa, or false, Araucarias. The former comprises four species, all of great dimensions, the most familiar being the *Arauc. imbricata* of Chili, where it forms vast forests, extending on the Andes from the snow-level, 1500 or 2000 feet downwards. A second American species is confined to Brazil, a third to a tract thirty miles long and only twelve miles broad, near Brisbane in Australia, and the fourth is only indigenous to Porte Molle, one of the Caledonian Isles, where it is confined to the summit of an extinct volcano, only half a mile in radius. The Columbeas have not been met with fossil, either in the Eocene or Cretaceous rocks, except from New Zealand, where two species are known from Cretaceous coal-bearing beds, and have been figured by Dr. Hector, though yet undescribed. The rarity of their preservation is not surprising, because their stations are mostly high rocky ridges, where there is an absence of water, rendering it unlikely that their remains would find their way into marine or fluviatile sedimentary strata. It would be unsafe, therefore, to infer that species belonging to this section did not exist in Europe contemporaneously with the species of Eutassa that have been found.

The Eutassas possess but three known existing species, all of gigantic size. One, a native of New Caledonia and New Hebrides, presents a fantastic columnar-like growth, over 200 feet in height; another, *Arauc. excelsa*, is indigenous to Australia and Norfolk Island, and towers to a height of 230 feet, with a trunk thirty feet in girth. The third grows in Australia, and is referred to in the description of the fossil species. All the species, it is very important to notice, are polymorphous, and the foliage when young differs considerably from that of adult trees.

Schimper states that with the Tertiaries the Araucarias became extinct in Europe, and Thiselton Dyer even believed them to have been extinct north of the Equator since the Oolitic age.¹ They seem, however, to have remained until the close of the Eocene.

ARAUCARIA GOEPPERTI, *Sternb.* (sp.). Pl. XI, fig. 1; and Pl. XII.

ARAUCARITES GOEPPERTI, *Sternberg.* *Verst.*, vol. ii, p. 204, pl. 39, fig. 4, 1821—1838.

STEINHAUERA SUBGLOBOSA, *Presl.* In *Sternb.*, *Flora der Vorwelt*, vol. ii, p. 202, pl. xlix, &c., 1821—1838.

ARAUCARITES STERNBERGI, *Goeppl.* In *Bronn*, *Geschichte d. Natur.*, vol. iii, p. 41, and also of numerous authors, 1841—1849.

SEQUOIA STERNBERGI, *Heer.* *Urw. d. Schweiz.*, p. 310, 1864, and later works.

ARAUCARIA VENETA, *Mass.* *Spec. Photogr.*, p. 69, pl. xxi, 1859.

¹ 'Roy. Geog. Soc. Proceedings,' 1878, vol. xxii, p. 427.

Non. S. Sternbergi, Heer, 'Flor. Tert. Helv.,' vol. i, p. 35, pl. xxi, fig. 5; vol. iii, pl. 2, figs. 1—4; pl. vii, figs. 3—5; 'Flor. foss. Arct.,' vol. i, pl. xxiv, figs. 7—9; vol. iii, pl. 2, figs. 1—4; A. Sternbergi, Mass., 'Flor. Senigal.,' p. 154, pls. 5—7, 40; Sismonda, 'Mem. Reale Accad. di Torino,' 1865, p. 404, pl. iv, fig. 6!

Upper part of Freshwater beds and Marine beds at Bournemouth.

Only foliage has yet been met with in England. The leaflets are moderately short, falcate, and awl-like, quadrangular in section, thickened at the base, and with the lower side produced and decurrent on the stem, disposed spirally round the branchlets, which they quit at first at a right angle and then curve gently upward and inward, free or in slight contact at the apex with the row above. The branchlets, eighteen to twenty inches in length, are usually simple for five or six inches, and then fork copiously and chiefly horizontally. They are articulated at the base, and when broken away a lozenge-shaped scar remains, internally hard and ligneous, the woody core penetrating the smallest forks, while the leaves spring from the external cortical system. The specimens either taper and end in a leafy rosette or are constricted and swell into an oval bud. Branchlets resembling these in the minutest particulars, articulated at the base, and representing one year's growth, are annually shed by *Araucaria Cunninghami*, and are doubtless buried at the present time on the muddy shores of the Brisbane River, very many miles away.

In *A. Cunninghami* the tough woody core of the branch penetrates half way into the cone, when it gradually becomes spongy and vascular, and is lost towards the termination in a pulpy mass. This is surrounded by a somewhat pulpy layer, a quarter of an inch in thickness, a continuation of the fleshy bark from which the leaves spring. Upon this the scales are arranged spirally and at nearly right angles. When immature they are socketed into depressed scars on the axis, but, as the cone ripens, the attachment ceases by desiccation, and the scales, to which the seeds are firmly soldered, become held only by a single woody fibre which, parting from the central woody core of the axis, penetrates the scale. When ripe and shaken by wind, the whole of the scales fall away at once, except a few barren ones towards the base. The branchlets fall chiefly, I believe, in the spring, long after the seeds have been shed. My friend, Leland C. Cossart, of Madeira, has, moreover, ascertained for me that foliage of *Araucaria Cunninghami* requires two or three days to sink; while of the mature seeds of a cone, none sank before five to six days, and at the end of ten days there were still about 15 per cent. at the surface, so that in moving water they would therefore necessarily be deposited separately. The axis of the cone remains on the tree, for cones are never produced on the annual articulated branchlets, but only on the persistent branches. Indeed, it appears that each compound scale of the cone is an altered deciduous branchlet and not, as in the Abietinæ, merely an altered leaf. Only in cases where some violence has operated could a young cone, with the sap still flowing, and therefore in a condition to hold together, become detached. These facts explain the absence of any trace of cones among the very large quantity of

¹ 'Verst.,' vol. ii, p. 204, pl. 39, fig. 4.

foliage met with at Bournemouth, and go far to support its determination. Such an abundance of foliage with a total absence of cones or seeds in a marine deposit is extremely rare.

The foliage is met with, hardly less abundantly, in many other Eocene localities in Europe, and in some of these fossil cones are not so absolutely unknown. One was figured by Sternberg¹ from Häring, completely covered with bracteated scales, as shown in the annexed figures of immature cones of *A. imbricata*, kindly lent me by Messrs. Veitch, and was considered to be, and described as, the cone of an *Araucaria*, comparable with *A. imbricata*. It was some years later refigured by Göppert, who believed the cone to belong to the foliage which he then described as *Araucarites Sternbergi*.¹ A second



FIG. 23.—Immature male and female cones of *A. imbricata*.—From Veitch's 'Manual of the Coniferae.'

cone was found at Chiavon and figured, together with foliage, by Massalongho² as an *Araucarites*. It was forty-five millimètres long and twenty-seven millimètres wide, with transversely rhomboidal scales, provided with triangulated, unciniform, recurved umbones. Though the photograph is not very distinct, 125 scales can be counted on the exposed half, so that the cone must have been composed of at least 250. None of these botanists, or others, ever doubted that these represented young and immature cones of *Araucaria*; but notwithstanding their structure Heer transferred them to *Sequoia*,³ and in the

¹ 'Haarlem Trans.,' 1850, pl. 44, fig. 2, p. 237.

² Specim. Photogr., pl. xxi.

³ Heer seems to have compared it with a different type from Iceland and the Miocene of Turin, with which *Sequoia* cones are associated, and hence, I believe, changed Sternberg's name.

'Flora of Bovey, p. 35, stated his opinion that Massalongho's cone is quite different from *Araucaria* and very like *Sequoia gigantea*, though the cone of the latter is formed of at most thirty to thirty-five scales of a perfectly different form (see fig. 12, p. 33). Ettingshausen has recently obtained a second cone from Häring which is much compressed and imperfect, but the form is seen to be globular and composed of very numerous scales which resemble in form those of *A. Cunninghami*. There can be little doubt but that all these are immature cones of *Araucaria*, accidentally severed in some manner from the tree.

Foliage identical with ours is found very abundantly at Chiavon, Sotzka, and apparently at Monte Colle and Monte Promina. In that from Häring the leaves seem a little less dense and slightly less curved. All these are placed in the lowest stage of the Miocene by Heer, but are usually considered to belong to the Upper Eocene or Oligocene. A much smaller and different form is figured under the name from Bilin, where it is rare, and another from the Miocene of Greenland; these, however, more nearly agree with quite another Conifer to be described from Mull and from Canna. None of the other references of specimens to this species appear to me to be correct.

The foliage is distinguishable from that of existing Eutassas, except *A. Cunninghami*, for in these the articulated adult branchlets are simple and the leaves broader and more imbricated. The only other Coniferæ which resemble it are *Cryptomeria japonica*, in which the leaves are much longer, straighter, and quit the stem at an angle of about thirty-five degrees, with very numerous and persistent cones; *Athrotaxis selaginoides* and *Dacrydium araucarioides*, in which the leaves are more imbricated, and *Sequoia gigantea*. It is, however, only the immature foliage of young plants of the latter which resembles it; and then the leaves are longer in proportion, less regularly disposed and less curved, and quit the stem at very acute angles, and therefore with their points irregularly overlapping the succeeding row. The cones of *Sequoia* are in addition small, composed of few scales, and so persistent on the branches that they are almost always found associated with the foliage.

The distribution of this *Araucaria* at Bournemouth is very clearly defined, and shows plainly that its habits, when growing in our latitude, did not differ from those it now possesses. No trace of it is met with west of the Pier, in the beds whose floras may be thought, from their characters, to have come from districts farther from the sea; but east of the Pier it abounds everywhere in company with Fan Palms, Eucalyptus, Aroids, Ferns, &c., and in certain beds of sandy mud of the "Marine series," the branchlets are heaped together in perfect preservation and cross each other in every direction.

The existing *Araucaria Cunninghami* forms vast forests on the shores of Moreton Bay, on the alluvial banks of the Brisbane River, and grows in the greatest profusion in the bush forests of the Richmond River. "The trees seem to thrive best near the coast, attaining in such a situation their greatest height, often from 100 to 130 feet, but gradually diminishing in height the farther the trees are inland. It would appear from

this that the sea air has a great effect on it.”¹ These bush forests are thus described by Moore:—“The bush is characterised by denseness of growth, the altitude, and beautiful dark green foliage of the trees, the presence of lofty climbing plants, which extend their slender pliant branches considerable distances, and by this means often embracing, as it were, into one common bond, many of the loftiest and largest trees. . . .

. . . . Another characteristic of forests of this description is a thick undergrowth of numerous kinds of ferns and other plants. Palms and tree ferns also usually abound, the former reaching a height, in some instances, of at least 130 feet. . . . On the stems and branches of the trees numerous kinds of epiphytal ferns and orchids grow, which, with the other plants referred to, contribute materially to give such forests a very tropical appearance.”²

It is clear from the association together of the *débris* of trailing Smilacææ and Aroids, and from the remains of large Fan Palms and Ferns, that our Eocene bush growth must have been very similar to that described by Moore. The physical aspects of the former stations of *Araucaria* on the alluvial banks of the great Bournemouth River, and its probable extension along the east coast of the Submerged Continent, must have approximated to those it now occupies on the Brisbane River and the shores of Moreton Bay on the East Coast of Australia. Nothing can be more impressive, indeed, than the remarkable agreement in habit between the *Araucaria* and associated plants that have passed away, and those that survive so far away. The long-embedded plants of our Eocene coasts seem to have risen up and to live again in a distant country, and through what exists there we are able to picture the long sandy coasts, beaten by an ocean surf and fringed with dark-foliaged and gigantic *Araucarias*, Gum-trees, luxuriant Palms and Ferns, whose remains have helped to form the cliffs and moors of pine-clad Bournemouth. If we contrast this with the comparative absence of any similar associated vegetation in the Mammoth Grove, we see how opposed would have been the contemplated reference of these branches to *Sequoia* under any known natural grouping.

Dixon, in the ‘Geology of Sussex,’ pl. ix, fig. 1, engraved a fragment of a Coniferous branch under the name of *Lycopodites squamatus*, Brong., from Bracklesham, which might possibly have belonged to this species, and there is a small fragment from Barton in the British Museum.

A somewhat similar Conifer occurs in the Bembridge Marls of Hempstead Cliff, Isle of Wight. The needles are longer, straighter, and less symmetrical, and the species is evidently distinct from *Araucaria Goepperti*. Whether, however, it is the Icelandic *Sequoia Sternbergi*, or a *Cryptomeria* or a *Dacrydium* like that from Borneo, which very closely resembles it, there is at present absolutely no evidence to indicate.

¹ ‘Industrial Progress of New South Wales,’ 1870, pt. ii, p. 643.

² *Id.*, p. 633.

TRIBE VI.—ABIETINÆ.

The genera *Pinus*, *Cedrus*, *Picea*, *Tsuga*, *Pseudotsuga*, *Abies*, and *Larix* are recognised by Bentham and Hooker in the *Genera Plantarum*, 1880. The tribe is most extensive, comprising some 150 species, including the Pines, Firs, Cedars, and Larches, and is almost exclusively confined to northern, and north temperate regions. There are no tropical species, and only one Pine in the Sunda Isles, including Sumatra, Java, and Borneo. The genera are all needle-leaved and cone-bearing, and with few exceptions produce winged samaroid seeds.

The Abietinæ did not make their appearance until after the other tribes of Coniferæ had long existed, and no remains of them are known of date older than the Jurassic. With the Wealden and Cretaceous periods they became plentiful, and already in the Neocomian and Gault the ancestors of several existing genera were completely differentiated. There are not wanting signs that in the later Tertiaries at least, they had acquired almost as great an extension as at present. The vast preponderance of fossil wood is, it is well known, coniferous, this being from its resinous nature capable of resisting decay, when immersed or buried, for a much longer time than ordinary Exogenous wood; but it is remarkable how very large a proportion of the Coniferous wood from the Tertiaries belongs to the Abietinæ, though the woods of other tribes surpass it in this property. Of upwards of a thousand specimens from the Brown-coal, examined by Goeppert, only three were not coniferous; and of all the woods from the underlying Amber-beds, only one could be referred to another tribe of Conifers.

It is difficult to estimate the area occupied at the present day by the Abietinæ, but in northern regions they are held to outnumber the broad-leaved trees by ten to one. In Europe *Pinus sylvestris* and *P. cembra* stretch from the most westerly Alps, across the Black Sea, to the Caucasus and Altai, and, uniting with *Abies sibirica* and *Larix sibirica*, form the colossal forests of Siberia, estimated at 1,200,000 square miles. In America the Pine-barrens stretch 300 to 500 miles uninterruptedly. In British North America, forests occupying 240,000 square miles are formed of *Abies nigra*, *A. canadensis*, and *Larix microcarpa*. Their colossal bulk and great economic importance have been already alluded to, but it was not mentioned that species of this tribe furnished the whole of the Amber of North Germany, and of these the value of the Samland deposits alone is estimated at £250,000,000.

The Abietinæ are represented in British Eocenes exclusively by the genus *Pinus*. It is remarkable that hardly any traces of them have been met with in any of the Floras in which leaves are preserved, their remains consisting only of cones, having, in the British rocks, been found almost exclusively in marine or estuarine deposits. The localities from which they have been collected are numerous, but except those from below

PLATE I.

FROM THE MIDDLE BAGSHOT, BOURNEMOUTH.

Cupressus taxiformis, Unger, sp.

- Figs. 1, 2. Exceptionally long branchlets, uniting the two kinds of foliage.
3, 4. Specimens illustrating the usual mode of occurrence of *Cupressus taxiformis*
in the Bournemouth Beds.
5, 6, 7. Examples of the distichous foliage.
5 *a*. An enlarged portion.
8. Exceptionally slender distichous foliage.
9, 10, 11. Imbricated foliage.
9 *a*, 11 *a*, 13. The same magnified.
12. Male catkins.
12 *a*. The same enlarged.

(From the "Upper Coastguard Beds" at Bournemouth. In the Author's Collection.)



PLATE II.

FROM THE MIDDLE BAGSHOT, BOURNEMOUTH.

Podocarpus incerta, sp. nov.

Figs. 1—5.

1 a. Portion enlarged.

(From the *Gleichenia* Beds at Bournemouth. Fig. 5 is from the Woodwardian Museum; the rest are in the Author's Collection).

Podocarpus eocænica, Unger.

6, 7, 11. Leaflets.

9, 10. Longer leaflets, probably of the same species.

8, 12. Smaller specimens ascribed doubtfully to *Podocarpus eocænica*.

(From the "Upper Coastguard Beds" at Bournemouth. In the Author's Collection.)

16. Leaf suggesting *Agathis*.

21. Scale of a cone? possibly belonging to *Agathis*.

(From the "Gleichenia Bed" at Bournemouth. In the British Museum.)

FROM THE BARTON SERIES, HORDWELL.

13, 14. Leaflets, possibly of *Podocarpus*. (In the British Museum.)

FROM THE LOWER BAGSHOT, ALUM BAY.

15. Leaf of *Podocarpus eocænica*, or an allied form. (In the Author's Collection.)

FROM THE WOOLWICH BEDS, BROMLEY.

Libocedrus adpressa, sp. nov.

17—20. Branchlets. (In the Author's Collection.)



EOCENE CONIFERÆ.

West & Newman & Co imp

PLATE III.

FROM THE MIDDLE BAGSHOT, BOURNEMOUTH.

Taxodium europæum, Brongt.

Figs. 1—9. Specimens from the "Willow Beds."

2 *a*, 6 *a*, 6 *b*, 9 *a*—9 *c*. Parts of the same, enlarged.

(In the Author's Collection.)

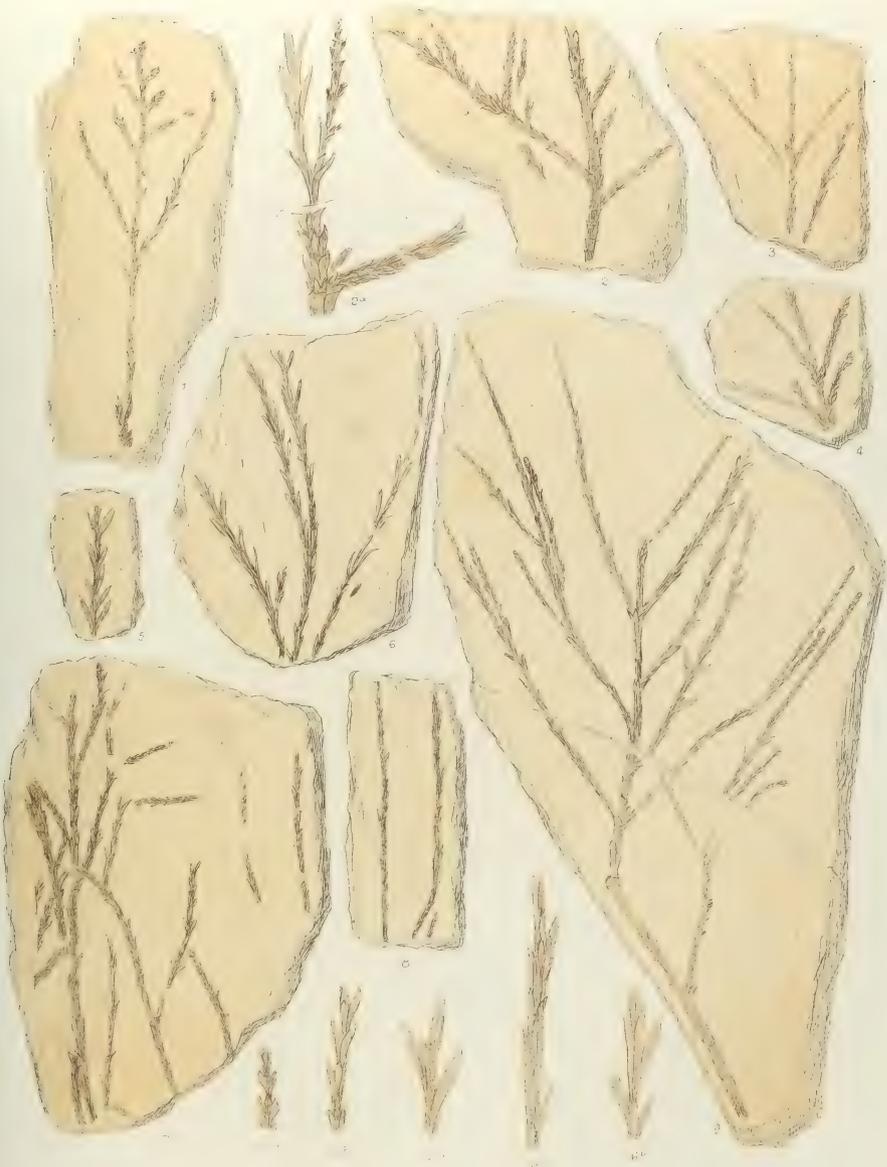


PLATE IV.

FROM THE MIDDLE BAGSHOT, BOURNEMOUTH.

Taxodium europæum, Brongt.

Figs. 1—8. Specimens from the "Laurel Beds."

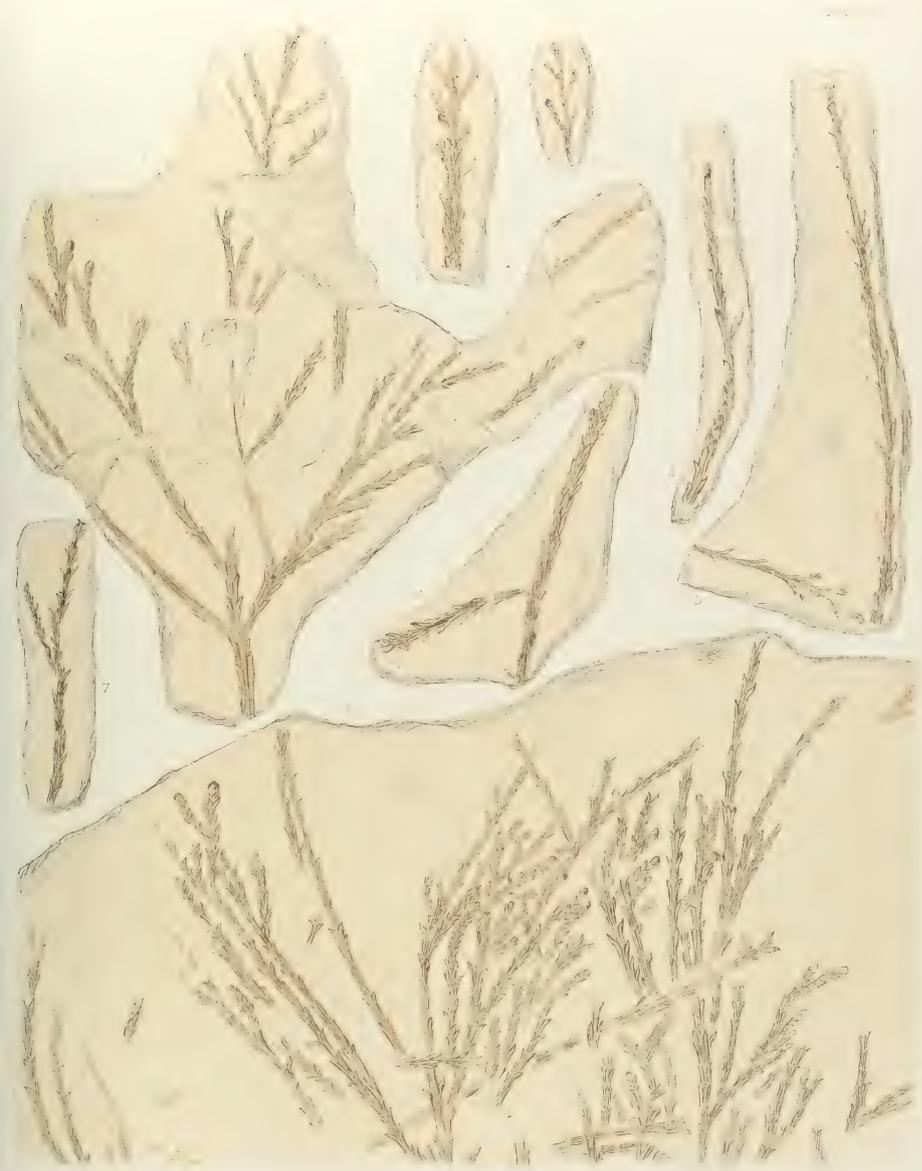


PLATE V.

MIDDLE BAGSHOT, BOURNEMOUTH.

Sequoia Tournalii, Brong., sp.

- Figs. 1, 3. Specimens exhibiting imbricated and distichous foliage on the same branch.
2, 4, 5, 9, 12. Examples of the distichous foliage.
6—8, 10, 11. Examples of the imbricated foliage.
10 *a*. A part of the same enlarged.

(All the specimens except figs. 9 and 12 are from the "Upper Coastguard Beds;"
fig. 12 is from the "Myrica Bed," and fig. 9 from near Poole. In the
Author's Collection.)

Cupressus taxiformis, Unger, sp.

13. Example of distichous foliage.
14. Scales of a cone.

(From a rolled block, embedded below the Coastguard Beds at Bournemouth. In
the Author's Collection.)



PLATE VI.

UPPER EOCENE HEMPSTEAD.

Sequoia Couttsia, Heer.

Figs. 1—6, 8. Cones and foliage.

9. Specimen of foliage from an ironstone concretion, Garnet Bay. (In the British Museum.)

MIDDLE EOCENE, BOVEY TRACEY.

7. Foliage.

10—12. Cones.

13. Seed.

14—17. Branchlets. (In the Jermyn Street Museum.)

18. Foliage of *S. Whymperei*, sp. nov. Natural size, Greenland. (In the British Museum.)

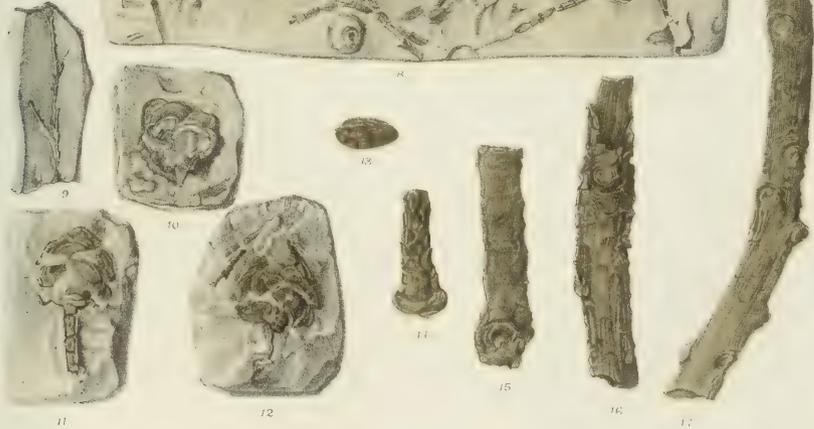


PLATE VII.

MIDDLE BAGSHOT, BOURNEMOUTH.

Taxodium eocænum, sp. nov.

- Figs. 1, 2. Branches, one half natural size.
2 *a*—2 *d*. Portions of foliage enlarged.
3. Branch with distichous foliage.
4. Branchlet, natural size.
5, 7. Male flowers.
6. Female flowers.
8. Seed of *Cupressus taxiformis*.

(From the "Upper Coastguard Beds," Bournemouth. In the Author's Collection.)



ECCENE CONIFERAE.

Wm. Newman & Co. imp.

PLATE VIII.

LOWER BAGSHOT, ALUM BAY.

Podocarpus elegans, De-la-Harpe, sp.

- Figs. 1—4, 6. Examples of an intermediate type of foliage.
5, 7, 8, 10, 12, 14. Examples of distichous foliage.
9, 13. Examples of imbricated foliage.
11. Branch showing imbricated and distichous foliage united.
15. Male flowers.
16. Fruit.
10 *a*. Distichous foliage, enlarged.

(1—5, 8, 11—13, 15, are in the British Museum, and the remainder in the Author's Collection.)



12.

13.

14.

15.

10.

16.

Eocene CONIFERÆ.

West Newman & Co. imp.

PLATE IX.

FROM THE LONDON CLAY, ISLE OF SHEPPEY.

Callitris Eittingshausenii, sp. nov.

- Figs. 1. Side view of an 8-valved cone.
2, 3. Basal views of the same.
4. View of the apex.
5. Apex of 6-valved cone.
6. Side view of the same.

(In the Author's Collection.)

Callitris curta, Bow., sp.

- 7, 8. Two views of a 3-valved cone.
9—11. Three views of a 4-valved cone. (The original specimen described by Bowerbank as *Cupressinites thujoides*.)
12. Section of a 4-valved cone. (The original specimen described as *C. crassus*, Bow.)
13—21. 5-valved cones. (Figs. 15—17, the original specimen, described as *C. subangulatus*, Bow.)
(7, 8, 13, 14, 18—21, are in the Author's Collection; the remainder in the British Museum.)

Podocarpus argillæ-londinensis, sp. nov.

- 35, 36. Side view and apex of the fruit. (In the Author's Collection.)

Ginkgo (?) eocænica, Ett. and Gard.

- 31, 32. Apex and side view of a medium sized fruit.
33, 34. End and side view of the largest fruit.
(In the British Museum.)

MIDDLE BAGSHOT, BOURNEMOUTH.

Cupressus taxiformis, Ung., sp.

22. Basal view of a cone.
24. Apex of same, showing the two apical scales soldered together.
23, 25. Side views of the same cone.
30. Foliage.
26. Smaller cone, probably of the same.
27. Cone resembling so-called cones of *Sequoia Couttsia*.
(The above are from the "Marine Beds.")
28, 29. Sections of a cone of *Cupressus taxiformis*, from the fresh-water "Black Bed" of the "Coastguard Beds."

(In the Author's Collection.)



THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

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MDCCCLXXXIII.

A MONOGRAPH

OF THE

BRITISH TRILOBITES

FROM THE

CAMBRIAN, SILURIAN, AND DEVONIAN FORMATIONS.

BY THE LATE

J. W. SALTER, A.L.S., F.G.S.

PART V.

PAGES 215—224.

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1864—1883.

NOTICE.

THE 'Monograph on the British Trilobites,' as originally proposed by the late Mr. J. W. Salter, was intended to comprise descriptions of the Group from the first appearance of the forms in the Cambrian strata to their final cessation in the beds of the Carboniferous series. Unfortunately death stayed the ready pen of the author in 1869; and the work, begun in 1864, was not resumed after 1867. Very many British Trilobites remain to be described. The author at the time of his decease had not reached the Carboniferous genera, and, indeed, had not had the opportunity of illustrating more than about one half of the total number of the Cambrian, Silurian, and Devonian species.

T. W.

6TH SEPTEMBER, 1883.

same old land) will be worth searching for the fossils of the ' Arenig or Skiddaw group,' for many years to come.

To finish the description of this large genus, I may add figures of one or two doubtful forms, respecting which some information is desirable. Two of them are referred to at p. 186.

Fig. 55 represents the original specimen of Prof. M'Coy's *Illænus latus*, from the Wrae limestone of Peeblesshire. I regard it as only a pressed and shortened head of *I. Bowmanni*, altered by cleavage action so as to destroy the proportions. The glabella-furrows, however, are rather shorter than usual; and unless we had the body and tail, it would be difficult to prove it to be that species.

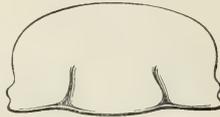
Locality. Bala Limestone; Wrae quarry, Peeblesshire.

Fig 56 is a figure of the species found in the true Llandeilo Limestone of Knockdolian, Ayrshire. I should have little hesitation in describing it as *I. crassicauda*, which I have before said, p. 193, has never certainly yet occurred in Britain; but the greatly truncated angles of the tail are sufficient to make me for the present quote it with doubt. The shape of the tail is identical with that figured by Dr. Volborth as the common Russian species, and the caudal fascia is of a like breadth: it is very much broader than any British species with which it can be compared, except *I. Portlockii*, pl. xxvi, fig. 3; but the less breadth of the axis, and the more remote fulcrum, as compared with that Caradoc species, are characters in which it resembles *I. crassicauda*, which comes from Llandeilo rocks.

Fig. 57 is a small imperfect head of a *Bumastus* from the Bala (or Hirnant?) Limestone near Chirk. It is a solitary specimen, and only shows enough to prevent our identifying it with either of the four species of *Bumastus* figured in our plates. The head is not at all carinate, as in *Bumast. Maccallumi*, pl. xxx, nor are there any glabella-furrows visible. But this may be because we have here the outside crust, which we do not know in the Ayrshire species. It is worth figuring, to incite collectors to search for it in its locality, a prolific spot, and one which contains many rare fossils.

Locality.—Upper BALA (or Hirnant) Limestone of Mynydd Fron Frys, near Chirk (presented to the Woodwardian Museum by the late Mr. Bowman in 1841).

FIG. 55.



Illænus Bowmanni?
(*I. latus*, M'Coy: Peeblesshire).

FIG. 56.



Illænus crassicauda, Wahl.?
Llandeilo Limestone of Knockdolian, Ayrshire.

FIG. 57.



I. (Bumastus), sp.
Mynydd Fron Frys,
near Chirk.

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TO THE

FAMILIES, GENERA, AND SPECIES DESCRIBED IN THE MONOGRAPH
OF THE BRITISH TRILOBITES OF THE CAMBRIAN, SILURIAN, AND
DEVONIAN FORMATIONS, BY THE LATE J. W. SALTER, A.L.S., F.G.S.

The synonyms are printed in Italics.

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* Prepared by the Rev. Prof. T. Wiltshire, M.A., F.G.S., &c., Hon. Sec. Pal. Soc.

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THE

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A MONOGRAPH
OF THE
BRITISH CARBONIFEROUS
TRILOBITES.

BY
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PART I.

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PRELIMINARY NOTICE.

The late MR. J. W. SALTER, in Part I of his 'Monograph of British Trilobites' (p. 2, Pal. Soc., 1864), gave a preliminary classification of Trilobites, in which he placed under the PROETIDÆ the following genera:—PHILLIPSIA, GRIFFITHIDES, BRACHYMETOPUS, PROETUS, and PHAETON¹, and in a "Notice to Correspondents" (facing p. 177 of his last Part, IV, 1867) he expressed an opinion that "it would be in some respects advisable to go on (in Part V) with the highest and most compact group of the smooth-eyed Trilobites, viz. the PROETIDÆ." Unhappily his labours were brought to a close by death, and I have taken up the unfinished narrative.

After much hesitation, it seemed most convenient to commence with the Trilobites of the Carboniferous Limestone, because, with the exception of the genus *Proetus*, they form a group by themselves which are only to be met with in one formation and in a limited area, at least in this country; and they also very greatly needed to be re-examined and carefully figured.

HENRY WOODWARD.

BRITISH MUSEUM (NATURAL HISTORY),
CROMWELL ROAD, LONDON, S.W.;
August 20th, 1883.

¹ Made a synonym of the genus *Proetus*, by its author Barrande.



THE TRILOBITES

OF THE

CARBONIFEROUS LIMESTONE.

INTRODUCTION.

CONSIDERABLE confusion has hitherto existed in the nomenclature of the various species of Trilobites from the Carboniferous Limestone series, partly arising from the fact of the very near affinities actually existing between the genera of *Phillipsia* and *Griffithides*, partly from the too often fragmentary condition of the specimens obtained, but also largely due to the unsatisfactory figures which accompany the descriptions of most of the early writers on the fossils of this group.

Thanks to the labours of Portlock, M'Coy, Valerian von Möller, Traquair, and others, many of the difficulties to a classification of these, our latest Trilobites, have been removed, and much help afforded in the task of unravelling the tangled skein of synonymy woven by Russian, German, French, Belgian, English, and Irish palæontologists during the past sixty years.

I have given, in the following pages, in chronological order, short notices of the principal works in which the species of Carboniferous Trilobites have been referred to, and in the subsequent descriptions I have attempted, to the best of my ability, to affix to each its proper generic and specific place.

I should but ill fulfil my duty were I to omit to return thanks to the many friends who have assisted me with the loan of specimens for this Monograph; notably I would mention Prof. T. McKenny Hughes, M.A., F.G.S., Woodwardian Professor of Geology in the University of Cambridge, who has most liberally placed the whole of the extensive series of Carboniferous Trilobites belonging to the Woodwardian Museum in my hands for examination and figuring.

I am equally indebted to Prof. A. Giekie, LL.D., F.R.S., F.G.S., Director-General of the Geological Survey of Great Britain and Ireland, and Prof. Edward

Hull, M.A., LL.D., F.R.S., Director of the Irish Branch, for permitting me the same opportunities of studying and figuring the beautiful type-series of forms out of the Jermyn Street Museum and the Museum of the Geological Survey in Dublin. To Dr. R. H. Traquair, F.R.S., the Rev. E. O. de la Hey, John Aitken, Esq., Joseph Wright, Esq., and my kind friends in Glasgow, Messrs. John Young, James Thomson, Robert Craig, J. Smith, and others, who have so willingly entrusted me with the choice specimens from their private collections for my work, I am especially thankful.

In a table further on, I give a list of the Divisions of the Carboniferous series of deposits as recognised in England, Scotland, and Ireland, in compiling and preparing which I am indebted to the kindness of my colleagues, the Messrs. R. Etheridge (father and son); also to Mr. Robert Etheridge, jun., for much valuable assistance in preparing the accompanying Bibliography.

BIBLIOGRAPHY
OF THE
TRILOBITES
OCCURRING IN THE
CARBONIFEROUS LIMESTONE, &c.

1. 1809. Mr. W. MARTIN, in his 'Petrificata Derbiensia,' publishes, under the name of *Entomolithus (Oniscites) Derbiensis*, the earliest description extant of a Carboniferous Trilobite. Under the genus *Phillipsia*, we give Martin's careful and interesting description of this fossil, which he considered to be "an insect, related to *Oniscus*."

2. 1822. MM. ALEX. BRONGNIART and A. G. DESMAREST, in their 'Histoire Naturelle des Crustacés Fossiles,' p. 145, pl. iv, fig. 12, under the name of *Asaphus*, figure a pygidium of *Phillipsia* from the black Carboniferous Limestone in the environs of Dublin.

3. 1823. Baron ERNST F. VON SCHLOTHEIM, in his 'Nachträge zur Petrefactenkunde,' Gotha (ii Abtheil., pp. 42-3), refers to a pygidium of a Trilobite which he also figures on plate xxii, fig. 6, under the name *Trilobites, Asaphus pustulatus* (vel *pustulosus*, see explanation of plate accompanying Atlas, p. 22), said to be from the youngest Upper Transitional Limestone of the Eifel. This is no doubt a Devonian Trilobite, but the name having been adopted by de Koninck it has become incorporated in the nomenclature of these later species with which it has no affinities.

4. 1825. EDOUARD D'EICHWALD, in his 'Geognostico-zoologicae per Ingriam marisque Baltici Provincias, nec non de Trilobitis observationes' (Casani), notices and figures, at p. 54, tab. iv, figs. 4 and 5, two pygidia of Trilobites, which he names, "*Asaphus Brongniarty*" (*sic*), fig. 5, and "*A. Eichwaldi*," fig. 4, on the authority of Fischer de Waldheim.

5. 1829. FRIEDERICH HOLL, in his 'Handbuch der Petrefactenkunde' (Dresden), p. 176, records *Asaphus (Phillipsia) Brongniarti*, and *A. (Phil.) Eichwaldi*, Fischer, in his list of Trilobites.

6. 1832. A. H. DUMONT, in his 'Mémoire sur la Constitution Géologique de la Province de Liège,' 'Mémoires Couronnés par l'Académie Royale de Bruxelles,'

tome viii, p. 353, gives in his table of fossils, *Calymene Tristani*, and *C. macrophthalmus* (which probably are equivalent to *G. globiceps* and *P. Derbiensis*) from the Upper Limestone of Richelle, Belgium.

7. 1836. Prof. JOHN PHILLIPS, in his 'Illustrations of the Geology of Yorkshire,' part ii, pp. 239, 240, pl. xxii, figs. 1—20, notices and names eight species of Carboniferous Trilobites from Yorkshire, Derbyshire, and Ireland. The originals of Phillips' species are very fragmentary and the figures are not good.

8. 1836. The Rev. Prof. BUCKLAND, in his 'Bridgewater Treatise,' vol. ii, p. 74, pl. 46, figs. 10 and 11, notices and figures two pygidia of Trilobites from the Carboniferous Limestone of Dublin and Northumberland which he names *Asaphus gemmuliferus*, and *A. caudatus* respectively.

9. 1830-37. G. FISCHER DE WALDHEIM, in his 'Oryctographie du Gouvernement de Moscou' (Moscow), p. 121, pl. xii, figs. 1 and 2, reproduces the two pygidia figured by Eichwald, under the name of *A. Eichwaldi*, and states that he considers them "as one and the same species, for which he retains the name of Eichwald; the more so as another Trilobite already bears the name of Brongniart."

10. 1838. Prof. HENRI MILNE-EDWARDS, in the 2nd edition of 'Lamarek's Histoire Naturelle des animaux sans vertèbres, présentant les caractères,' &c., vol. v, p. 234, quotes *Asaphus globiceps* (= *Griffithides globiceps*) and *P. seminifera*, from the Carboniferous Limestone.

11. 1839. DR. H. F. EMMRICH, 'de Trilobitis, Dissertatio petrefactologica,' etc. (Berlin), notices several Carboniferous Limestone Trilobites, viz., *Asaphus Dalmani* (= *Phillipsia Derbiensis*); *As. globiceps* and *Calymene* (= *Griffithides globiceps*).

12. 1840. EDOUARD d'EICHWALD, published in the 'Bulletin scientifique publié par l'Académie Impériale des Sciences de St. Pétersbourg;' a paper entitled, "die Thier- und Pflanzenreste des alten rothen Sandsteins und Bergkalks im Nowogordischen Gouvernement," in which he notices (p. 4) a Carboniferous-Limestone Trilobite from Bystriza, under the name of *Otarion Eichwaldii*, Fischer, but without a figure (referred to *Ph. mucronata* by von Möller).

13. 1841. Prof. L. G. DE KONINCK, in the 'Nouveaux Mémoires de l'Académie Royale de Sciences de Bruxelles' (tome xiv, pp. 1—20, with plate), publishes two species of Trilobites from the Carboniferous Limestone, namely, *Asaphus gemmuliferus* and *A. Brongniarti*.

14. 1843. CAPT. (afterwards GENERAL) J. E. PORTLOCK, R.E., F.R.S., in his 'Report on the Geology of the county of Londonderry and parts of Tyrone and Fermanagh' (Dublin), pp. 305—313, pl. xi and xxiv, gives careful descriptions of eight species of *Phillipsia* and *Griffithides*, with figures of the same.

15. 1843. DR. HERMANN BURMEISTER, in 'Die Organisation der Trilobiten

aus ihren lebenden Verwandten entwickelt,' etc. (Berlin), pp. 117—139, describes *Æonia*, sp. (= *Phillipsia*); *Archegonus* (= *Griffithides*) *globiceps*; and *Asaphus* (= *Phillipsia*) *pustulatus*.

16. 1843. PROF. DR. GOLDFUSS, in 'Leonhard und Bronn's Neues Jahrbuch,' &c., 8vo, pp. 537—567, gives his "Systematische Uebersicht der Trilobiten," etc. pl. iv, v, vi, and notices *Asaphus Dalmani* (= *Ph. Derbiensis*), *Gerastos Brongniarti* (= *Ph. Eichwaldi*), *Phacops* (= *Griffithides*) *globiceps*, etc., pp. 558—565.

17. 1843. FR. WILH. HÖNINGHAUS, in his 'Trilobiten der geognostischen Sammlung' (Crefeld), p. 7, cites *Asaphus Dalmani* (= *Phillipsia Derbiensis*).

18. 1843. J. B. J. D'OMALIUS D'HALLOY, in his 'Précis élémentaire de Géologie' (Paris), p. 515, cites *Asaphus Brongniarti* (= *Ph. Eichwaldi*).

19. 1844. PROF. L. G. DE KONINCK, of Liège, in his 'Description des Animaux Fossiles dans le Terrain Carbonifère de Belgique,' 1842-44, pp. 595—607, pl. lii and liii, describes and figures six species of *Phillipsia* and a detached hypostome of the same, from the Carboniferous rocks of Tournay, Visé, etc., Belgium.

20. 1844. PROF. F. M'COY, in a 'Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland' (Dublin), pp. 160—163 (pl. iv), describes six species of *Griffithides* and ten species of *Phillipsia*, but *without* localities.

21. 1845. MURCHISON DE VERNEUIL and DE KEYSERLING, in their 'Géologie de la Russie d'Europe,' etc., vol. ii, 4to (Paléontologie by M. de Verneuil), pp. 376—378, describe a pygidium of *Ph. Eichwaldi*, from the Valdai, and another pygidium named *Ph. Ouralica*, from the Ural Mountains.

22. 1845. DR. H. F. EMMERICH, in 'Leonhard und Bronn's Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde' (pp. 18—62), "Ueber die Trilobiten" (with a plate), notices several Carboniferous species; notably *Phillipsia equalis*, *Ph. ornata*, and *Griffithides globiceps*.

23. 1846. DR. H. F. EMMERICH's (spelt "Emmerich") paper, "Ueber die Trilobiten," was translated and reproduced by Richard Taylor in his 'Scientific Memoirs,' vol. vi, pp. 253—291.

24. 1846. DR. H. BURMEISTER, 'The Organisation of Trilobites deduced from their living affinities' (edited by Professors Bell and E. Forbes—for the Ray Society, London), is a translation of the work published in Berlin in 1843, but "revised, augmented, and in part re-written by the Author."

25. 1846. ALEX. VON KEYSERLING, in his 'Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land im Jahre 1843' (St. Petersburg), quotes "*Phillipsia Eichwaldi* and *P. truncatula*," p. 291, as occurring in the Carboniferous Limestone of Wytschegda and Sopljussa, Petschora.

26. 1846. DR. T. OLDHAM, in the 'Journal of the Geological Society of

Dublin,' vol. iii, part iii, p. 188, pl. ii, figures and describes a very perfect specimen of *Griffithides globiceps* (re-drawn on our Pl. VI, fig. 1 a, b), from the Carboniferous Limestone of Millicent, Clane, Kildare.

27. 1847. PROF. F. M'COY, in the 'Annals and Magazine of Natural History,' vol. xx, p. 229, founded the genus *Brachymetopus* to contain *Phillipsia* (?) *discors*, M'CoY, *P.* (?) *Maccoyi*, Portlock, and *B. Strzeleckii*, M'CoY, therein described and figured (pl. xii, figs. 1 a and b).

28. 1848. DR. H. G. BRONN, in the "Nomenclator" to his '*Index Palæontologicus*, oder Uebersicht der bis jetzt bekannten fossilen Organismen,' &c. (Stuttgart, 2 vols.), enumerates five species of *Griffithides*, and seventeen species of *Phillipsia*.

29. 1849. DR. H. G. BRONN issued the "Enumerator" to his '*Index Palæontologicus*,' giving nine species of *Phillipsia*, and four species of *Griffithides*.

30. 1852. M. JOACHIM BARRANDE, in his great work, 'Système Silurien du Centre de la Bohême,' t. iii, fig. 10, figures *Griffithides* (*Ph.*) *globiceps* from the Carboniferous Limestone.

31. 1852-54. PROF. DR. FERD. ROEMER, in his 'Palæolethæa; Kohlen-Gebirge' ('Bronn's Lethæa Geognostica,' Stuttgart, &c.), gives descriptions and figures (p. 594, taf. ix, figs. 8, 9, 10), *Ph. Derbiensis*, *Grif.* (*Ph.*) *globiceps*, and *Ph. gemmulifera*.

32. 1854. PROF. MORRIS, in the 2nd edition of his 'Catalogue of British Fossils,' enumerates three species of *Brachymetopus*, five species of *Griffithides*, and seven species of *Phillipsia*, from various British and Irish localities.

33. 1855. PROF. F. M'COY, in his 'Systematic description of British Palæozoic Fossils in the Geological Museum, Cambridge' (published in Prof. Sedgwick's 'British Palæozoic Rocks,' Cambridge), describes a species of *Griffithides* (figured in pl. 3 D, figs. 10, 11), and three species of *Phillipsia*, all from British localities.

34. 1855. DR. B. F. SHUMARD, in G. C. Swallow's 'First and Second Annual Reports of the Geological Survey of Missouri,' gives at p. 199 a description of *Phillipsia Meramecensis*, Shumard (pl. B, fig. 9), from the "Archimedes Limestone, Meramec River, Fenton, St. Louis."

35. 1856. MR. GEORGE TATE, of Alnwick, described (in the 'Proceedings of the Berwickshire Naturalists' Club,' p. 234), a mucronate-tailed Trilobite, from the Carboniferous Limestone of Northumberland, under the name of *G. Furnensis*. (See *Phillipsia Eichwaldi*, var. *mucronata*.)

36. 1858. DR. B. F. SHUMARD and G. C. SWALLOW, in their "Descriptions of New Fossils from the Coal-measures of Missouri and Kansas," in 'Transactions of the Academy of Sciences, St. Louis, Missouri,' vol. i, No. 2, record *Phillipsia Mis-*

souviensis, *Ph. major*, and *Ph. Cliftonensis*, said to be from the "Upper and Middle Coal-Measures." They are not accompanied by figures.

37. 1858. Dr. GEO. G. SHUMARD, in his "Observations on the Geological Formations in New Mexico" ('Trans. Acad. Sci. of St. Louis'), pp. 273—297, describes (at p. 296) a new species of *Phillipsia* under the name of *Ph. perannulata*, from the White Limestone, Guadalupe Mountains, New Mexico.

38. 1860. M. VON GRÜNEWALDT, in his 'Beiträge zur Kenntniss der sedim. Gebirgsformation des Urals' (St. Petersburg), notices two species of Carboniferous-Limestone Trilobites, from Russia, viz., *Ph. Derbiensis* (p. 139, t. v, fig. 12) and *Ph. indeterminata* (p. 140, t. v, fig. 10).

39. 1860. M. EDOUARD D'EICHWALD, in his 'Lethæa Rossica ou Paléontologie de la Russie' (vol. i, pp. 1435—1441, and Atlas of plates, tab. liv, figs. 8—12), gives descriptions of eight species of Carboniferous Trilobites, all of which he refers to the genus *Griiffithides*; but his figures are most unsatisfactory and cannot be relied upon at all.

40. 1862. Prof. M'COY's 'Synopsis of the Characters of the Carboniferous-Limestone Fossils of Ireland' was *re-issued* at this date, by Sir RICHARD GRIFFITH, with a new Title-page, and an Appendix, of the Localities of the Irish Carboniferous-Limestone Fossils, pp. 209—271.

41. 1863. Prof. Dr. FERD. ROEMER, in the 'Zeitschrift der Deutsch. geologischen Gesellschaft' (p. 570, t. xiv, fig. 1 a, b), describes and figures *Phillipsia mesotuberculata*, from the Carboniferous formation of Königs-Grube, Silesia.

42. 1863. Mr. E. BILLINGS, in the 'Canadian Naturalist and Geologist' (vol. viii, p. 209), gives a "Description of a new species of *Phillipsia* from the Lower Carboniferous Rocks of Nova Scotia," under the name of *Ph. Howi*.

43. 1863. Mr. ALEX. WINCHELL, in the 'Proceedings of the Acad. of Nat. Sciences, Philadelphia' (part. 1 p. 24), describes two species of *Phillipsia*, viz., *Ph. insignis*, Winch., and *Ph. Maramecensis?* Shum., from the Burlington Limestone, Burlington, Iowa.

44. 1865. Messrs. MEEK and WORTHEN (in the 'Proceeds. of the Acad. Nat. Sci. Philadelphia') describe at p. 268, three species of Carboniferous Trilobites, viz.:—*Phillipsia (Griiffithides) Portlocki*, *Ph. (G.) scitula*, and *Ph. (G?) Sangamonensis* from Illinois, the two last-named from the Upper part of the Coal-Measures, Springfield, Ill.

45. 1865. Mr. ALEX. WINCHELL (in the 'Proc. Acad. Nat. Sci. Philadelphia,' p. 132) describes two species of *Phillipsia*, viz., *Ph. doris*, Win., and *Ph. Rockfordensis*, Win., from the Goniatite-limestone of Indiana.

46. 1865. Messrs. J. W. SALTER and HENRY WOODWARD prepared a 'Chart of Fossil Crustacea,' the figures engraved by J. W. Lowry, and accompanied by 'a Descriptive Catalogue of all the genera and species figured' (nearly 500 in number).

Figures and references are given to twelve species of Carboniferous Trilobites, mostly British.

47. 1866. Dr. H. B. GEINITZ, in his 'Carbonformation und Dyas in Nebraska' (Dresden, pp. 102, with five plates), figures and describes a *Phillipsia*, from the limestone of Plattsmouth, Nebraska (p. 1, pl. i, fig. 1).

48. 1867. VALERIAN VON MÖLLER contributed to the 'Bulletin de la Société Impériale des Naturalistes de Moscou,' a paper, "Ueber die Trilobiten der Steinkohlenformation des Urals," in which he figures and describes seven species of Carboniferous Trilobites from Russia, and gives a most excellent catalogue of all the species already described from that formation.

49. 1867. SIR R. I. MURCHISON, in his 'Siluria' (4th edition, p. 209, Fossils (79), figs. 1 and 2), gives a woodcut of a head of *Brachymetopus Ouralicus*, de Vern., and of an entire specimen of *Phillipsia pustulata*, the figures are too small, however, to show the characters clearly. This also appeared in the 3rd edition, p. 283 (1854).

50. 1868. Mr. C. FRED. HARTT, A.M., in the 'Canadian Naturalist and Geologist' (Montreal, New Series, vol. iii), notices at p. 214 *Phillipsia Vindobonensis* from the Carboniferous Limestone of Nova Scotia.

51. 1869. PROF. R. H. TRAQUAIR, M.D., F.R.S., in the 'Journal of the Royal Geological Society of Ireland,' Dublin, contributes a most valuable paper on *Griffithides (Phillipsia) mucronatus* with excellent figures of the same.

52. 1870. MESSRS. MEEK and WORTHEN published (in the 'Proceed. Acad. Nat. Sciences, Philadelphia') a paper with "Descriptions of New Species and Genera of Fossils from the Palæozoic Rocks of the Western States," in which, at p. 52 they describe two new species of Trilobites, *Phillipsia tuberculata*, M. and W., and *Ph. (Griffithides) lufu*, M. and W., the former from the Lower Carboniferous of Illinois, and the latter from Indiana.

53. 1872. F. B. MEEK, in his 'Report on the Palæontology of Eastern Nebraska' (at p. 238, plate iii, fig. 2 a, b, c), figures and describes *Phillipsia major*, Shumard, from the Upper Coal-Measures of Clinton County, Missouri, and on Vermilion River, Kansas.

54. 1872. Mr. R. ETHERIDGE, F.R.S., in an Appendix to R. Daintree's paper "On the Geology of Queensland" ('Quarterly Journal of the Geological Society of London,' 1872, vol. xxviii, p. 338, pl. xviii, fig. 7), describes and figures a Carboniferous Trilobite under the name of *Griffithides dubius*, Eth. The specimen is obscure.

55. 1873. MESSRS. F. B. MEEK and A. H. WORTHEN, in their 'Palæontology of Illinois' (being vol. v of the 'Geological Survey of Illinois,' A. H. Worthen, Director; Springfield, Illinois, pp. 525—529, and pp. 612—618), describe and figure *Proctus (Phillipsia) ellipticus* (pl. 14, fig. 8), *Phillipsia (Griff.) Port-*

lockii, *Ph. (Grif.) bufo*, *Ph. (Grif.) scitula*, and *Ph. (Grif.) Sangamonensis* (pls. 19 and 32), the two last-named being from the Upper Coal-Measures of Illinois.

56. 1874. Dr. H. TRAUTSCHOLD (in 'Nouv. Mémoires de la Soc. Imp. des Naturalistes de Moscou,' tome xiii, p. 300) describes three species of *Phillipsia*, viz. *Ph. globiceps*, *Ph. Grunewaldti*, and *Ph. pustulata*, Schlot., from the Carboniferous Limestone of Mjatschkowa, Russia.

57. 1875. F. B. MEEK, Palæontologist, in 'Report of the Geological Survey of Ohio' (vol. ii, part ii, Palæontology, p. 323, plate 18, fig. 3), describes *Phillipsia* (*Griffithides*?) *Lodiensis*, Meek—probably a *Brachymetopus*.

58. 1875. Mr. ROBERT ETHERIDGE, F.R.S., in a Table of Fossils accompanying "The Geology of the Burnley Coalfield" ('Memoirs of the Geological Survey, England and Wales,' p. 178), records one species of *Griffithides* and five species of *Phillipsia* from the Carboniferous Limestone of Bolland and Clitheroe.

59. 1875. Mr. W. H. BAILY, in his 'Figures of Characteristic British Fossils with Descriptive Remarks' (London, vol. i, pp. lxxiii and lxxiv, and p. 118, pl. 41, figs. 1, 2, and 3), figures and notices *Brachymetopus Ouralicus*, *Phillipsia pustulata*, and *Griffithides globiceps*, from several Irish and English localities.

60. 1875. Prof. Dr. KÖRBER (in the 'Sitzungsberichte der math.-naturw. Classe der Kaiserl. Akad. der Wiss. Wien,' Band lxxi, Abth. i, at p. 529, taf. 1, fig. 1) notices *Phillipsia Grunewaldti*, Möll., from the Coal-formation of Barents Island, Nova-Zembla.

61. 1876. M. FALY, at a meeting of the Société Géologique de Belgique (19th March), exhibited a specimen of a Trilobite from the phtanite coal of Casteau, near Mons, closely related to *Phillipsia globiceps*, Phillips.

62. 1876-77. Prof. L. G. DE KONINCK, in his 'Recherches sur les Fossiles Paléozoïques de la Nouvelle-Galles du sud (Australie),' (Bruxelles, pp. 348—353), notices and figures *Phillipsia seminifera*, Phil., *Griffithides Eichwaldi*, G. Fischer, and *Brachymetopus Strzeleckii*, M'Coy.

63. 1877. Dr. H. WOODWARD, F.R.S., published 'A Catalogue of British Fossil Crustacea, with their Synonyms and the Range in time of each genus and order' (printed for the Trustees of the British Museum, London, pp. xii and 156), containing three species of *Brachymetopus*, four of *Griffithides*, and eight of *Phillipsia*, found in the Carboniferous Limestone of Great Britain and Ireland.

64. 1878. Mr. ROBERT ETHERIDGE, JUNR., in his 'Catalogue of Australian Fossils' (Cambridge), p. 232, notices the occurrence of two species of *Griffithides* (*G. dubius* and *G. Eichwaldii*), and two of *Phillipsia* (*P. parvula* and *P. seminifera*, p. 42), from Queensland and New South Wales.

65. 1878. Dr. J. W. DAWSON, F.R.S., in his 'Acadian Geology' (London, pp. 824), at p. 313 gives a woodcut and description of *Phill. Howi*, and a description of *Phillipsia Vindobonensis*, Hartt.

66. 1879. PROF. J. D. DANA, in his 'Manual of Geology' (3rd edition, New York), p. 304 and p. 308, refers to the Carboniferous Trilobites *Phillipsia*, *Griffithides*, and *Brachymetopus*, and at p. 342 he records *Ph. Missouriensis*, *P. major*, and *P. Cliftonensis*, Shumard, from the Upper Coal-measures of Missouri; and *P. scitula*, M. and W., common in Illinois and Indiana. At p. 308 he gives a figure of *Phil. (Griffithides) seminifera* (after De Koninck), and quotes also *P. pustulata*, as occurring in the Irish Rocks.

67. 1879. PROF. H. A. NICHOLSON, in his 'Manual of Palæontology' (2nd edition), 2 vols., p. 371, gives the distinguishing characters of *Phillipsia* and *Griffithides*, but figures *Phillipsia (Griffithides) seminifera* (reproduced from Dana's 'Geology.')

68. 1879. PROF. A. VON KOENEN, of Marburg, in the 'Neues Jahrbuch für Mineralogie, Geologie und Palæontologie' (p. 309), gives a description of "The Culm Fauna from Herborn," consisting of more than fifty species; and he describes two species of *Phillipsia*, viz. *Ph. æqualis*, H. von Meyer, sp., and *P. latispinosa*, Sandberger, sp.

69. 1879. MR. ROBERT ETHERIDGE, JR., in 'Explanation of Sheet 31, Memoirs of the Geological Survey of Scotland' (p. 81), refers to the occurrence, in "The shale above the Castlecary Limestone," of remains of a species of *Phillipsia*, nearly allied to *P. pustulata*, Schlot., or *P. seminifera*, Phillips.

70. 1882. PROF. A. GEIKIE, LL.D., F.R.S., in his 'Text-book of Geology' at p. 724, under the Carboniferous Fauna, observes, "Trilobites now almost wholly disappear, only two or three genera of small forms (*Griffithides*, *Phillipsia*, *Brachymetopus*) being left."

FAMILY PROETIDÆ.

This family comprises the one Silurian genus *Proetus*,¹ and the three Carboniferous genera—*Phillipsia*, *Griffithides*, *Brachymetopus*, which form the subject of our present memoir.

Genus I.—PHILLIPSIA, *Portlock*, 1843.

General form oval; glabella with nearly parallel sides, marked by either two or three short lateral furrows; the posterior angles, forming the basal lobes, always separated by a circular furrow from the rest of the glabella; eyes large, reniform, surface delicately faceted;² cervical furrow deep; free cheek separated from the glabella by the axial suture which forms an acute angle with the circular border of the cheek in front of the glabella; whilst the facial suture cuts obliquely across the posterior margin, just behind the eye, leaving a small pointed portion fixed to the glabella by the neck-lobe; angles of cheeks more or less produced, margin of head incurved forming a striated and punctated rim. Thoracic segments nine in number, the axis distinctly marked off from the side-lobes or pleuræ by the axial furrows; the abdomen, or pygidium, usually with a rounded border, the axis composed of from 12 to 18 coalesced segments.

The following is General Portlock's description of the genus *Phillipsia*, taken from his 'Report on the Geology of Londonderry, &c.' (8vo. 1843, pp. 305, 306).

"General form, oval. Cephalo-thorax divided into three compartments by the elevation of the glabella above the plane of the cheeks. Glabella, bounded on the sides by nearly parallel lines, and rounded in front; the general form approaching

¹ M. Barrande suggests that Dr. Sandberger's genera *Trigonaspis* and *Cylindraspis*, from the Devonian of Nassau, also belong to the genus *Proetus*. Prof. Dr. Ferd. Roemer has figured and described four species of *Proetus* from the Harz, and Messrs. Meek and Worthen have named a species *Proetus* from the Lower-Carboniferous series of Jersey Co. Illinois, so that *Proetus* serves to connect this otherwise detached group of Mountain-Limestone forms with their relatives in the Silurian and Devonian formations.

² Messrs. Meek and Worthen, in their description of two Carboniferous Trilobites from Illinois and Indiana, remark, "eyes apparently smooth, but showing, when the outer crust is removed, numerous very minute lenses beneath," 'Geol. Surv. Illinois,' vol. v, "Palæontology," 1873, 4to, pp. 528, 529. This observation may serve to explain the fact that many specimens do not show the faceted surface at all clearly; this is especially the case in the genus *Griffithides*. Emmrich believed it possible to use this character of the external surface of the eyes of Trilobites as a means of classification, but I have not been able to accept his proposed arrangement based on this structure. (See Emmrich, *op. cit.*, 1845, in "Bibliography," p. 5.)

to cylindrical; marked on the sides by three sets of segmental lines, corresponding to and representing the cephalo-thoracic furrows of *Phacops* and *Calymene*, but which are not present in *Proetus*. The first, from the base, of these lines is rounded, so as to include a circular space corresponding to the tubercle of the lower cephalo-thoracic segment of *Calymene*; the second is also slightly curved; the third nearly straight. Between the two sets of lines there is a space equal to more than one-third of the whole breadth of the glabella, corresponding to the similar axal or connecting space in the glabella of *Phacops* and *Calymene*. The cheeks, slightly convex; in form spherical triangles. Eyes, lunate; situated on the cheeks, but very near to the glabella, to the axis of which their chord or longer axis is parallel; surface under a magnifier very finely reticulated. Neck-furrow deep. Wings, or margins, separated from the front and cheeks by an imperfect line or furrow which is connected with the neck-furrow, and end posteriorly in sharp angles, more or less prolonged as spines. The margin is turned down, and forms, on the under surface, a narrow, striated rim.

“Thorax composed of nine segments, or, including the neck-segment, ten; and it requires some care to avoid mistaking the first pygidial for the last thoracic segment as it is constructed on the same principle as those of the thorax, though its parts are fused together and form one whole with the other pygidial segments. The pleuripedes are compound as in *Phacops*, *Calymene*, &c.

“Pygidium exhibiting, both in the axal and lateral lobes, distinct segments by which it is further separated from *Proetus*. The axal lobe and the lateral segments do not extend to the external edge, but have a considerable marginal space. It may be here remarked that as this form of pygidium recurs in another Mountain Limestone genus, although the corresponding forms of cephalo-thorax are strikingly different, the genus cannot be satisfactorily determined from a specimen of the pygidium alone.”

1. PHILLIPSIA DERBIENSIS, *Martin*, sp., 1809. Plate I, figs. 1—9.

ENTOMOLITHUS (ONISCITES) DERBIENSIS, *Martin*. Petrif. Derb., t. xlv, figs. 1 and 2, 1809.

ASAPHUS RANICEPS, *Phillips*. Geol. Yorks., vol. ii, t. xxii, figs. 14 and 15, 1836.

PHILLIPSIA DERBIENSIS, *De Koninck*. Anim. Foss., t. liii, fig. 2, 1842.

— JONESII, var. SEMINIFERA, *Portlock*. Rep. Geol. Londonderry, &c., p. 308, t. xi, fig. 5, 1843.

— DERBIENSIS, *Morris*. Cat. Brit. Foss., p. 114, 1854.

— JONESII, var. SEMINIFERA, *McCoy*. Brit. Pal. Foss., p. 183, 1855.

PHILLIPSIA DERBIENSIS, *Salter & Woodw.* Cat. and Chart Foss. Crust., p. 16, fig. 111, 1865.

— — *H. Woodw.* Cat. Brit. Foss. Crust., p. 55, 1877.

Glabella smooth, somewhat gibbous, in front; sides nearly straight, with two short furrows near the front of the eye, and a circular furrow around the basal lobe at each posterior angle of the glabella; neck-furrow deep, neck-lobe rather broad, with one small tubercle on centre; fixed cheek very small; facial suture oblique, leaving a small angular portion attached to the neck-lobe on either side. Eyes very large in proportion to head; reniform, smooth, but when well preserved showing a fine and minutely-faceted surface. Facial suture uniting with outer border of free cheek, and forming a very acute angle, where it joins the glabella in front and a less acute angle behind the eye, where it unites with the posterior border. A broad groove or furrow surrounds the free cheek running exactly parallel to its own outer border; the posterior angles of the head project slightly backwards, but are not produced into cheek-spines. The incurved under margin of the shield is finely striated as well as punctated. The hypostome (seen *in situ* in one of our specimens, Pl. I, figs. 4 *a*, *b*) is large; the mesial lobe is broad and spatulate, the surface being finely striated with wavy longitudinal lines; the lateral lobes or alæ are small, smooth, and pointed.

The thorax, which is roundly arched, consists of nine smooth and well-defined segments, the first only having a minute tubercle on the centre. The axis of the thorax, which next the head is considerably broader than its side lobes, diminishes gradually in breadth backwards to the pygidium, where it is only equal to its pleuræ in breadth; the pleuræ, which are smooth, are all faceted to enable the animal to roll itself up into a ball. The axis of the abdomen, or pygidium, shows it to be composed of thirteen coalesced segments, the pleuræ being united in a rounded shield, the border of which is smooth, as the ribs die out before they quite reach the margin. There is a faint tendency to ornamentation on the axis of the tail.

Formation.—In Carboniferous Limestone, and in “Rotten-stone” band.

Localities.—Bolland and Settle, Yorkshire; Castleton, Derbyshire; “Rotten Stone,” Matlock, Derbyshire; Longnor; Arnside; Blackrock and Little Island, Co. Cork; Middleton; Carnteel, Tyrone; Castlepollard, West Meath, and Limerick, West of Dromore Wood.

This is undoubtedly the earliest species of Carboniferous Trilobite recorded, and is probably next in historical antiquity to the famous “Dudley Locust,” *Calymene Blumenbachii*, described by Lyttleton in 1750, from the Wenlock (Upper Silurian) Limestone.

Fortunately we are acquainted with several perfect specimens of *P. Derbiensis*, two of which are figured in our Plate I.

Fig. 2 *a, b*, is a beautiful and very perfect specimen somewhat curved (as if not quite unrolled) from the Carboniferous Limestone of Longnor, Staffordshire, the original of which is preserved in the Museum of Practical Geology, Jernyn Street.

This specimen, which is imbedded in hard limestone, has all the segments of the body well preserved and united together, a rare occurrence in the Carboniferous Limestone. The entire form is carefully reproduced in the outline, fig. 6.

Two other nearly entire specimens, preserved on a piece of Carboniferous "Rottenstone" from Matlock, Derbyshire, are represented in Plate I, fig. 4 *a*. These are from the National Collection, Natural-History Museum, Cromwell Road. Owing, however, to the soft nature of the matrix no very fine structure can be observed, but in one of the specimens the hypostome ($\pm b$) can be distinctly seen *in situ*.

The specimen represented in Plate I, figs. 1 *a, b*, is interesting as the type of Phillips' *Asaphus raniceps*, but I see no reason for separating this little head from *P. Derbiensis*, although, from the fact of its being slightly flattened above, the glabella appears to overhang the border more than in the normal forms.

Two other heads in good preservation, figs. 3 and 5, the former from Settle, Yorkshire (from the Woodwardian Museum, Cambridge), and the latter from Castleton, Derbyshire (from the Cabinet of the Rev. E. O. de la Hey), exemplify well the general character of the head of this species.

Fig. 2 shows the finely faceted character of the eyes, as do also some admirable specimens recently received from Prof. E. Hull, M.A., LL.D., F.R.S., from the Geological Survey Museum, Dublin.

After examination of all the specimens, and a careful consideration of General Portlock's descriptions, I see no reason to retain *P. Jonesii* or *P. Jonesii*, var. *seminifera*, M'Coy, as separate species, distinct from *P. Derbiensis*. In this view, I am happy to be in accord with my friend Prof. Morris, M.A., F.G.S., whose carefully prepared 'Catalogue of British Fossils' is still honoured with a place of respect for the critical care displayed by its author in its compilation, although now nearly thirty years old, and sadly in need of a new edition.

The subjoined is the original description of *Phillipsia Derbiensis*, given by Mr. W. Martin, in his *Petrificata Derbiensia* (1809), and named by him *Eutomolithus Oniscites (Derbiensis)*.¹ "This fossil," he says, "is not frequent in many parts of the country. It is principally met with in the black marble at Ashford, where it very rarely occurs in a perfect state; the head and body being found, for the most part, separate from each other." Martin describes it as "A petrified insect. The original an *Oniscus*. The body oblong-ovate, broad and rounded at the head,

¹ 'Petrif. Derb.' tab. xlv, figs. 1, 2. In the same work, on plate xlv*, figs. 1, 2, Martin represents what seems to be intended for *Griffithides (Phillipsia) seminifera*, Phil. sp., hereafter described.

smaller and more pointed at the tail; convex, marginated; the margin entire, or not divided by the segments of the back. Head or thorax large, gibbous, equal in breadth to the abdomen; semicircular in front, with a broad, distinct, striated margin, joining that of the body; behind straight, separated from the back by a transverse line. The surface of the head longitudinally divided into three distinct parts; the middle one of these gibbous, rounded, and, when examined under a glass, apparently somewhat rough or scabrous. Between this part and the back a small protuberance, constantly surmounted by a single minute point or tubercle, which, however, is not visible without the assistance of a magnifier. The lateral portions of the surface of the head are nearly of a triangular form; each furnished near the centre with a large lunated tubercle, discovering, in perfect specimens, a reticulated structure, like that of the eyes of living insects, when magnified. The back of the insect is composed of strong, convex, triarquate segments, their number varying from twenty to twenty-four, each marked with a line of very minute tuberoles. The middle parts of the segments are more elevated than those of each side, and form collectively, down the back, a keel-shaped prominence, which ends somewhat obtusely before it reaches the margin of the tail. The segments of the keel directly transverse, those on each side, particularly near the tail, somewhat oblique. The tail obtuse, entire, and destitute of any appendage.

“The above-described parts are all that are ever present in the fossil.—And as the under side is constantly filled with the stone which constitutes the matrix, it would be impossible to examine the legs and inferior parts of the abdomen, did they remain, which it is evident, however, they do not; the petrification being formed merely from the upper shell, or covering of the back and head. . . .

“The lunated tubercles on the head were apparently invested in the recent subject with a much thinner integument than the other parts of the insect. In perfect specimens the dark colour of the limestone is always seen through the present sparry covering of these protuberances, while the rest of the petrification, from the greater thickness of the crust, appears perfectly white and opaque. There can scarcely be a doubt that the parts in question were the eyes in the living animal. Their form, as well as the evident difference of their native covering from that of the body, first led to this conclusion; but what places the matter almost beyond uncertainty is their reticulated structure.—This, with the help of a glass, is sufficiently visible: and we may observe that such a structure, while it proves the nature of the parts where it is found, is also illustrative of the operation under which the mineral change has been effected.—Since only a *slow* and *gradual substitution* of fossil for organic matter could have preserved in the petrification a conformation thus minute.”

2. PHILLIPSIA COLEI, M'Coy, 1844. Plate II, figs. 1—10.

PHILLIPSIA COLEI, M'Coy. Synop. Carb. Foss. of Ireland, p. 161, tab. iv, fig. 6, 1844.

— — Morris. Cat. Brit. Foss., p. 114, 1854.

— — H. Woodw. Cat. Brit. Foss. Crust., p. 55, 1877.

Head-shield broadly-semicircular; glabella but slightly elevated, the central convexity not reaching to the front border, but separated by a broadly-expanded margin which makes the head one third wider in front than at its posterior border; glabella marked by two short lateral furrows and by a small basal lobe on each side, the neck-furrow is rather strongly marked, the neck-lobe is slightly broader than the first free segment; the posterior margin is divided obliquely by the facial suture which runs in a very undulating line between the glabella and the free cheek; eyes large, reniform, no facets visible; cheeks arched, somewhat produced at the posterior angles, surrounded by a furrow parallel to the border; free segments nine; axis very slightly arched, equal to its pleuræ in breadth anteriorly, but diminishing slightly towards the pygidium; pleuræ faceted, extremities slightly produced and recurved: pygidium semicircular, axis slightly arched and composed of twelve coalesced segments; pleuræ only faintly indicated, margin of pygidium smooth and slightly bevelled. Surface of head and body generally (save the extremities of the pleuræ) finely granulated.

A detached hypostome found in the same piece of matrix with one of the Survey specimens has been referred to this species. It is 7 mm. long and 4 mm. broad. It is oblong in form; the alæ are very minute, the central lobe is gibbous and ornamented with five raised concentric striæ or wrinkles, irregularly disposed. (See Pl. II, fig. 6.)

This well-marked species was named by M'Coy after the present Earl of Enniskillen; and, having only been found in Ireland, it has escaped the entanglements of palæontological literature, and is in consequence without synonyms. Although quite distinct from any other species of *Phillipsia*, it is marked by excellent generic characters.

In the peculiar broad, smooth, circular border to the front of the glabella this species approaches nearest to *Ph. truncatula* and *Ph. Eichwaldi*. It differs from *Ph. Derbiensis*, in which the glabella is very gibbous and actually overhangs the front border. But in the broad, short, and flattened form of the pygidium we seem to lose the ordinary tail of the Carboniferous Trilobite and to find a strong resemblance to the pygidium of *Asaphus* and *Ogygia* proper. This leads one to observe that the form of the pygidium appears to be a less constant character and of much less value for classification than the cephalic shield.

The specimens figured in Plate II are all from the Museum of the Geological Survey of Ireland.

Formation.—Carboniferous Limestone.

Localities.—Little Island, Cork ; N. E. of Ballintra and Carrickbreeny, Donegal ; Doohybeg, Co. Limerick, Ireland.

We subjoin Prof. M'Coy's original description of *Phillipsia Colei*, from his "Synopsis."¹

"*Specific Characters*.—Elongate, oval; length rather less than twice the width; sides parallel; cephalo-thorax smooth; glabella rounded in front, but not encroaching on the margin, slightly convex, constricted at the sides; cephalo-thoracic furrows distinct, cheeks large, flattened; wings narrow, ending posteriorly in short triangular spines; eyes small, lunate. Thorax: axial lobe rather wider than the lateral ones; each segment having a row of minute, crowded, irregular granulations; pygidium rounded, margin broad, finely granulated, each segment having a row of numerous, crowded, very unequal granulations, larger than those of the thorax.

"This species resembles *P. Kellii*, of Portlock, but is easily distinguished by the character of the granulation of the segments. Length 11 lines, width 6 lines; length of glabella 4 lines, width 6 lines. I have dedicated this elegant fossil to the Earl of Enniskillen."

3. PHILLIPSIA GEMMULIFERA, *Phillips*, sp. 1836. Plate III, figs. 1—8.

- ASAPHUS, *sp. indet.*, *Brong. & Desmar.* Hist. Nat. des Crust. Foss., p. 145, pl. iv, fig. 12, 1822.
- "STOKESII," *Fischer.* Oryct. du Gov. de Moscou (footnote, p. 121, *sine descriptione*), 1830—37.
- GEMMULIFERUS, *Phil.* Geol. Yorks., vol. ii, pl. xxii, fig. 11, p. 240, 1836.
- — *Buckland.* Bridgw. Treat., vol. ii, p. 74, pl. 46, fig. 10, 1836.
- PHILLIPSIA PUSTULATA, *De Koninck* [*sed non Trilob. pustulatus*, Schlot, 1823]. Desc. Anim. Foss. Terr. Carbonif. de Belg., p. 603, tab. liii, fig. 5, 1842—44.
- KELLII, *Portlock.* Rep. Geol. Lond., p. 307, pl. xi, figs. 1, a—c, 1843.
- QUADRISERIALIS, *M'Coy.* Synop. Carb. Foss. Ireland, pl. iv, fig. 8, p. 162, 1844.
- PUSTULATA, *Morris.* (In part only.) Cat. Brit. Foss., p. 114, 1854.
- — *Salter & H. Woodw.* Cat. and Chart Brit. Foss. Crust., p. 55, fig. 109, 1865.
- — *H. Woodw.* Cat. Brit. Foss. Crust., p. 55, 1877.

¹ 'Carb. Foss. Ireland' (1844), p. 161.

General form an elongated oval; head semicircular, glabella rounded anteriorly, the raised central portion marked by two short lateral furrows on each side, and by the usual rounded basal lobes, surrounded in front of the eyes by a rather broad, flat, circular border formed by the fixed cheek, which contracts behind the eyes, but extends obliquely outwards on each side from the neck-lobe, which is rather wider and more strongly marked than the succeeding free segments of the thorax.

Eyes moderately large, reniform, smooth, for, when the faceted surface is visible, the lenses are very minute. Free cheeks terminating in an acute angle on the anterior border, and elongated posteriorly into spines which reach to the fifth thoracic somite. Raised portion of the cheek sparsely granulated, border smooth and broad, under margin striated. The nine free thoracic somites are nearly of equal size, the raised axis being slightly broader than its pleuræ; the axis smooth, pleuræ very minutely granulated and bluntly terminated.

Axis of pygidium composed of sixteen coalesced somites with four to five granules in a row on each axial somite, about thirteen lateral ridges to the pygidium with about six granules on each; margin narrow, plain.

Formation.—Carboniferous Limestone.

Localities.—Bolland, Yorkshire; Clithero, Lancashire; Derbyshire; Kildare; St. Doolagh, Co. Dublin; Limerick, west of Dromore Wood; Hook Head, Wexford; and Little Island, Cork.

It has been a source of no small anxiety to adjust the various claims of authors to priority in the naming of this species.

I was at first led astray by Prof. De Koninck, and, guided by him, had placed *P. gemmulifera*, *P. Kellii*, and *P. quadriserialis* under *P. pustulata*. But upon referring to Schlotheim's "*Trilobites pustulatus*" ('Nachträge zur Petrefact.,' Gotha, 1823), I found not only that his figure could by no possibility be made to accord with any Carboniferous Trilobite, but on referring to the text he states that his specimen was derived "aus dem jüngerem Uebergangs-Kalkstein von der Eiffel;" or from the newer Transition Limestone (Devonian). It is in fact a pygidium of *Phacops*, or *Dalmania*.

Dismissing then *P. pustulata* from the list, it was next necessary to consider the rival merits of *P. gemmulifera* and *P. Kellii* to precedence. "*Asaphus gemmuliferus*" was the name given by Phillips to a pygidium in the "Gilbertson Collection" from Settle, but his representation of it is not satisfactory, and it was with pleasure that I turned to Portlock's figure and able description of *P. Kellii*, based not on a pygidium alone (on which he asserts it is quite unsafe to make a species) but upon an entire specimen. Here I felt at last was solid ground to rest upon. But on looking carefully over the Gilbertson Collection I discovered the original specimen, figured by Phillips as "*A. gemmuliferus*." Now, this is readily

seen, on comparison, to be identical with the pygidium of *Phillipsia Kellii*, and as it does not appear likely to be easily confounded with its nearest relative, *P. truncatula* (which species has 18 tail-segments, whilst *P. gemmulifera* has but 15), according to the laws of priority Phillips' name must stand, although based upon a detached pygidium only.

As far back as 1822 MM. Brongniart and Desmarest, in their 'Histoire Naturelle des Crustacés Fossiles,' figured a tail of a Trilobite from the Carboniferous Limestone near Dublin,¹ after a drawing by Mr. Stokes, but they do not name it. Fischer, in his 'Oryctographie du Gouvern. de Moscou,' states² that this Trilobite was named by them "*Asaphus Stokesii*," but, although I have made diligent search, I cannot confirm this statement of Fischer's, and it seems certain that Brongniart and Desmarest did not give any specific name or description of this fossil, merely calling it "*Asaphus*." The name *Stokesii* must therefore be attributed to Fischer, and not to Brongniart and Desmarest.

The subjoined is Prof. Phillips' original description of *A. (Phillipsia) gemmulifera*, 'Geol. Yorks,' vol. ii, p. 240.

"*Asaphus gemmulifera*, Phillips.

"Each abdominal lobe ornamented by six longitudinal lines of elevated puncta; the transverse furrows undulate the limb (the cast is nearly smooth). I suppose Brongniart's fig. 12, pl. iv, represents this species."

We extract the following valuable remarks by Portlock on Phillips' *Asaphus gemmulifera*:

"Professor Phillips ('Geology of Yorkshire') has described eight species of Trilobites, all of which he includes provisionally in the genus *Asaphus*. The genera of two of these species, *Asaphus granuliferus*, pl. xxii, fig. 7, and *Asaphus gemmulifera*, pl. xxii, fig. 11, cannot be determined with certainty from the figures which represent pygidia only. Of the other species, *Asaphus seminiferus*, pl. xxii, figs. 8, 9, 10, *Asaphus truncatulus*, pl. xxii, figs. 12, 13, and probably *Asaphus obsoletus*, in part, pl. xxii, figs. 3, 5, belong to the present genus. On comparing Phillips' fig. 12 with pl. xi, fig. 1 b [of Portlock's Rept. Geol. Lond.], a striking general resemblance will be perceived; he, however, represents the glabella as quadrisulcate, whereas the number of sulci in the Irish specimens is only three, a number consistent with the view here taken of the genus. The posterior angles also of the cephalothorax of Professor Phillips' figure do not project backwards so far as in the Irish species; these two points of difference may, however, be the result of some slight imperfections in Professor

¹ This figure is evidently that reproduced in 'Buckland's Bridgewater Treatise,' vol. ii, p. 74, pl. 46, fig. 10, stated to be from the "Transition Limestone, Dublin," and named by him "*Asaphus gemmulifera* of Phillips."

² In a footnote to p. 121 (op. cit., 1830—37).

Phillips' specimens. The head (fig. 12) does not, of course, belong to the same individual as the abdomen (fig. 13). Between fig. 13 and the magnified representation in fig. 1 *c* a similar resemblance is evident; in fig. 1 *c*, however, the margin (limb of Phillips) is not striated; but it may be presumed, from the remarks already made on the striæ of the pygidia of Trilobites, that there is this difference, simply because in one case the natural cast exhibits the external, in the other the internal surface; as, however, the term *truncatulus* seems to have no peculiar reference to this species, it will be named after the gentleman, Mr. Kelly, who supplied the beautiful specimen figured here" (op. cit., pp. 306, 307).

The beautiful and perfect specimen of *Phillipsia* drawn on Pl. III, fig. 1, is the type of that called *P. Kellii* by Portlock, who thus described it:—¹

"Elongated oval; length .9", breadth .5" nearly. *Cephalothorax* elevated, bounded by a flattened margin or wings, which extend at the posterior angles into spines, as far as the fifth thoracic segment. *Glabella* convex, elongated, even in front with the cheeks, but not extending to the edge of the margin; rounded in front, at the sides bounded by lines nearly parallel, yet with a slight curvature inwards. Breadth equal to about one third of the total breadth of cephalothorax; the third or anterior cephalothoracic furrow very faint; *cheeks* large, and the eyes being comparatively small there is a large clear space; *eyes* do not reach the neck furrow behind, nor extend beyond the third furrow in front; neck-furrow deep.

"*Thorax*.—Axal lobe about equal to lateral lobes in breadth; axal segments not marked by tubercles, which are arranged, however, along the arched division of each pleuripes, not along the angular division, and continue up to the knee or bend of the segment, which is strongly marked.

"*Pygidium* rather wider than long, about fifteen axal and thirteen lateral segments, each marked by six small tubercles, so arranged as to form longitudinal lines on the axal and lateral lobes; distinct margin. Cephalothorax, including the neck-segment, one third the whole length; thorax rather less than a third; abdomen rather more" (op. cit., p. 307).

On Pl. III, fig. 8, the artist has endeavoured to represent one of the eyes of a specimen of *Ph. gemmulifera*, obtained by the late Mr. John Rofe, F.G.S., from the Carboniferous Limestone of Clitheroe, Lancashire. The eye is extremely perfect, and measures one millimètre in breadth and three millimètres in length. The surface is beautifully faceted hexagonally, each facet being convex on its exposed surface. Taking the number of transverse facets at 16, and of longitudinal rows at 36, there would be about 576 facets in the eye of this Trilobite.

¹ 'Geology of Londonderry' (1843), p. 307.

4. PHILLIPSIA TRUNCATULA, *Phil.*, sp. 1836. Pl. III, figs. 9—14.

ASAPHUS TRUNCATULUS, *Phillips*. Geol. Yorks., vol. ii, pl. xxii, figs. 12, 13, 1836.

PHILLIPSIA ORNATA, *Portlock*. Rep. Geol. Lond., p. 307, pl. xi, fig. 2 a, 1843.

— TRUNCATULA, *M^cCoy*. Syn. Carb. Foss. Ireland, p. 163, 1844.

Head-shield broadly arched; glabella twice as long as broad, rounded in front, only slightly elevated; basal lobes rather produced, with three short lateral furrows on each side, two of which are anterior to the compound eyes; neck-lobe distinctly marked, and, like the surface of the glabella, rather closely granulated; fixed cheek narrow behind, forming a small, rounded, palpebral lobe above each eye, and expanding into a wide flat circular border in front of the glabella; eyes reniform, smooth; raised portion of the free cheek sparsely granulated; border smooth and broad, terminating in a strong short cheek-spine which is striated beneath.

Thoracic rings wanting.

Pygidium.—Axis composed of eighteen coalesced somites, with six granulations on each axial segment; coalesced ribs of border also granulated; no distinct border to pygidium.

Formation.—Carboniferous Limestone.

Localities.—Bolland and Settle, Yorkshire; Castleton, Derbyshire; Monaster; Millicent; Limerick; Hook Head, and Malakeede, near Dublin, Ireland.

This species has happily escaped the fate of its predecessor, having only been named twice, by Phillips in 1836, and by Portlock in 1843. The head has one more lateral furrow than the other species of *Phillipsia*, and it has the greatest number of coalesced segments in its pygidium of any Carboniferous form. Its nearest ally is *Ph. gemmulifera*, figured on the same plate (Pl. III).

The following is Prof. Phillips' original description of *Phillipsia truncatula* given in his 'Geology of Yorkshire' (1836, vol. ii, p. 240).

"Depressed, mesial lobe of the head quadrisulcate, bituberculate; the eyes lunate; lmb continuous, truncate, with undulating parallel striæ; six lines of elevated puncta on the abdominal lobe."

Portlock says¹ of this species, which he calls *ornata*:

"This specimen is imperfect; the form of the glabella approximates closely to that of the preceding species [*P. Kellii*]; it does not, however, extend, as in it, to the points of the cheeks or posterior edge of the margin, and its furrows are more strongly marked. The furrows are ornamented by tubercles, and the whole surface is granular. The tubercles of the pygidium are more elevated, but its general form is nearly the same as that of *P. Kellii*, and it closely resembles *Asaphus truncatulus*."

¹ 'Geology of Londonderry' (1843), p. 307.

5. PHILLIPSIA EICHWALDI, *Fischer*, sp. 1825. Pl. IV, figs. 2, 4—11, 13, 14.

- ASAPHUS EICHWALDI, *Fischer*. MS. Geognostico-zool. per Ingriam Balt. Prov., p. 54, tab. iv, fig. 4, 1825. (Published by Eichwald.)
- — *Fischer de Waldheim*. Oryctog. du Gouv. de Moscou, p. 121, pl. xii, figs. 1 and 2, 1830-37.
- OTARION EICHWALDI, *Eichw.* Bulletin Scient. de St.-Petersbourg, p. 4, "Die Thier. &c., des Bergkalks im Nowogorod. Gouv., &c.," 1840.
- PHILLIPSIA CÆLATA, *M^cCoy.* Synop. Carb. Foss. Ireland, p. 161, tab. iv, fig. 4, 1844.
- — *Morris*. Cat. Brit. Foss., p. 114, 1854.
- GRIFFITHIDES MESO-TUBERCULATUS, *M^cCoy.* Brit. Pal. Foss. Cambridge, p. 182, pl. 3D, figs. 10 and 11, 1855.
- PHILLIPSIA EICHWALDI, *von Möller*. Trilob. der Steinkohlen. des Ural; Bull. Soc. Imp. des Natur. de Moscou, part 1, p. 121, 1867.
- CÆLATA, *H. Woodw.* Cat. Brit. Foss. Crust., p. 55, 1877.

Head-shield circular, glabella slightly gibbous in front, but not overhanging the fixed border which surrounds its anterior margin, and also forms a rounded palpebral lobe over each eye; basal lobes distinctly marked, rather triangular in form, with two short lateral furrows on each side of the glabella at the back of the eyes. The head is marked by two pores, one on each side of the raised glabella just in front of the eyes (I discuss their nature later on);¹ eyes rather large, and somewhat strongly faceted, the facets being larger than in *Ph. gemmulifera*; neck-lobe broad, marked by a single tubercle on centre, and by a row of fine granulations or minute tubercles along its posterior border, like those on the axis of the thorax, and separated on each side by a strong furrow; raised free cheek, small, but surrounded by a broad, flat margin, bevelled on the edge and striated on the under rim, cheeks produced posteriorly into a long spine, which reaches even to the ninth thoracic somite; the entire head-shield, save the margin, is ornamented by very fine granulations; axis of thorax and abdomen very distinct, each ring being marked by a row of very minute, spine-like granulations along its posterior border; ends of pleuræ roundly terminated. *Pygidium* composed of sixteen coalesced somites, central axis ornamented like thoracic axis; lateral lobes of pygidium about eleven in number; margin smooth; border rounded, and striated with fine parallel lines.

Hypostome.—The hypostome (figs. 4 and 7), which is finely striated, has an oblong, median axis, slightly pointed at the extremity like a heraldic shield. Fig. 7 has lost its alæ, but fig. 4 shows them to have been triangular in form.

¹ See Appendix to this Monograph at end of Part II.

Formation.—Carboniferous Limestone.

Localities.—Bolland, Yorkshire; Derbyshire; Tyrone, Ireland; Lennoxton, Campsie; Newfield Quarry, High Blantyre, Lanarkshire; Gateside, Beith; Auchenskeith and Bowertrapping, near Dalry; Robroyston, near Glasgow; Auchenberg, near Lesmahagow; Capelrig, E. Kilbride; Gair, Carluke; Boghead, near Hamilton, Scotland.

6. PHILLIPSIA EICHWALDI, var. MUCRONATA, *M'Coy*, 1844. Pl. IV, figs. 1, 3, 12, and 15.

- ASAPHUS CAUDATUS, *Buckland*. Bridg. Treat., vol. ii, p. 74, pl. 46, fig. 11, 1836.
 OTARION EICHWALDI, *Eichwald*. Die Thier- und Pflanzenreste des Gouvern. Novgorod, p. 4. (Bullet. scientif. de St.-Petersb.), 1840.
 PHILLIPSIA MUCRONATA, *M'Coy*. Synop. Carb. Foss. Ireland, p. 162, tab. 4, fig. 5, 1844.
 — EICHWALDI, *Verneuil*. Geol. de Russie, vol. ii, p. 376, tab. xxvii, fig. 14, 1845.
 GRIFFITHIDES FARNENSIS, *G. Tate*. Proc. Berwick Nat. Club, p. 234, 1856.
 — EICHWALDI, *Eichwald*. Lethæa Rossica, Format. anc., p. 1435; Atlas, pl. liv, fig. 10, 1860.
 — (OR PHILLIPSIA) EICHWALDI, *Salter & Woodw.* Cat. and Chart Foss. Crust., p. 16, fig. 116, 1865.
 PHILLIPSIA MUCRONATA, *Möller*. Ueber die Trilob. der Steinkohl. des Ural, &c. Bull. de la Soc. Imp. des Nat. de Moscou, No. 1, p. 121, 1867.
 GRIFFITHIDES MUCRONATUS, *Traquair*. Journ. Roy. Geol. Soc., Ireland, Dublin, pp. 213—218; and Plate, figs. 1—7, 1869.
 — — *H. Woodw.* Cat. Brit. Foss. Crust., p. 37, 1877.

In this variety MUCRONATA, the only difference we have been able to detect is in the pygidium, in which the posterior border instead of being rounded, as in *Ph. Eichwaldi*, is produced into a short blunt micro.

Formation.—Carboniferous Limestone.

Localities.—Beadnell, Northumberland; Settle, Yorkshire; Wilkieston, Fife; Gallowhill, Strathavon; Swindridge and Bowertrapping, near Dalry; Caaf Water, Linn.; Dalry; Garple Water, Muir-kirk; Sculliongour, near Lennoxton, Campsie; Scotland.

Subjoined is the original description of *Griffithides mucronatus* by Prof. M'Coy, given in 1844.¹

“*Specific Characters.*—Pygidium semi-elliptical, terminating posteriorly in a

¹ See ‘Syn. Carb. Foss. Ireland,’ p. 162, pl. iv, fig. 5.

short, mucronate, obtuse point; axial lobe nearly as wide as the lateral ones; about fifteen axial and nine lateral segments; surface smooth.

“This is the only Trilobite I know of in the Mountain-limestone with a mucronate or pointed tail. Length of pygidium four lines, width five lines.”

We are indebted to Professor R. H. Traquair, M.D., F.R.S., &c., for a very carefully prepared *résumé* of the literature of this species, from which we make the following extract (‘Journal of Roy. Geol. Soc. of Ireland,’ Vol. II, New Series, p. 213).

“In the year 1844 M’Coy figured, under the name of *Phillipsia mucronata*, the pygidium of a Trilobite from the Irish Carboniferous Limestone, and which he considered as new, remarking that he was acquainted with no other Carboniferous form having the caudal extremity prolonged, as in this instance, into a pointed spine or mucro.¹ But a trilobite, apparently the same as this, had previously been known to Continental observers under a different name; for, in 1840, we find Eichwald² mentioning a Carboniferous trilobite from Bystriza, in the Government of Novogorod, in Russia, in which the tail is prolonged into a long pointed spine, and whose cephalic shield has on each side a long process. The name quoted for this species is *Otarion Eichwaldii* (Fischer), but the description is, indeed, sufficiently vague, and is not accompanied by any figure. However, in 1845, Verneuil,³ in figuring and describing as ‘*Phillipsia Eichwaldii*’ a pygidium, to all appearance belonging to the same species as the Irish specimen, put aside the name ‘*mucronata*’ (M’Coy) as a synonym of ‘*Eichwaldii*’ (Fischer). This example was followed by Bronn⁴ and by Morris,⁵ and the remains of this species, not uncommon in many British localities, are at present very generally labelled and catalogued as *Phillipsia* or *Griffithides Eichwaldii*.

“On turning back, however, to Fischer’s original description and figure of *Asaphus Eichwaldii* from Vereia, in the Government of Moscow, published in 1825,⁶ we are surprised to find a *rounded* pygidium represented and described. The head is spoken of as unknown, but as regards the tail we read: ‘*Cauda depressa, subrotundata segmentis tredecim ad quatuordecim, margine angustato, sulco infra profundo.*’ Again, in 1837,⁷ the same pygidium was figured and described by Fischer. The figure looks as if it were taken from the same specimen represented in the former work, although the rounding of the caudal extremity is

¹ ‘Synopsis of the Carb. Foss. Irel.,’ pl. iv, fig. 5.

² ‘Die Thier- und Pflanzenreste des alten Rothen Sandsteins und Bergkalks im Nowogorodischen Gouvernement.’ (‘Bull. Sci. de St.-Peterb.,’ 1840.)

³ ‘Géol. de Russia’ (1845), vol. ii, p. 376, t. xxvii, fig. 14.

⁴ ‘Index Palæontologicus.’ Stuttgart, 1848, vol. ii, p. 958.

⁵ ‘Cat. Brit. Foss.’ London, 1854, p. 109.

⁶ Contained in a work by Eichwald, entitled ‘Geognostico-zoologica, per Ingriam marisque Baltici provincias, nec non de Trilobitis observationes.’ Casan, 1825, p. 54, t. iv, fig. 4.

⁷ ‘Oryctographie du gouvernement de Moscou,’ p. 120, pl. 12, fig. 2, *a*, *b*.

not here given so definitely as altogether to preclude us from the idea that a spine might have been there, and had been broken off. What we read is, however, definite enough, 'La queue est subconique arrondie.'

"Can this, then, be the same species as that in which Eichwald, in 1840, says the tail is prolonged into a long spine? Is *Asaphus Eichwaldii* of Fischer really the *Otarion Eichwaldii* of Eichwald? De Koninck did not think so in 1842, for he gives Fischer's *Asaphus Eichwaldii* as the probable synonym of *Phillipsia (Griffithides) globiceps* (Phillips sp.), a well-known species with rounded tail.¹ However, before saying anything more in answer to this question, it is necessary to investigate still further the literature of the pointed-tailed species.

"In 1860, Eichwald² gave an entire figure of *Griffithides Eichwaldii*, accompanied by a description more in detail than that which he published in 1840. The figure given in the 'Lethæa Rossica' will be seen, however, to present some marked discrepancies with those by which the present paper is illustrated.³ The cephalic spines are shown of enormous length, the eyes occupy a most remarkable anterior position close to the margin of the cephalic shield, and more than one line or furrow crosses the central part of the head. The number of thoracic rings is nine, of axial segments in the pygidium, eighteen. No reference is made in the description to any ornamentation of the surface.

"In 1867, Valerian von Möller⁴ in describing a pygidium of this species, from the neighbourhood of Tschernischkinaja, in the Government of Kaluja in Russia, pointed out the delicate ornamentation of the surface, not before noticed as characteristic of the so-called *Griffithides Eichwaldii*. He criticised Eichwald's figure in the 'Lethæa Rossica' with great severity, going even so far as to doubt its genuineness, and to suspect its being 'a not quite successful restoration in which the characters of two quite different forms occur, that of *Phillipsia mucronata*, and of another hitherto little known species.' To this Trilobite Möller restored M'Coy's name of '*Phillipsia mucronata*,' accepting Fischer's description of '*Asaphus Eichwaldii*' as applying to a round-tailed species. Von Eichwald, in his reply⁵ to von Möller's criticism, maintained the identity of Fischer's *Asaphus Eichwaldii* with the mucronate-tailed species, and asserted the presence of a small depression or opening at the end of the pygidium which indicated a broken-off process."

¹ 'Description des Animaux fossiles qui se trouvent dans le terrain carbonifère de Belgique,' p. 600.

² 'Lethæa Rossica, Formations anciennes,' p. 1435, Atlas, pl. liv, fig. 10.

³ Reproduced in our Plate IV, figs. 1 and 3.

⁴ "Ueber die Trilobiten der Steinkohlenformation des Ural, nebst einer übersicht und einigen Ergänzungen der bisherigen Beobachtungen über die Koblen trilobiten im Allgemeinen." Von Valerian von Möller. 'Bull. de la Société Impériale des Naturalistes de Moscou,' 1867, pt. 1, p. 121.

⁵ "Die Lethæa Rossica und ihre Gegner., erster Nachtrag." Von E. von Eichwald. 'Bull. de la Soc. Imp. Nat. de Moscou,' 1867, iii, p. 202.

As the original specimen of *A. Eichwaldi* cannot be found, and it seems certain that two forms of pygidium have been observed and figured from Russia—one a *mucronate* and the other a *non-mucronate* form, it appears to be most satisfactory in every way to adopt the course suggested by von Möller, and give the name of *Phillipsia Eichwaldi*, Fisher sp., to the non-mucronate form, and retain for the other the name of *Ph. mucronata* of M'Coy.

As, however, it is equally certain from the evidence afforded by a large series of specimens—chiefly from the Scottish Carboniferous series—that there are *two forms*, apparently identical in every respect, *save* that one has a mucronate and the other a non-mucronate pygidium, it would be better to go a little further and propose to make M'Coy's species *mucronata* a variety of *Phillipsia Eichwaldi*, of Fischer.

Prof. Traquair retains the generic name of *Griffithides* for his mucronate form on the ground that the lateral glabellar furrows, characteristic of the typical *Phillipsiæ*, are wanting. We would venture to assert that, although not clearly to be seen in Prof. Traquair's specimens, they are present in all the examples of this species, and that when not visible it is simply due to the state of preservation of the individual specimen. The form is undoubtedly a true *Phillipsia*; and, although at first we were unable to see the wisdom of attempting to maintain the two genera, *Phillipsia* and *Griffithides*, for these closely related Carboniferous Limestone forms of Trilobites, we are now prepared to maintain them without hesitation, and can point to good characters by which they may be readily distinguished. Of course, when the materials are very fragmentary it is next to impossible to define their place positively, but when once the whole specimen of any one species has been correctly figured (as we hope will be found to be the case in the plates accompanying this Monograph) a great deal of the difficulty disappears.

Not having been fortunate enough to see Mr. George Tate's type-specimen of *G. (Phillipsia) Farnensis*, we must accept as conclusive the opinion of Prof. Traquair that this species is only a synonym of *Phillipsia mucronata*, M'Coy. We have been favoured with the loan of the type-specimens of M'Coy's *G. mesotuberculatus*, from the Woodwardian Museum, Cambridge, and are satisfied that it is synonymous with his *Ph. mucronata*.

7. PHILLIPSIA QUADRILIMBA, *Phil.*, sp. 1836. Pl. VII, fig. 1.

ASAPHUS QUADRILIMBUS, *Phillips*. Geol. Yorks., vol. ii, p. 239, pl. xxii, figs. 1, 2, 1836.

PHILLIPSIA QUADRILIMBA, *H. Woodc.* Cat. Brit. Foss. Crust., p. 56, 1877.

Nothing is known of this species save from Prof. Phillips' figure and description, which is here reproduced. I have not succeeded in tracing the original specimen.

The following is Prof. Phillips' description of *Asaphus quadrilimbus*, taken from the 'Geology of Yorkshire,' vol. ii, p. 239, pl. xxii, figs 1, 2.

"Fig. 1.—The head. Margin quadrato-carinate, minutely striated; surface smooth; eyes very minutely reticulated. Fig. 2.—Abdomen."

Prof. Phillips figures a portion of a detached head and an imperfect tail, but they certainly did not belong to the same individual, and certainly not to the same species.

Formation.—Top of Lower Scar Limestones.

Locality.—Bolland, Yorkshire.

Genus 2.—GRIFFITHIDES, Portlock, 1843.

Outline oblong-oval; glabella pyriform, gibbous in front, destitute of lateral furrows; basal lobes inflated; cervical lobe broad; eyes small, lunate, smooth; axial furrow marking division of free cheek clearly defined, outline broadly triangular, outer posterior angle sometimes produced into a cheek-spine. Thorax with nine segments; pygidium rounded, composed of about thirteen coalesced somites.

The subjoined is the original description of the genus *Griffithides*, given by Portlock (1843), op. cit., p. 310.

"*Cephalothorax*.—Semi-oval, longitudinal; glabella strongly marked and gibbous, rounded in front, narrowed posteriorly into an obsolete neck, with a furrow more or less distinct on each side; *cheeks*, triangular spaces very slightly convex; *wings* either ending in an angle posteriorly or prolonged backwards in a flattened spine. Eyes near the axis, not large, lunate, smooth (?). The minute neck tubercle sometimes present.

"*Thorax*.—The pleuripedes are compound, in number nine, or with the neck-segment ten.

"*Pygidium*.—Fully developed and strongly resembling that of *Phillipsia*.

"A genus replacing *Asaphs* and *Phacops* in the Carboniferous system; it is dedicated to Mr. [afterwards Sir Richard] Griffith." Portlock also observes, p. 309:

"The determination of the true genus of the other Mountain-limestone Trilobites to be now described is attended with considerable difficulty, as no fully expanded specimen has as yet been found¹; . . . however, enough has been preserved to give . . . a general idea of the forms of the cephalothorax and pygidium, and of the structure of the thoracic segments. The form of the cephalothorax, and the position and arrangement of the eyes, resemble closely the genus *Asaphus* as restricted, and parti-

¹ This was in 1843, but several complete specimens of *Griffithides* have since been obtained.

cularly *A. expansus* and *Hemicrypturus Razamowskii* of Green; but . . . there is a perfectly developed pygidium, closely resembling that of *Phillipsia*. From the abundance of such pygidial relics, and the total absence of any other, it may fairly be presumed that a pygidium with axial and lateral segments fully developed was a generic peculiarity. The glabella is also more elevated than in the true *Asaphs*. In the absence of perfect specimens the formation of a new genus is difficult; but since the group is distinguished from the *Asaphs* of older rocks by the fully developed pygidium, it is advisable to separate them. It may also be here remarked that Green's cast of *Hemicrypturus Razamowskii*, and Pander's figures of *A. expansus*, seems to show that the lateral segments of the thorax in those species were compound, as in *Phacops* and *Calymene*, whereas they are merely folded in *Asaphus latifrons* of this work; in the species here figured they are also compound, so that there appears to be a blending of the characters of the several sections one into the other."

8. GRIFFITHIDES SEMINIFERUS, *Phillips*, sp. 1836. Pl. V, figs. 1—9; and Pl. VIII, fig. 14.

ASAPHUS SEMINIFERUS, *Phillips*. Geol. Yorks., vol. ii, p. 240, pl. xxii, figs. 8, 9, 10, 1836.

PHILLIPSIA GEMMULIFERA, *De Koninck*. Animaux Foss. Terr. Carb. Belgique, p. 603, pl. liii, fig. 3 (non Phillips), 1842.

— — *M'Coy*. Synopsis Carb. Foss. Ireland, p. 162, 1844.

— SEMINIFERA, *Morris*. Cat. Brit. Foss., p. 114, 1854

— — *Salter & H. Woodw.* Cat. and Chart Foss. Crust., p. 15, fig. 110, 1865.

— — *H. Woodw.* Cat. Brit. Foss. Crust., p. 55, 1877.

General form ovate-oblong: head-shield arcuate, glabella large gibbous, overhanging the anterior border; basal lobe pyriform; neck-lobe broad, separated by a wide furrow above and below; eyes small, reniform, smooth; raised portion of free cheek, glabella, and neck-furrow coarsely and irregularly granulated, margin of free cheeks smooth, lateral angles not produced into cheek-spines, thoracic segments nine, axis wider than pleuræ, only diminishing very slightly towards the pygidium; each segment ornamented by a single row of coarse granules (about eight on each side and ten on the axis); axial furrows strongly marked; segments arched, ends of pleuræ rounded, faceted portion smooth: pygidium composed of twelve coalesced somites, axis tapering gradually to an obtuse extremity; side ribs about nine, ornamented each by a single row of tubercles eight to ten on axis, about eight on each pleura; margin of pygidium narrow, edge bevelled.

Hypostome broad and short, wings not distinct from central lobe; obliquely striated, free extremity rounded and emarginated.

The subjoined is Phillips' description of *Asaphus (Griffithides) seminiferus*:¹

"Head poroso-granulated, mesial lobe bisulcate on the sides, and bituberculated at the base; *abdomen* with tumid lobes; ribs roughened, with eight or ten unequal prominent subglobose puncta; limb not striated. The first segment of the middle lobe mucronate.

Formation.—"Rotten Stone" Band; Carboniferous Limestone.

Locality.—Matlock, Derbyshire; Settle, Yorkshire; and Blackrock, near Cork.

9. GRIFFITHIDES GLOBICEPS, *Phillips*, sp., 1836. Pl. VI, figs. 1, 3, 4, 5, 6.

ASAPHUS GLOBICEPS, *Phillips*. Geol. Yorks., vol. ii, p. 240, pl. xxii, figs. 16—20, 1836.

GRIFFITHIDES GLOBICEPS, *Portlock*. Rept. Geol. Londonderry, p. 311, t. xi, figs. 9 a, b, 1843.

PHILLIPSIA GLOBICEPS, *De Koninck*. Anim. Foss. Terr. Carb. Belgique, p. 599, tab. liii, fig. 1, 1844.

GRIFFITHIDES GLOBICEPS, *M'Coy*. Synopsis Carb. Foss. Ireland, p. 160, 1844.

— — *Oldham*. Journ. Geol. Soc. Dublin, vol. iii, pt. 3, p. 188, pl. 2, 1846.

— — *Morris*. Cat. Brit. Foss., p. 109, 1854.

— — *Salter & Woodw.* Cat. and Chart Foss. Crust., p. 16, fig. 117, 1865.

— — *H. Woodw.* Cat. Brit. Foss. Crust., p. 37, 1877.

General form ovate-oblong: head elevated, glabella very gibbous, overhanging the anterior border of shield, contracting rapidly to about half the width behind, where it unites with the neck-lobe; basal lobes prominent, triangular, to which the eyes seem to be united without the intervention of the fixed cheek; but there is a very narrow border united to the glabella forming the palpebral lobes which join the lateral lobes, or nearly so; neck-lobe narrow, axis strongly arched; lateral portion crossed by cheek-suture obliquely; eyes very small but exceedingly prominent; cheeks very narrow and compressed, ending in short, blunt spines; margin of head striated longitudinally; eyes very minutely faceted; thoracic segments nine in number, strongly trilobed; axis wider than the pleuræ; the posterior portion of each segment strongly corrugated, and each pleural groove extending rather beyond the fulcral point; the extremity of each pleura is rounded and broadly faceted: pygidium rounded, consisting of eleven coalesced somites, which in the axis continue the corrugated character of the thorax, but diminish to a

¹ See 'Geol. Yorks.,' 1836, vol. ii, p. 240, pl. xxii, figs. 8, 9, 10.

blunt termination considerably within the border; the ribs of the pygidium are double and die out before reaching the edge of the tail-shield, leaving a somewhat wide smooth margin. Surface of head very finely punctate.

Formation.—Carboniferous Limestone.

Localities.—Bolland and Settle, Yorkshire; Forest of Wyre, Oretton; Milicent, Clane, Kildare; Waterford, Clonea; Derryloran, Tyrone; Blackrock, Cork; and Athlone, Ireland.

Hypostome.—A detached hypostome from Derryloran, Tyrone (see Pl. VI, fig. 5), belonging to one of these species of *Griffithides*, if not to *G. globiceps*, has very well-marked characters.

The upper border is strongly arched, the centre is tumid; the two wings form blunt angles, giving breadth to the attached anterior border; the sides curve inward almost to the lower end where there is a slight expansion; the lower free extremity is only half as wide as the upper; the rim or border is raised and the angles truncated, the inner portion of the lower extremity is slightly raised.

Of *Griffithides globiceps*, Prof. Phillips in his 'Geology of Yorkshire' (1836), vol. ii, p. 240, writes as follows:—"Limb quadrate, with four imbricating striæ; eyes lunate on a globular projection; head globular. (This agrees better than any other which I have seen with *E. Derbiensis* of Martin, t. 45, * 1.)"

General Portlock's description is as follows! (1843):—"Glabella short and almost globular in front; length four tenths, breadth three tenths of an inch; greatly elevated above the cheeks; narrowed at the base to less than one half the breadth in front; cheeks triangular, slightly convex; eyes short, lunate, connected with the glabella by a projection or nucleus; no visible reticulation; the wings end posteriorly in sharp angles, and in perfect specimens appear strongly striated; the margin is raised above the level of the cheeks; the neck-furrow is deep; total breadth of the cephalothorax more than seven tenths of an inch. This is referred to Professor Phillips' species, as it agrees closely with it in the characters of the cephalo-thorax, and is noted by him as occurring in the County of Kildare."

Dr. Oldham, in the 'Journ. Geol. Soc. Dublin,' 1846 (vol. iii, part 3, p. 188, pl. ii), figures and describes two very perfect specimens of *Griffithides globiceps*, which by the kindness of Prof. Hull, F.R.S., we are enabled to reproduce on our Plate VI, figs. 1 *a*, *b*, and 3.

Dr. Oldham speaks of this species as one of the most abundant and typical Trilobites of the Carboniferous Limestone." . . . General form, elongated, oval, body contractile, divided into three nearly equal parts by the cephalothorax, thorax, and pygidium; entire surface marked with minute irregularly disposed granulations, these are only seen in well-preserved specimens. Cephalothorax semi-elliptic; glabella short, pyriform, very tumescent, approaching to globular

¹ 'Geology of Londonderry,' p. 311.

in front, considerably elevated above the cheeks, narrowed behind to about one half its breadth in front, the tubercles, or projecting portions which connect the eyes with the glabella, forming the remainder of the breadth, divided from the cheeks by well-marked furrows; it is marked by three nearly obsolete cephalothoracic furrows on either side. These are scarcely seen when perfect, but are obvious in the cast; cast minutely punctured or granulated. Cheeks spherico-triangular, convex, so thickened on the outer edge as to form a distinct border or rim, elevated above the cheeks and rounded, which is prolonged backwards into short pointed spines (they are broken off in fig. 1). This rim or border ('wings') is marked with sharply raised longitudinal lines, the number varying in different specimens and in different parts of the rim, as they do not extend the whole length (our figures are deficient in showing this). These raised lines are wanting in the cast which is smooth. The raised rim is continued across the cephalothorax where it joins the thorax, and is here of the same form and structure as the first transversal segment of the thorax, from which it is sometimes not easily distinguished. In front of the glabella the rim is much smaller than along the margin of the wings, and is turned under the margin, forming a flat expansion. *Eyes* small, suboval, very prominent; when perfect covered with a smooth, corneous, transparent membrane; but under this very finely and beautifully reticulated, not oblique (the apparent obliquity of the eye being caused by the position of the tubercle or projection which unites it with the glabella), covered above with a distinctly granulated 'velum palpebrale,' the outline of which corresponds to the facial suture. Neck-tubercle frequently seen.

"In the furrows which separate the cheeks and glabella, about half way between the front of the eye and the anterior margin, I have observed in all the tolerably preserved specimens which I have seen, a small hole or indentation. These are constant and therefore obviously connected with the structure of the creature, although I cannot offer an explanation of their use. They are similar to those noticed by Portlock in his *Ampyx Sarsii*.¹

"*Thorax*-joints nine in number; when perfectly preserved the joints of the medial segment or axis appear simple, but are marked internally with a transverse furrow, the joints of the lateral segments ('pleuripedes,' Portlock) are compound, being marked along their centre by a furrow which follows the outline of their form but does not reach the outer margin, and so formed by flattening on the edge as to admit of their folding freely over one another, when the animal was contracted; the axial and lateral lobes are nearly equal in breadth, but differ much in sectional form.

"*Pygidium*, a little more than semicircular, middle lobe consisting of eleven costæ, divided by well-marked furrows and simple (De Koninck says fourteen, our

¹ I refer to this structure in my Appendix to Part II.

specimens do not confirm this), which diminish successively; the lateral lobes have about thirteen costæ, simple and united at the margin by a smooth rim, the furrows which divide the costæ becoming obsolete or nearly so before they reach the outer edge; this smooth rim occupies about one third of the breadth of the lobe.

“When rolled up this smooth rim partly covers the wings of the thorax. . . . It is remarkable that M. de Koninck, in his excellent ‘Description des Anim. foss. dans le terr. Carbonif. de Belgique,’ though figuring (pl. liii, fig. 1) a Trilobite with strongly reticulated eyes, as *P. globiceps*, states in the text, in more than one place and most particularly, that the eyes are smooth. Indeed, although his description is in general accurate enough, his plate represents a fossil, which in many respects totally differs from the *Asaphus globiceps* of Phillips to which he refers it.”

10. GRIFFITHIDES ACANTHICEPS, *H. Woodw*, *sp. nov.* Pl. VI, figs. 2, 10, and 11; and Pl. VII, figs. 2 and 3.

Head-shield semicircular, produced in front, glabella very gibbous, overhanging the anterior margin, twice as wide in front as at the nuchal furrow, the whole surface strongly granulated; basal lobes very small, rounded; neck-furrow deep; neck-lobe rounded; fixed cheeks exceedingly narrow, scarcely discernible, forming a rounded palpebral lobe (the surface of which is granulated) over each eye and a narrow rim around the glabella; eyes small, finely faceted; inner raised portion of cheeks granulated, margin smooth, posterior angle produced into long cheek-spines equal to the glabella in length.

Thorax consisting of nine free segments, surface of thorax smooth without ornamentation; axis arched, rather wider than its pleuræ, broader next the head and diminishing very slowly to the pygidium; each of the pleuræ strongly grooved down the centre, posterior portion rounded and slightly raised, anterior portion slightly depressed; feral points distinctly marked, extremity of pleuræ faceted in front and rounded.

Abdomen or pygidium composed of about thirteen coalesced somites, border smooth, slightly channelled, ribs terminating close to border. Extremity of pygidium very slightly pointed.

The specimens in which the head, thorax, and abdomen of this species are preserved united, are figured on Pl. VII, figs. 2 and 3, having been discovered too late for insertion on Pl. VI.

Formation.—Carboniferous Limestone.

Localities.—Craco, near Grassington; Settle, Yorkshire; and Castleton, Derbyshire.

I had certainly no intention of burdening the list of Carboniferous Limestone Trilobites with another species, and I had, in fact, placed figs. 2, 10, and 11, Pl. VI, provisionally under *G. globiceps*; but on a more detailed examination of the original of fig. 10, it occurred to me something more might be made out by developing it further. To my surprise two long spines were uncovered, and I then perceived that figs. 2 and 11 had at one time also possessed cheek-spines, but these have since been broken off. *G. globiceps*, on the contrary, has blunt and short cheek-spines, large basal lobes to the glabella, and the portion of the test preserved shows the head-shield to have been finely punctate, whereas in *G. acanthiceps* the surface of the head-shield is distinctly granulated.

The discovery of the detached head with the long cheek-spine of this species, proving it to be distinct from *G. globiceps*, led me to a further and closer examination among the remaining doubtful specimens, and one belonging to Mr. J. Aitken, having been skilfully developed by our (Brit. Mus.) Mason, Mr. C. Barlow, revealed the same character of the head as in the specimen from the Woodwardian Museum, and in addition exposed the thorax and abdomen very fairly preserved, enabling me to complete the description of *G. acanthiceps* (see Pl. VII, fig. 2).

Another specimen, also from Cambridge, exhibiting a detached head and pygidium upon the same piece of matrix, is drawn (on Pl. VII fig. 3).

11. GRIFFITHIDES LONGICEPS, *Portlock*, 1843. Pl. VI, figs. 7, 8, and 9.

- GRIFFITHIDES LONGICEPS, *Portlock*. Rep. Geol. Londonderry, p. 310, t. xi, figs.
7 a, b, 1843.
- — *M'Coy*. Synopsis Carb. Foss. Ireland, p. 160, 1844.
- — *Morris (in part)*. Cat. Brit. Foss., p. 109, 1854.
- — *H. Woodw. (in part)*. Cat. Brit. Foss. Crust., p. 37, 1877.

General form ovate-oblong; head-shield very large in proportion to the rest of the body, forming two fifths of the entire length; glabella very gibbous, pyriform, basal lobes obtusely triangular, with a tubercle on the centre of each; fixed cheeks very narrow, but expanding rather at the sides of the glabella in front of the eyes; axial portion of the neck-lobe very broad, and separated by a strong furrow, and bearing one tubercle on its centre; eyes moderately large, reniform, surface very finely faceted; raised inner portion of free cheek rather narrow, surface finely granulated, outer margin wide, posterior angles produced into broad and stout spines, reaching to the fifth segment of the thorax; thorax composed of nine free segments, the axis arched, equalling half the entire breadth of the thorax; each segment bordered by ten or eleven granules on its axis along the posterior border, and seven or eight on each pleura; pleuræ rounded at their extremities, pygidium

composed of thirteen coalesced somites, ornamented in a similar manner to the free thoracic ones; axis tapering to a blunt extremity, and surrounded at its termination by the smooth border of the tail-shield; ribs nine in number, dying out near the margin.

Formation.—Carboniferous Limestone.

Localities.—Settle, Yorkshire; Cookstown, Tyrone; Creggane, Limerick; Brockley, near Lesmahagow.

The following is Portlock's original description of his *Griffithides longiceps*:¹

"*Glabella* elevated, rounded, and swollen in front, but narrowing gradually towards the base, the external surface covered with minute dots, and, when removed, the surface below appears rather granular or rugose; length rather more than four tenths of an inch, breadth in front three tenths, and at the base three twentieths; eye-projection, very small, and near the base. Thorax imperfect, but showing the lateral segments to be compound. Pygidium, in length four tenths, breadth five tenths of an inch; axial lobe elevated; segments thirteen, with about twelve granules or small tubercles on each, and a rounded extremity also covered with granules; lateral segments about nine on each side, with a row of small tubercles on each, not quite extending to the margin, which is flattened or turned up, and strongly striated on the edge and under surface. The prolongation of the segments is marked by slight elevations on the margin; the flattened and turned-up margin of the pygidia of this genus is generally more striking than in *Phillipsia*, in which the pygidial margin follows the slope of the lateral segments, but the character depends in part upon the condition of the crust, being more marked when it is decorticated."

In Prof. Morris's 'Catalogue of British Fossils,' p. 109, and also in H. Woodward's 'Catalogue of British Fossil Crustacea,' p. 37, Portlock's *Griffithides longispinus* ('Geol. Rep.,' Lond., p. 312, pl. xxiv, fig. 12) is made a synonym of *Griffithides longiceps*, Portl. A careful examination of Portlock's type specimen, kindly lent to me by the authorities of the Museum of Practical Geology, Jernyn Street, enables me to state that it is quite distinct from *G. longiceps*, and I figure it, with others, on Pl. VII, figs. 5 and 6.

12. GRIFFITHIDES PLATYCEPS, Portlock, 1843. Pl. VI, fig. 13.

GRIFFITHIDES PLATYCEPS,	Portlock.	Rep. Geol. Lond., p. 311, pl. xi, fig. 8, 1843.
—	—	Morris. Cat. Brit. Foss., p. 109, 1854.
—	—	H. Woodw. Cat. Brit. Foss. Crust., p. 37, 1877.

¹ 'Geology of Londonderry' (1843), p. 310.

This species, which was founded upon a glabella only by Captain (afterwards General) Portlock, who obtained it from the Carboniferous Limestone of Tyrone, Ireland, is thus noticed by him in his 'Report on the Geology of Londonderry and Tyrone' (p. 311). "Fig. 8 is a larger individual, of probably another species [distinct from *longiceps*]; the surface is granular, and it is proportionately flatter; it may be called *Griffithides platyceps*." The specimen figured on our Pl. VI, fig. 13, and enlarged twice the natural size, was obtained from the Carboniferous Limestone of Derryloran, Tyrone, the original being preserved in the Museum of the Geological Survey of Ireland, Dublin.

13. GRIFFITHIDES OBSOLETUS, *Phillips*, sp., 1836. Pl. VI, fig. 12.

- ASAPHUS OBSOLETUS, *Phillips*. Geol. Yorks., vol. ii, p. 239, pl. xxii, figs. 3—6, 1836.
 — GRANULIFERUS, *Phillips*. *Ibid.*, fig. 7, 1836.
 PHILLIPSIA BRONGNIARTI, *De Koninck*. Anim. Foss., t. liii, fig. 7, 1842.
 — — *Morris*. Cat. Brit. Foss., p. 114, 1854.
 — — *Salter & H. Woodw.* Cat. and Chart Foss. Crust.,
 p. 16, fig. 113, 1865.
 — — *H. Woodw.* Cat. Brit. Foss. Crust., p. 55, 1877.

This species is founded on a very broad and smooth pygidium, nearly one fourth broader than long, composed of ten coalesced somites, the axis much broader than the pleural portion; each of the nine rib-like plicæ marked by a furrow down the centre (as in the pygidium of *G. globiceps* already noticed), the margin of the tail-shield is smooth.

The glabellar portion of the head, most probably belonging to the same individual (being enclosed in the same piece of matrix), although mutilated, exhibits peculiar and delicate striations over its entire surface. The head (somewhat restored) is figured by Prof. Phillips with the pygidium. This specimen is the type of Phillips' figure in the 'Geol. of Yorkshire,' and was at that time in the Gilbertson Collection, and is now in the British Museum (Natural History).

Formation.—Carboniferous Limestone.

Locality.—Bolland, Yorkshire.

The following is Prof. Phillips' original description of his *Asaphus obsoletus* (op. cit., p. 239):

"Abdominal lobes ventricose; transverse undulations obtuse; surface smooth with undulating lines; the limb with oblique undulating striae; head finely striated, undulated lines roundish and lumpy."

The name of *Ph. Brongniarti*, Fischer, sp., 1825, being the oldest, had been adopted by De Koninck in 1841 for this specimen in lieu of Phillips' name of

obsoletus (given in 1836), which has since figured as a synonym; but as Fischer de Waldheim expressly says in his work,¹ already quoted in reference to two pygidia of Trilobites named by him, *Asaphus Eichwaldi* and *A. Brongniarti*, "I think that size alone is not sufficient to make two species; I consider them as one and the same species, for which I have retained the name of Eichwald, the more so as another Trilobite already bears the name of Brongniart." It seems, therefore, clearly undesirable to revive a specific name which its author had already cancelled, and to apply it to a form which certainly cannot be correlated with that originally intended to be described under the defunct term.

14. GRIFFITHIDES LONGISPINUS, *Portlock*, 1843. Pl. VII, figs. 5 a, b, c, and 6.

GRIFFITHIDES LONGISPINUS, <i>Portlock</i> .	Geol. Rept. Lond., p. 312, pl. xxiv, fig. 12, 1843.
—	— <i>M' Coy</i> . Carb. Foss. Irel., p. 161, 1844.
—	LONGICEPS, <i>Morris</i> . Cat. Brit. Foss., p. 109, 1854.
—	— <i>Salter and H. Woodward</i> . Cat. and Chart Brit. Foss. Crust., p. 16, fig. 115, 1865.
PHILLIPSIA	— <i>V. von Möller</i> . Trilob. der Steinkohl., pp. 19 and 73, 1867.
GRIFFITHIDES	— <i>H. Woodward</i> . Cat. Brit. Foss. Crust., p. 37, 1877.

General form elongated-oval; head wider than long; glabella very gibbous in front, slightly overhanging the anterior border, much broader in front than behind the eyes; basal lobes small, rounded; neck-lobe strongly arched, narrow, divided from the glabella by a deep neck-furrow; fixed cheeks narrow, where they pass from the posterior border and above the eyes, forming the small, rounded, palpebral lobes, after which they expand again slightly on each side of the glabella before the facial suture unites with the front border; surface of glabella thin and irregularly tuberculated; free cheeks small, elevated, channelled around the eye and the border, the small area so enclosed covered with numerous, rather coarse, and irregular bead-like ornamentations; eyes reniform, moderately small, smooth; margin of cheeks produced into rather long cheek-spines ("long, flat, striated spines," *Portlock*²); margin of head-shield incurved and finely striated. Thoracic segments nine in number, axis strongly arched, each segment having a narrow elevated central rib, ornamented with about twelve small tubercles or spines, with a smooth anterior articular portion and a less elevated posterior border; the pleuræ are strongly grooved, and are bent down at the fulcral point, their

¹ 'Oryc. Gouv. Moscou,' p. 121.

² There is reason to conclude that one of these spines existed when *Portlock* wrote his description, although it is only now indicated by a fragment and by the scar where it once rested.

extremities being faceted and obtusely pointed. Pygidium composed of from twelve to fifteen¹ coalesced segments; axis strongly arched and ribbed like the thorax, but no ornamentation visible; side lobes of pygidium also arched; the ribs running to the border; a wide striated margin is exposed where decorticated.

Formation.—Carboniferous Limestone.

Locality.—Carnteel, Tyrone, Ireland.

I was formerly of the same opinion as my friend Prof. Morris that *Griffithides longispinus* of Portlock was identical with the *G. longiceps* of the same author, and this opinion was also shared by V. von Möller; but, having been favoured with the opportunity of examining Portlock's original specimens of both these forms, I have satisfied myself that they are entitled to be kept distinct.

In *G. longispinus* the small raised cheeks are covered with rather large bead-like tubercles; the glabella is longer in proportion, and has a few scattered tubercles on the surface; the neck-lobe is narrow.

In *G. longiceps* the head-shield is finely granulated, the neck-lobe is broad, the basal lobes are larger, and only one tubercle marks the centre of each. The thoracic segments are more strongly arched in *G. longispinus*, and the pygidium is composed of more somites than in *G. longiceps*, and is more elongated and more highly arched than in the latter.

I think a comparison of our figures of *G. longiceps* (Plate VI, figs. 7 and 8) with those of *G. longispinus* (Plate VII, figs. 5 *a*, *b*, *c*, and 6) will satisfactorily show all the points in which these two species resemble and differ from one another.

Subjoined we give Portlock's original description of his *Griffithides longispinus*, 'Report on the Geology of Londonderry,' &c., p. 312, 1843:

"This beautiful species approximates to *G. longiceps*, as the specimen figured in pl. xi, fig. 9, is imperfect, and may, therefore, have had lateral spines; there are, however, some good marks of distinction, the glabella is not quite so long nor so narrow, and the pygidium is rather longer, has fifteen axial segments, and is smooth, whilst the thoracic segments are granulated; these may, however, be only in part accidental variations from peculiar circumstances, wear, &c. The glabella is gibbous, and longer than in *G. globiceps*. The wings [free cheeks] pass anteriorly under or in front of the glabella, and are prolonged backwards in long, flat, striated spines (see magnified view, pl. xxiv, fig. 12 *b*). Though the granulations are well marked on the thoracic segments (pl. xxiv, fig. 12 *e*) none are visible in this specimen on the pygidium (fig. 12 *c*); when decorticated a large striated and nearly vertical margin appears, as in fig. 12 *d*, which also shows that the under surface does not exhibit the extension of the segments to the margin

¹ The extremity is injured so that the exact number cannot now be ascertained.

which is seen on the upper surface of the crust, and hence that in the two conditions they might appear different fossils.”

15. GRIFFITHIDES CALCARATUS, M'Coy, sp., 1844. Pl. VII, fig. 13.

GRIFFITHIDES CALCARATUS, M'Coy. Synop. Carb. Foss. Ireland, p. 160, pl. iv,
fig. 3, 1844.

— — V. von Müller. Trilob. der Steinkohl., p. 19, 1867.

— MUCRONATUS, H. Woodw. Cat. Brit. Foss. Crust., p. 37, 1877.

This species was founded by Prof. M'Coy in 1844 for a specimen from Ireland,¹ of which he figures the head only, but describes the head and tail also. We have not been so fortunate as to see the original of M'Coy's figure, but we give his own description as follows :

“Cephalothorax semi-oval ; glabella smooth, ovate, most convex in the middle of its length ; cheeks small, triangular, flat, smooth ; wings strongly striated, broad, prominent, rounded, terminating posteriorly in long flattened spines ; eyes moderately lunate (smooth ?), connected with the glabella by a nucleus on each side ; pygidium with a smooth margin, each segment with a row of very minute granulations.

“This beautiful species is most nearly allied to the *G. longispinus* of Portlock, but is at once distinguished by its smooth cheeks ; the eyes, also, in the present species, are differently formed and placed, and the glabella is much smaller and less prominent in front. Length of glabella five lines ; greatest width three lines ; width at base one line ; width of cephalothorax seven lines ; length of eyes one and a half lines ; width one line ; length of posterior alar spine three lines.

“The pygidium has a broad, smooth margin or limb, in which it differs from that of *G. longispinus*, in which the segments are extended to the margin. There is a single row of very minute granules on each segment. Width of pygidium five lines” (op. cit., p. 160).

Although I placed *G. calcaratus* in 1877 as a synonym under *G. mucronatus*, I find that neither the description nor figure admit of its being so disposed of, and I therefore give it on M'Coy's authority.

Valerian von Möller says of *Griffithides calcaratus* : “M'Coy only figures the cephalothorax. It is nearly related to *Ph. globiceps*, Phill., but is distinguished from this species by the very inferior size of the glabella, and by the long, flattened cheek-spines ; and from another Trilobite, *Ph. longiceps*, Portl. (= *G. longispinus*, Portl.), with which it is also nearly connected, it differs in its very narrow glabella and the wide flattened border around the pygidium (op. cit., p. 19).”

¹ Said to be from the Upper Limestone, Roughan, Dungannon.

PLATE I.

CARBONIFEROUS TRILOBITES.

Phillipsia Derbiensis, Martin, sp. 1809. (P. 12.)

FIGS. 1 *a* and 1 *b*.—Head, from the Carboniferous Limestone, Bolland, Yorkshire. (Gilbertson Coll.) Magnified four times. 1 *a*, top view; 1 *b*, side view of same. Original specimen in the British Museum (Nat. Hist.), Cromwell Road, S.W.

FIGS. 2 *a* and 2 *b*.—A complete specimen from the Carboniferous Limestone, Longnor, Staffordshire. Magnified three times. 2 *a*, side view; 2 *b*, top view of same. Original specimen in the Museum of Practical Geology, Jermyn Street, S.W.

FIG. 3.—Detached head, from the Carboniferous Limestone, Settle, Yorkshire. Magnified three times. Original specimen in the Woodwardian Museum, Cambridge.

FIGS. 4 *a*.—Entire specimen; and 4 *b*.—Hypostome of same, from the "Rotten stone" band of the Carboniferous Limestone, Matlock, Derbyshire. Fig 4 *a*, magnified twice, and 4 *b* (the hypostome of 4 *a*), magnified four times. Original specimen in the British Museum (Nat. Hist.).

FIG. 5.—Detached head, from the Carboniferous Limestone of Castleton, Derbyshire. Original specimen in the collection of the Rev. E. Oldridge de la Hey, M.A., Marple, Cheshire. Magnified three times.

FIG. 6.—*Phillipsia Derbiensis*, Martin, restored outline.

FIG. 7.—*g*, Outline of glabella; *c*, outline of free cheek.

FIG. 8 *a*, *b*.—Top view and section in outline of one of the thoracic somites.

FIG. 9.—Outline restoration of pygidium, enlarged.

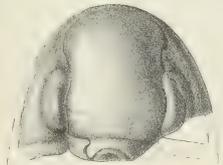
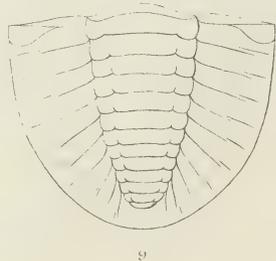
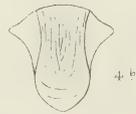
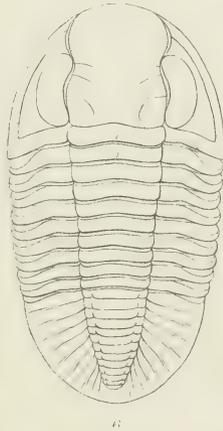
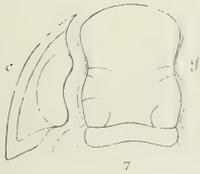


PLATE II.

CARBONIFEROUS TRILOBITES.

Phillipsia Colei, M'Coy. 1844. (P. 16.)

FIG. 1.—A small and rather mutilated specimen, wanting the cheek or genal portion of the head and some of the thoracic somites. The eye on the left side is well preserved. Magnified six times natural size.

FIG. 2.—A larger and more perfect specimen; the genal portion of the head is not preserved clearly, and the eyes are wanting. Magnified twice natural size.

FIG. 3.—Another example, wanting the lateral portion of the head and the eyes; the thoracic segments on one side are very well preserved. Magnified three times natural size.

FIG. 4.—This specimen is preserved as an intaglio only, but shows the glabella, the thoracic somites, and the pygidium united. Magnified three times natural size.

FIG. 5.—A very complete caudal shield or pygidium. Magnified twice natural size.

FIG. 6.—A detached hypostome. Magnified four times.

All the above specimens are from the Museum of the Geological Survey of Ireland, Dublin, and were obtained from the black Carboniferous Shale, occurring in rocks in a stream opposite Flax Mill, north-east of Ballintra and Carrickbreeny, Donegal, Ireland.

FIG. 7.—*Phillipsia Colei*, M'Coy. Restored outline, three times enlarged.

FIG. 8.—Outline of glabella, *g*. Cheek, *c*, separated to show the suture.

FIG. 9 *a, b*.—One of the thoracic ribs drawn in outline, seen from above, and in profile.

FIG. 10.—The pygidium, drawn in outline.

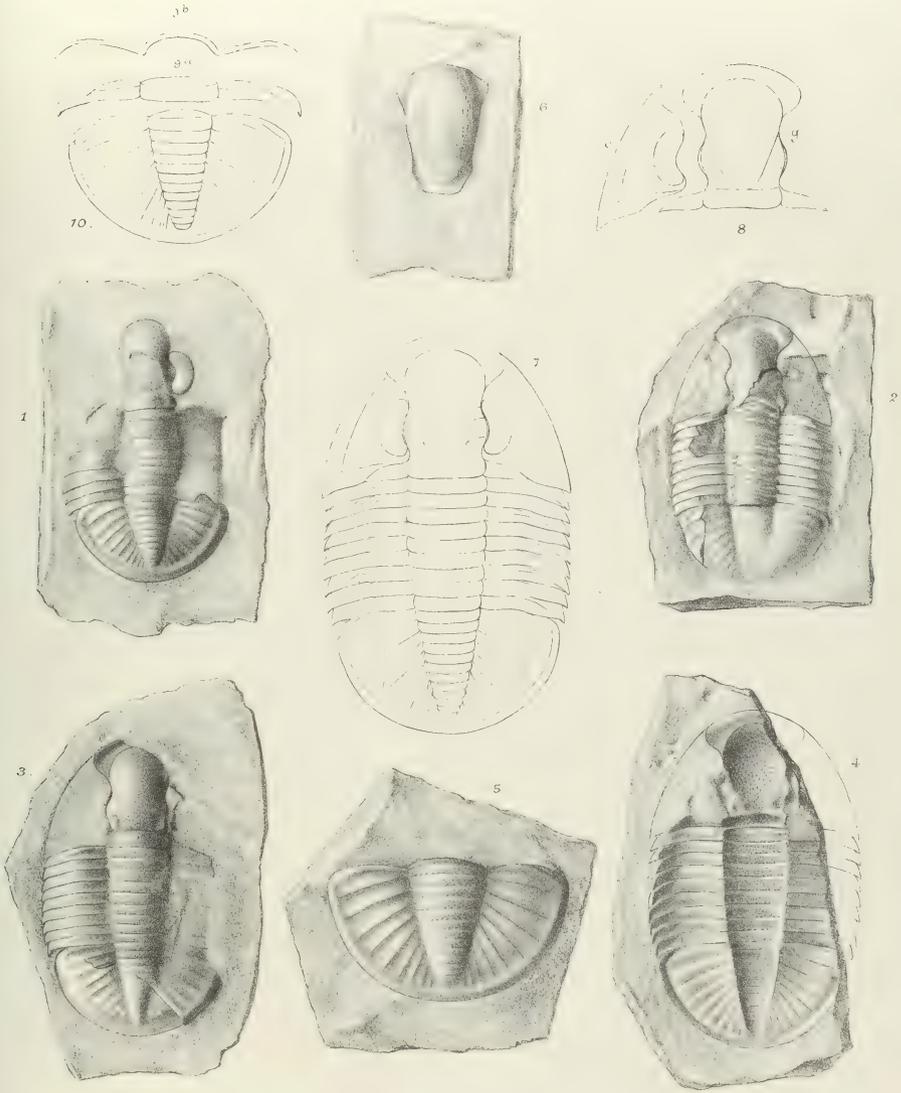


PLATE III.

CARBONIFEROUS TRILOBITES.

FIGS. 1—8.—*Phillipsia gemmulifera*, Phillips, sp., 1836. (P. 17.)

FIG. 1.—A very perfect and entire specimen in hard crystalline Carboniferous Limestone, Kildare, Ireland. Magnified three times natural size. Original specimen in the Museum of Practical Geology, Jermyn Street.

FIG. 2.—A perfect detached head (one of the eyes showing the faceted surface very clearly), preserved in dark crystalline Carboniferous Limestone, St. Doolagh, Dublin. Magnified twice natural size. Original specimen in the Museum of the Geological Survey of Ireland, Dublin.

FIG. 3.—An entire thorax and abdomen, but without a head, from the Carboniferous Limestone, Clitheroe, Lancashire. Magnified twice natural size. Original specimen in the collection of John Aitken, Esq., of Sandfield, Urmston, Manchester.

FIG. 4.—A very perfect detached pygidium, preserved in white crystalline Carboniferous Limestone; said to be from Derbyshire (more probably from Settle, Lancashire). Magnified twice natural size. Original specimen in the British Museum (Nat. Hist.), Cromwell Road.

FIG. 5.—Another well-preserved detached pygidium, in crystalline Carboniferous Limestone from Bolland, Yorkshire. Magnified twice natural size. Original specimen in the British Museum (Nat. Hist.), Cromwell Road.

FIG. 6.—*Phillipsia gemmulifera*, Phil., sp. Restored outline.

FIG. 7 *a* and *b*.—One of the thoracic somites, drawn in outline.

FIG. 8.—One of the eyes enlarged six times to show the facets. From a specimen in Mr. John Rofe's collection, now in the British Museum (Nat. Hist.), Cromwell Road.

FIGS. 9—14.—*Phillipsia truncatula*, Phillips, sp., 1836. (P. 21.)

FIG. 9.—A detached head, from black Carboniferous Limestone, with *Fenestella* from Hook Point, Co. Wexford, Ireland. Drawn of natural size. Original specimen in the Museum of the Geological Survey of Ireland, Dublin.

FIG. 10.—A second detached head, from the same formation and locality. Natural size.

FIGS. 11 and 12.—Two detached pygidia, from the same locality. Original specimens of figs. 10, 11, and 12, in the Woodwardian Museum, Cambridge.

FIG. 13.—*Phillipsia truncatula*, Phil., sp. Restored outline of head.

FIG. 14.— „ „ Restored outline of pygidium.

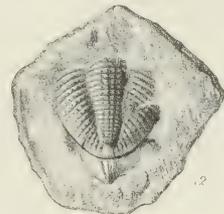
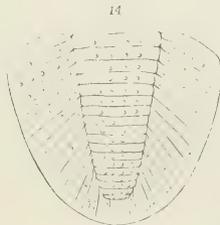
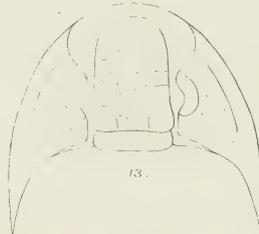
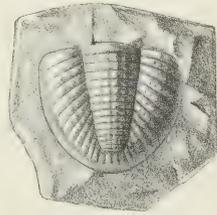
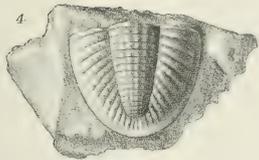
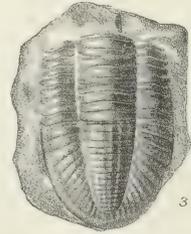
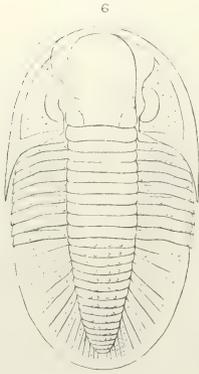
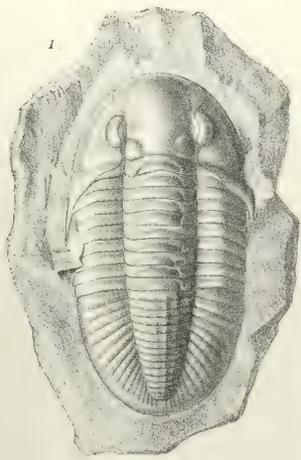


PLATE IV.

CARBONIFEROUS TRILOBITES.

FIG. 1.—*Phillipsia Eichwaldi*, var. *mucronata*, M'Coy. An almost complete specimen showing the mucronate tail, and the long cheek-spines so characteristic of this species. The right side is however injured. From the black Carboniferous Limestone of Wilkiestone, Fife. Drawn natural size. Original specimen in the cabinet of Dr. R. H. Traquair, F.R.S., of Edinburgh. (P. 23.)

FIG. 2.—*Phillipsia Eichwaldi*, Fischer, sp. A nearly perfect specimen, agreeing closely with Fig. 1 in all particulars of structure save that the mucro of the pygidium is wanting. From the Lower Limestone series, Newfield Quarry, near High Blantyre, Lanarkshire. Magnified twice the natural size. Original specimen in Mr. J. Young's collection, Glasgow. (P. 22.)

FIG. 3.—*Ph. Eichwaldi*, var. *mucronata*, M'Coy. A detached head magnified twice the natural size, from the same horizon and locality as Fig. 1. From Dr. Traquair's cabinet. (P. 23.)

FIG. 4.—*Ph. Eichwaldi*, Fischer, sp. A detached hypostome, believed to belong to this species. Enlarged three times the natural size. From the Upper Limestone series, Dalry, Ayrshire. Original specimen in Mr. John Young's collection. (P. 22.)

FIG. 5*a*.—A nearly entire rolled-up specimen, the cheek-spines and extremity of the pygidium are wanting; the facets of one eye are beautifully preserved. (P. 22.)

FIG. 5*b*.—Thoracic-abdominal segments of same fossil. The original specimen in Mr. J. Thomson's collection, Glasgow.

FIG. 6.—Detached glabella, showing pores (*p*) on each side of head in front of the eyes. From same locality and collection as Fig. 4. Enlarged twice natural size. (P. 22.)

FIG. 7.—Detached hypostome. From the Upper (Carboniferous) Limestone Series, Dalry, Ayrshire. Magnified four times natural size. Original specimen in the collection of Mr. R. Craig, Langside, Beith, Ayrshire. (P. 22.)

FIG. 8.—Underside of head, exhibiting the pores (*p*) upon the underside of the margin of the glabella, at its union with the cheeks on each side, in front of the compound eyes. Lower (Carboniferous) Limestone Series, Sculliongour near Lennoxtown, Campsie, Sterlingshire. Magnified twice natural size. Original specimen in Mr. John Young's collection, Glasgow. (P. 22.)

FIG. 9.—Part of thorax and perfect rounded pygidium. From the same locality and formation as Fig. 7. Magnified twice natural size. Original specimen in Mr. J. Young's collection. P. 22.

FIG. 10.—Head, closely associated with a rounded pygidium, like Figs. 9 and 13. Showing pores (*p*) at sides of glabella as in Figs. 6 and 8. Enlarged twice natural size. From the same locality and formation as Fig. 9. Original specimen in Mr. Young's collection. (P. 22.)

FIG. 11.—Free cheek showing the compound eye and the long cheek-spine, magnified twice natural size. From Shale below Fourth Limestone, Dalry. Original specimen in Mr. J. Smith's collection, Stobs, Kilwinning. (P. 22.)

FIG. 12.—*Ph. Eichwaldi*, var. *mucronata*, M'Coy. Mucronated pygidium (twice natural size) from Shale below Upper Limestone, Garple Water, Muirkirk. Mr. J. Smith's collection. (P. 23.)

FIG. 13.—*Ph. Eichwaldi*, Fischer, sp. Rounded pygidium like Fig. 9, and from the same locality and collection as Figs. 7 and 9. Magnified twice natural size. (P. 22.)

FIG. 14*a*, *b*, and *c*. A nearly entire and rolled-up specimen, the cheek-spines are broken off, but were evidently long as in Figs. 1 and 2. The tail is non-mucronate, as in Fig. 2. Both specimens are from the same locality and collection. *a*, View of head seen from above; *b*, profile of same; *c*, the pygidium of same specimen. Magnified twice natural size. (P. 22.)

FIG. 15.—*Ph. Eichwaldi*, var. *mucronata*, M'Coy. Outline restoration; (*p*) position of pores on glabella. (P. 23.)

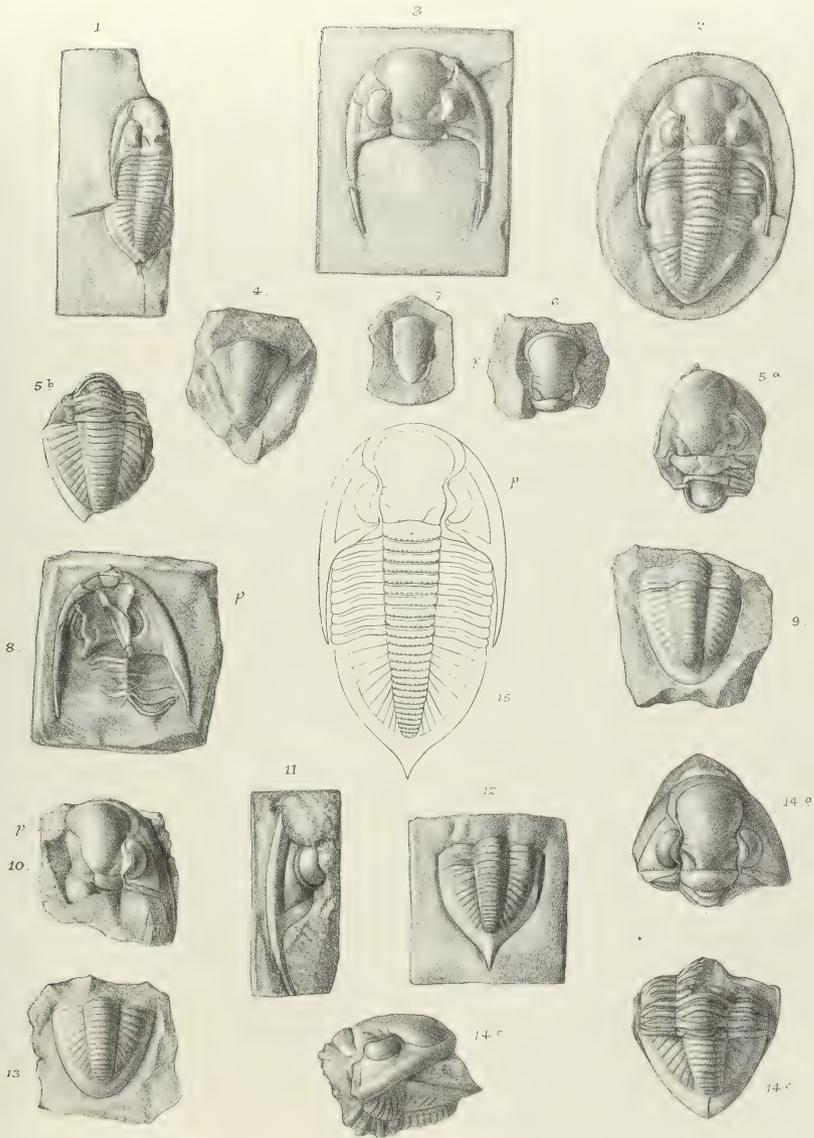


PLATE V.

CARBONIFEROUS TRILOBITES.

Griffithides (Phillipsia) seminiferus, Phillips, sp. 1836. P. 28.

FIG. 1.—Intaglio of a nearly perfect specimen associated with a detached pygidium and fragment of another specimen preserved in the same piece of matrix. Drawn of natural size.

FIG. 2.—Copy of a cast in relievo. Taken from Fig 1.

FIG. 3.—Another specimen, also preserved in intaglio, showing glabella, without the cheeks, and the nearly entire thorax and abdomen very well preserved.

FIG. 4.—A specimen in relievo, nearly entire, although not very sharply preserved. The glabella, which is partly removed, shows the hypostome (*h*) *in situ* beneath. Fig. 7 shows the same hypostome enlarged.

FIG. 5.—A group of probably four individuals, preserved in relief (with one pygidium in intaglio) in the same piece of matrix.

All the above are from the "Rottenstone band" in the Carboniferous Limestone of Matlock, Derbyshire, and are preserved in the British Museum (Nat. Hist.), Cromwell Road.

FIG. 6.—*Griffithides (Phillipsia) seminiferus*, Phil., sp. Outline restoration. Twice natural size.

FIG. 7.—The hypostome enlarged twice.

FIG. 8 *a*, *b*.—One of the thoracic somites. *a*, Seen from above; *b*, seen in section.

FIG. 9.—The pygidium restored in outline and enlarged.

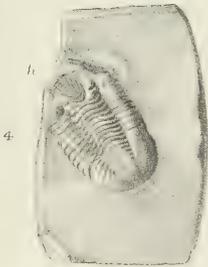
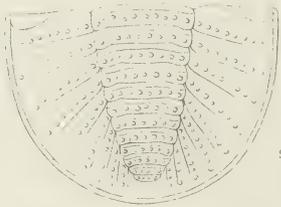
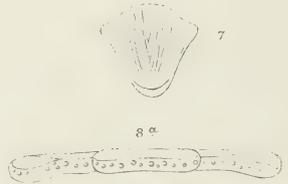
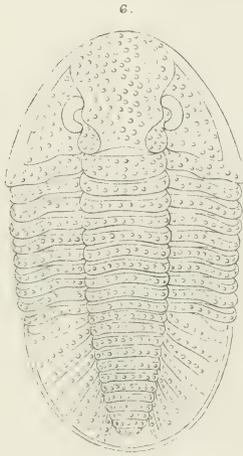
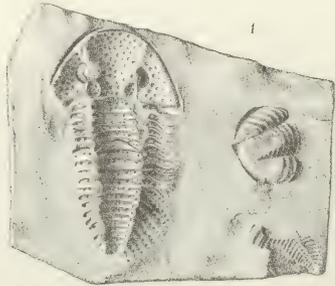


PLATE VI.

CARBONIFEROUS TRILOBITES.

FIGS. 1 *a* and *b*.—*Griffithides globiceps*, Phillips, sp. *a*, Upper view; *b*, side view of an entire specimen from the Carboniferous Limestone, Millicent. Magnified once and a half natural size. Original specimen in the Museum of the Geological Survey of Ireland, Dublin. (P. 29.)

FIG. 2.—A nearly perfect head of *Griffithides acanthiceps*, H. Woodw., from the Carboniferous Limestone, Settle, Yorkshire. Enlarged one and a half times natural size. Original specimen in the Woodwardian Museum, Cambridge. (P. 32.)

FIG. 3.—An entire rolled-up example of *G. globiceps*. Enlarged twice natural size. From the same locality, formation, and collection as Fig. 1. (P. 29.)

FIG. 4.—Pygidium of same species, from same. (P. 29.)

FIG. 5.—Hypostome. Enlarged four times natural size. From the Carboniferous Limestone, Tyrone, Derryloran. Original in the Geological Survey Museum, Dublin. (P. 29.)

FIG. 6.—Pygidium from the Carboniferous Limestone, Bolland, Yorkshire. Magnified twice natural size. Original specimen in the British Museum (Nat. Hist.). (P. 29.)

FIG. 7.—*Griffithides longiceps*, Portlock. An entire specimen. Magnified twice natural size. Carboniferous Limestone. Ireland. Original in the Museum of Practical Geology, Jermyn Street. (P. 33.)

FIG. 8.—Outline restoration of same. Enlarged about four times. (P. 33.)

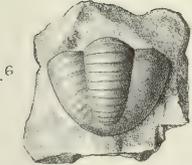
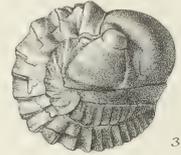
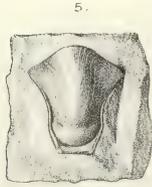
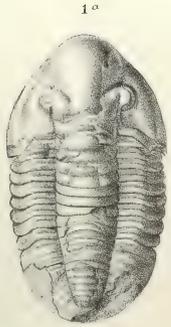
FIG. 9.—Pygidium of *G. longiceps*. Carboniferous Limestone; Ireland. Original specimen in the Museum of the Geological Survey of Ireland, Dublin. Magnified twice natural size. (P. 33.)

FIG. 10.—*G. acanthiceps*. Detached head from the Carboniferous Limestone of Settle, Yorkshire. Drawn natural size. Original in the Woodwardian Museum, Cambridge. (P. 32.)

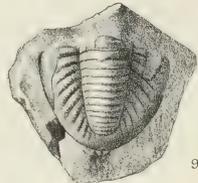
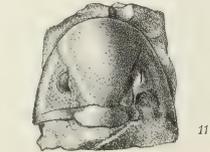
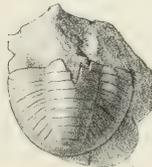
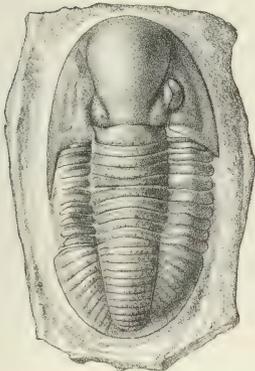
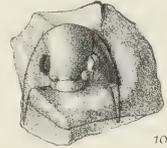
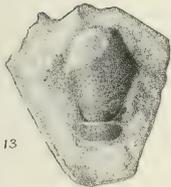
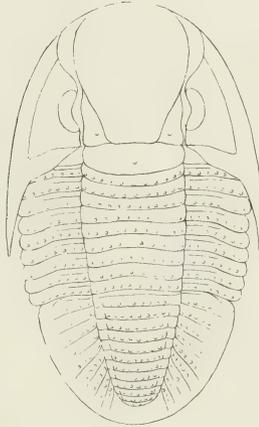
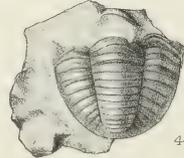
FIG. 11.—*G. acanthiceps*. Detached head. Enlarged once and a half natural size. From the Carboniferous Limestone. Original in the cabinet of the Rev. E. O. de la Hay. (P. 32.)

FIG. 12.—*G. obsoletus*, Phil. Pygidium. Drawn natural size. From the Carboniferous Limestone of Bolland, Yorkshire. Original specimen in the British Museum (Nat. Hist.). (P. 35.)

FIG. 13.—*Griffithides platyceps*, Portlock (an imperfect glabella only). Enlarged twice natural size. From the Carboniferous Limestone, Tyrone, Derryloran. Original specimen in the Museum of the Geological Survey of Ireland, Dublin. (P. 34.)



8.



THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCLVII.

VOLUME FOR 1883.

LONDON :

MDCCCLXXXIII.

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 PALEONTOGRAPHICAL 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 PALEONTOGRAPHICAL 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. V.

PART II.

SILURIAN SUPPLEMENT.

PAGES 135—242; PLATES VIII—XVII.

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1883.

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Further researches will be necessary before it can be possible to offer a definite classification of the spiral-bearing Brachiopoda in their respective groups. The following provisional sketch, however, has been drawn up by Mr. Glass and myself in order to assist those Palæontologists who may feel inclined to continue the investigation.

Families or Groups of spiral-bearing Brachiopoda.	Direction of spirals.	Attachments to hinge-plate.	Shape of loop.	Position of loop in relation to the spirals.
1. <i>Spiriferidae</i> , King, 1846 (but much restricted) <i>Spirifera</i> <i>Cyrtia</i> <i>Syringothyris</i> <i>Cyrtina</i> <i>Ambocalia</i> <i>Uncites</i> <i>Spiriferina</i> <i>Suessia</i> <i>Reticularia</i>	The bases of the spirals facing each other in the centre of the shell, but usually with their apices having a more or less upward direction towards the posterior angle of the lateral margins of the shell The spirals are sometimes directed backwards into the rostral cavity of the ventral valve, as in <i>Cyrtina heteroclita</i>	Straight	Either, as in <i>Spirifera</i> or <i>Cyrtia</i> , consisting of two processes directed downwards but not uniting Or, as in <i>Cyrtina</i> , two processes directed downwards but uniting at an acute angle Or, as in <i>Spiriferina</i> and <i>Uncites</i> , a straight or curved horizontal band. In <i>Spiriferina</i> this band is simple; in <i>Uncites</i> it has a slight upward projection in the centre	Either between the spirals and directed backwards towards their ventral side, as in <i>Spirifera</i> , <i>Cyrtia</i> , and <i>Cyrtina</i> . Or between the spirals, but almost on a level with their dorsal surface, as in <i>Spiriferina</i> and <i>Uncites</i> .
2. <i>Nucleospiridae</i> , Dav., 1881 <i>Nucleospira</i> <i>Retzia</i> <i>Meristina</i> ? <i>Trematospira</i>	The bases of the spirals facing each other in the centre of the shell, the apices of the spirals being directed towards the lateral margins of the shell	The primary lamellæ shortly after attachment to hinge-plate bent backwards towards ventral valve	Simple, V-shaped, with sharp angular extremity, sometimes prolonged into a spine-like process	Between the spirals and near their centre. Directed almost horizontally from dorsal to ventral side of spirals.
3. <i>Athyridae</i> , Phillips, 1841 <i>Athyris</i> <i>Kayseria</i> <i>Whitfieldia</i> <i>Bifida</i> <i>Merista</i> <i>Meristella</i>	As in <i>Nucleospiridae</i>	As in <i>Nucleospiridae</i>	A more complex loop than in <i>Nucleospira</i> , bifurcating, and variously extended after the two primary lamellæ of the loop have become united	Between the spirals, and extending upwards from about their centre.
4. <i>Atrypida</i> , Dall, 1877 <i>Atrypa</i> <i>Calospira</i> <i>Thecospira</i> <i>Anoplotheca</i> <i>Koninckina</i> <i>Koninckella</i> <i>Davidsonia</i> <i>Glossia</i> <i>Zygospira</i>	The bases of the spirals directly facing the bottom of the ventral valve, or more or less turned outwards towards the lateral margins of the shell In <i>Thecospira</i> the apices of the spirals face the bottom of the ventral valve	The primary lamellæ shortly after attachment to hinge-plate bent outwards towards lateral margins of shell	Simple, uniting by a downward V-shaped curve, but not having a sharp extremity. (Whitfield has figured the loop of some examples of <i>Atrypa reticularis</i> as having a sharp extremity. Neither Mr. Glass nor myself, however, have met with such examples.)	Above and exterior to the spirals.

Families or Groups of spiral-bearing Brachiopoda.	Direction of spirals.	Attachments to hinge-plate.	Shape of loop.	Position of loop in relation to the spirals.
5. <i>Anazygidae</i> , Dav., 1882 <i>Anazyga</i> <i>Dayia</i> <i>Hindella</i>	<i>Anazyga</i> as in <i>Zygospira</i> (<i>Atrypidae</i>) <i>Dayia</i> and <i>Hindella</i> as in <i>Nucleospira</i>	<i>Anazyga</i> and <i>Dayia</i> as in <i>Atrypa</i> <i>Hindella</i> as in <i>Nucleospira</i>	Simple V-shaped loop with rounded or angular extremity, and sometimes having a short spine-like continuation	At the base of the spirals, and directed upwards, being either exterior to the spirals, as in <i>Anazyga</i> , or between and interior to the spirals, as in <i>Hindella</i> , or between the primary lamellæ on the dorsal side of the spirals, as in <i>Dayia</i> .

At p. 82 of this Supplement *Uncites* has been placed in the Family NUCLEOSPIRIDÆ, but subsequently Mr. Glass thought it should be put under SPIRIFERIDÆ, because it has straight attachments to the hinge-plate and its spiral arrangement is very like that of *Spiriferina*. The loop seems almost horizontal and does not go backwards so far towards the ventral side of the spirals as in *Nucleospira*. As far as we can see all those specimens whose spirals have straight attachments to the hinge-plate should be included in the SPIRIFERIDÆ. This characteristic is very marked, and there is nothing in the case of *Uncites* to override its significance.

As to the ANAZYGIDÆ, it seems to us that the rising of the loop from the bottom of the spirals is a very permanent and unmistakable character, and well marks off the class.

Of course all classes or families have mutual likenesses, and more or less run into each other, and we have to choose for purposes of classification, so far as is possible, the most marked divergencies. Now

Spiriferidæ is clearly marked by straight attachments to the hinge-plate.

Anazygidæ, by loops rising from bottom of spirals.

Atrypidæ, by loop exterior to and above spirals.

Nucleospiridæ, by loop in centre being simple and extending horizontally from dorsal to ventral side of spirals.

Athyridæ, by loop more complex and extending upwards from the centre of the spirals.

Everything, however, in connection with the classification of the Brachiopoda must be considered as provisional. A final arrangement is not yet attainable.

Genus—CYRTIA, Dalman, 1827.

19. *CYRTIA EXPORRECTA*, *Wahl.* Dav., *Sil. Mon.*, Pl. IX, figs. 13—24; *Sil. Sup.*, Pl. VI, figs. 13, 13a; and Pl. VIII, figs. 4, 5.

At p. 102 of my 'Silurian Monograph, I say,' "In England *Sp. exporrecta* ranges from the Lower Llandovery to the Ludlow. Since then Dr. C. Callaway has found an unmistakable specimen of this species in the Horderley sandstone at Chatwall, Salop, and of this I give a figure (*Sup.*, Pl. VIII, figs. 5, 5a). He writes me that the horizon is about the middle of the Caradoc series. The subdivisions of the Salopian Caradoc in the descending order are: 5, Trinucleus shale; 4, Onny flags; 3, Horderley sandstone (horizon of the *C. exporrecta*); 2, Hamage shales; and 1, Hoar-Edge grits. This is the first and only specimen of the species I have seen or heard of so low down as the Middle Caradoc. *Cyrtia exporrecta* was found by Mrs. R. Gray on the Upper Llandovery at Penkill in the Girvan district.

The Rev. Norman Glass has developed the spirals of this species as well as their attachments and, of these figures will be found in Pl. VI of this Supplement.

Genus—SPIRIFERA, Sowerby (Spirifer), 1820.

20. *SPIRIFERA PLICATELLA*, *Linné.* Dav., *Sil. Mon.*, Pl. IX, figs. 1—8; *Sup.*, Pl. VI, figs. 11, 12; and Pl. VIII, figs. 2, 3.

The exact stratigraphical range of this variable species has not yet been completely determined. We know positively of its presence in the Llandovery, Wenlock, and Ludlow formations. In the Explanation of Sheet 15 of Map of the Geol. Survey of Scotland, p. 15, 1871, Mr. R. Etheridge quotes it from the Caradoc of the Leadhills district in Scotland. The specimen upon which this identification was founded has been lost or mislaid, as it could not be found among the specimens from that locality in the Museum of the Geological Survey of Scotland. I believe the identification to be a mistaken one, as all the other Brachiopoda I have been able to examine from that locality were Caradoc species, with no trace of *Sp. plicatella* among them.

In Scotland, *Sp. plicatella*, var. *radiata*, was found plentifully by Mrs. R. Gray in the Penkill beds (Upper Llandovery) at Bargany Pond Burn, Girvan, also at Penwhapple Glen in beds of the same geological age.

The variety *globosa*, Salter (*Dav.*, *Sil. Mon.*, Pl. IX, figs. 7, 8), seems to occur under the name of *Spirifer Davousti* de Verneuil, in the Lower Devonian at Brulon, Sarthe,

France (see 'Explication de la Carte Géologique de France,' Vol. 4, Atlas, pl. xv, figs. 1, 2). A specimen given to me by Mr. Ehlert is scarcely distinguishable from some of the Dudley-Wenlock specimens.

Very fine preparations of the spirals and their attachments, from the able hands of Mr. Glass, will be found figured in Pl. VI of this Supplement. Spirifers are not known to exist in our Lower-Silurian and Cambrian Rocks, the solitary example of the Spiriferid *Cyrtia trapezoidalis* excepted. They are also specifically few, but individuals abound in the Upper-Silurian and especially in the Wenlock formation.

A vast number of specimens of *Spirifera plicatella*, var. *radiata*, var. *interlineata*, and var. *globosa*, *Sp. sulcata*, *Sp. elevata*, and *Sp. crispa*, were obtained by Mr. G. Maw from the Wenlock Limestone and its shales in Shropshire. *Sp. crispa* and *Sp. elevata* were the most abundant forms. The only other British Silurian species of the genus, *Sp. bijugata*, M'Coy, has not been hitherto discovered in our English or Scottish rocks.

The spirals of *Sp. crispa* have been developed by the Rev. N. Glass, and a figure will be found in Pl. IV of this Supplement. *Sp. sulcata* is a beautiful and finely sculptured species, but apparently less abundant than the other forms above recorded.

Genus—MERISTA, *Suess*, 1851.

21. MERISTA? CYMBULA, *Dav.* Sil. Mon., Pl. XXII, figs. 28, 29; Sup., Pl. VIII, figs. 6 to 9.

Since describing this species at p. 204 of my 'Silurian Monograph,' Mrs. R. Gray has found larger and better preserved examples, as well as internal casts of the ventral valve, in the Upper Caradoc at Thraive and Drummuck in the Girvan Valley, Ayrshire. These Scottish specimens agree with those from the same formation that have been discovered at Hindre-Wen, Cerrig-y-Druuidion, and which we have already described and illustrated. It has not, however, been possible to determine the genus to which this small species should be referred, as we do not know whether it was provided or otherwise with internal spiral supports. We leave it therefore provisionally with *Merista*, from which it will probably have to be removed as soon as its interior characters shall have been determined. None of our Scottish examples, collected by Mrs. R. Gray, exceeded 4 lines in length by $3\frac{1}{2}$ lines in breadth.

The shell is marginally either nearly circular or slightly longitudinally oval, broadest and rounded anteriorly, tapering somewhat posteriorly; hinge-line very obtusely angular, and a little shorter than the breadth of the shell. Ventral valve deep and uniformly convex, beak proportionately rather large and incurved, no area nor foramen observable; dorsal valve slightly convex at its posterior lateral margins, concave along the middle and anteriorly; surface smooth.

In external shape this small species bears much general resemblance to *Koninckia Leonhardi* (Wissmann); and, if it is provided with spiral appendages, they may possibly be somewhat similarly arranged. Anyhow, thanks to Mrs. R. Gray's discovery of several perfect internal casts of the ventral valve, and of a specimen of the same valve with its interior well preserved, it has been possible to define some of its characters, which are exactly similar to those of the specimen from Cerrig-y-Druidion in Wales. The valve is possessed of a kind of shoe-lifter process, somewhat similar to what we find in *Merista* or *Camarium* of Hall. Unfortunately we know nothing with respect to the interior of the concave or dorsal valve. The fossil does not appear to be very rare at Drummuck, so that it is to be hoped that better examples will be collected, and thus to clear up the uncertainty as to the genus to which the species should be referred. See also p. 134.

Genus—STREPTIS, *Dav.*, 1881.

22. STREPTIS GRAYII (ATRYPA ?), *Dav.* Sil. Mon., Pl. XIII, figs. 14—22.

STREPTIS GRAYI, *Dav.* Geol. Mag., new ser., vol. viii, p. 150, pl. v, fig. 13, 1881.

The exterior characters of this puzzling little shell have been fully described and illustrated in p. 141 of my 'Silurian Monograph;' but I have never been able to feel satisfied with respect to its internal characters, so as to determine whether the shell was provided with calcareous lamellæ for the support of the labial appendages.

In 1846 I picked up two or three examples at Hayhead, near Walsall, and described and figured the fossil in 1848 under the name of *Terebratula Grayi*. In 1859 Salter (in 'Siluria') made of it a *Rhynchonella*; Lindström, in 1860, a *Spirigerina*?; and in my 'Silurian Monograph' I provisionally put it with *Atrypa*?, adding "My endeavours to procure specimens showing the internal characters have proved fruitless, and I cannot determine exactly the genus." As justly remarked by Prof. Hall, at p. 38 of 'The 16th Annual Report of the State Cabinet of Natural History of New York,' "So long as we remain unacquainted with the interior of the shell, we are compelled to refer the species to some genus having similar forms, though the fibrous or punctate structure may, in many instances, prove a valuable aid in these references."

Possessing, thanks to Mr. G. Maw's liberality, a number of good examples, I sent some of them to the Rev. N. Glass to operate upon, and after many experiments on perfectly preserved specimens, filled with spar and suitable to his operations, he informed me that he could in none of them detect the slightest trace of calcified supports, nor the trace of a loop or spiral, and he was of opinion that it could not be referred to any of the genera into which it had been provisionally located. I therefore, in 1881, proposed to place the fossil under a distinct genus, and selected the name *Streptis* (twisted), all the

specimens discovered having presented that character; and I added "no calcareous support for the labial appendages; cardinal process much produced; hinge-teeth large and prominent."

Mr. Whitfield writes me on the 22nd of March, 1881: "Your *Streptis Grayi* is a form you sent to Prof. Hall many years ago; at that time he handed them to me; I cut two individuals and found spirals similar to those of *Atrypa*." This statement would not, however, quite agree with what Prof. Hall wrote me at the time, and which will be found alluded to in a footnote on p. 141 of my 'Silurian Monograph.' He said in his letter that spirals had not been actually discovered but might ultimately be found, and Prof. Hall has since assured me that none had ever come to his notice. Further, experiments may determine the point at issue.

Streptis Grayi is not a very rare shell and can be readily obtained by washings from the Lower-Wenlock Shales at Buildwas in Shropshire. It occurs also in the Upper-Silurian Rocks of Bohemia, and has been figured by Mr. Barrande in vol. v, pl. 83, fig. 3, of his monumental work, 'Système Silurien du Centre de la Bohême,' 1879. None of the Swedish specimens of the species I have been able to examine showed any trace of spiral appendages.

Genus—EICHWALDIA, Billings, 1858.

23. EICHWALDIA CAPEWELLI, *Dav.* 'Sil. Mon., Pl. XXV, figs. 12—15; Sil. Sup., Pl. VIII, figs. 15, 16.

RHYNCHONELLA RETICULARIS?	<i>Hall.</i>	Trans. Alb. Inst., vol. iv, p. 217. Abstract, p. 23, May, 1863.
EICHWALDIA	— —	20th Report State Cabinet Nat. Hist., p. 275, 1867. 28th Annual Report, pl. xxvi, figs. 50—54, 1875.
—	CAPEWELLI, <i>Dav.</i>	Lindström; Fragmenta Silurica, p. 25, pl. 2, fig. 16—20, 1880.

At p. 193 of my 'Silurian Monograph' I described the external characters of this beautiful little shell, also some of its interior details.

I have always felt uncertain whether this shell was provided with any calcified supports for the labial appendages. In 1881 I placed in the hands of Mr. Glass a number of well-preserved specimens obtained by Mr. G. Maw from his washings of the Lower-Wenlock Shales of Buildwas, and after many trials Mr. Glass arrived at the conclusion that it had none.

Having received from Prof. Hall a number of well-preserved specimens of his *Eichwaldia reticulata* from the Niagara groups at Waldron, Indiana, I found that they

agreed in every respect with my previously described *E. Capewelli*; and at p. 170 of the 'Twenty-eighth Annual Report of the New York State Museum of Natural History,' he says, in his description of his species, "Surface of the shell, except a small space on the umbo of the ventral valve, covered by finely reticulate marking, with elongate, generally hexagonal pits or openings, with thin and sharp ridges between; these markings vary in different specimens, and also on different parts of the same individual, being generally finest on the cardinal slopes. The small, triangular space near the ventral beak, which is destitute of marking, has the appearance of having been exfoliated; but since this is an invariable character in all the individuals examined, varying in size with the size of the shell, it is probably dependent upon organic causes."

All the many English as well as foreign specimens of *E. Capewelli* I have examined presented the same smooth, triangular space at the ventral beak.

In his 'Fragmenta Silurica,' pl. 2, Professors Angelin and Lindström give several fine illustrations of the external and internal characters of *E. Capewelli* from Swedish specimens, and amongst them figures of the smooth, triangular space at the beak of the ventral valve. The characters of the interior surface of the beak are also shown, and one of their figures has been reproduced in Plate VIII, fig. 16, in order to help to the better understanding of the internal characters of this remarkable genus and species.

In the fifth vol., pl. 81, figs. 1, 2, 3, of his magnificent work on the 'Système Silurien du Centre de la Bohême,' 1879, Mr. Barrande figures three apparently distinct species of *Eichwaldia*, which, like *E. Capewelli*, show a small, smooth, or unsculptured part at the beak of the ventral valve. From his figures the characters of the sculpture differ in all three, and none of them seem identical with our *E. Capewelli*. It had been suggested to me that the appearance of the sculpture of the surface of *E. Capewelli* is precisely that of certain *Polyzoa* one is accustomed to meet with in Palæozoic rocks, a fact that had struck Mr. R. Etheridge, jun., as well as Prof. Nicholson; but to accept the ornamentation as that of an encrusting Polyzoon we must suppose that the shell had been entirely replaced by the parasite, as sometimes occurs with *Hydractinia*. Sections, however, show a perfectly homogeneous structure of the whole thickness of the shell.

Eichwaldia Capewelli occurs sparingly throughout the Wenlock series, but seems more abundant, as far as I can judge from the present state of our information, in the Lower-Wenlock Shales, but it is also not a very rare shell in the Wenlock Limestone of certain places.

Genus—TRIPLESIA, Hall, 1859.

At p. 197 of my 'Silurian Monograph' is a brief allusion to the history and characters of this genus, and I still entertain the opinion that TRIPLESIA should *not* be regarded as a

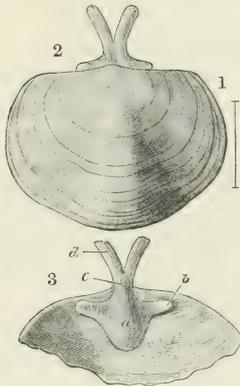
synonym of Billings' genus *CAMARELLA*. Hall's genus would apply to such shells as *Triplesia extans*, Emmons, sp.; *T. Ortoni*, Meek, sp.; *T. insularis*, Eichwald, sp.; and *T. Wenlockiensis*, Dav.; while *Camarella* is by Billings typified by such shells as *C. longirostris* and *C. varians* of Billings. I am therefore unable to concur in the opinion expressed by Mr. S. A. Miller in his valuable Catalogue of the Genera and Species of the American Palæozoic Fossils (1877), namely, that *Triplesia* is a synonym of *Camarella*, nor can I admit that the numerous species he classes under *Camarella* all belong to that genus.

Neither Hall nor Billings has sufficiently defined the characters of the genera they have established, nor have they described the internal characters; thus much confusion has prevailed with respect to their true generic value.

Triplesia does not appear to have had spiral supports for the labial appendages. In my 'Silurian Monograph' I followed M'Coy, Phillips, Salter, and others, while erroneously describing the *Ter. insularis* of Eichwald as a species of *Orthis*. Since then, the finding of well-preserved internal casts and isolated valves enables me to refer that species to Hall's *Triplesia*. Thanks to the kindness of Mr. Whitfield, I have also been able to examine typical examples of *T. extans* and *T. Ortoni*. The cardinal process in the last-named form is very remarkable. It is more or less developed in different species of the genus. In *T. Ortoni* it is unusually large, measuring about one third of the length of the dorsal valve; it is much thickened and rounded at and near its base (*a*), with a projection at each of its lateral extremities (*b*); the stem of the process (*c*) is nearly cylindrical, about a line and a half in length, when it bifurcates and forms two smaller diverging branches, each of which measures about one line in breadth by one and a half in length (*d*). In *T. Ortoni* the cardinal process seems nearly vertical, or on nearly the same plane as that of the valve, extending beyond the umbo about three lines, the bifurcating branches sloping inwards to some small extent.

I am informed by Mr. Whitfield that in *T. extans* the cardinal process is the same, but more slender and somewhat smaller. In all the specimens of *T. insularis* that have come under my notice the cardinal process was broken or incomplete, but was evidently relatively smaller than in *T. Ortoni*. The interior markings in *T. insularis* are very remarkable, and will be noticed a little further on in the description of that species.

Among our British species *T. insularis* and *T. Wenlockiensis* are evidently referable to Hall's *Triplesia*. The *Triplesia* (? *Atrypa*) *incerta*, Dav., *T.* (? *Atrypa*) *apiculata*, Salter,



Triplesia Ortoni, Meek, sp.
1. Dorsal valve: 1, net length; 2, enlarged.
c. Cardinal process projecting beyond umbo. 3. Interior of dorsal valve showing cardinal process; enlarged.

T. (?) Grayæ, Dav., and *T. (?) Orthis spiriferoides*, M'Coy, are provisionally referred to *Triplesia*, as some uncertainty still prevails with respect to their generic characters.

In true *Triplesia* the fold occurs on the dorsal valve, the sinus in the ventral one, while it is the reverse in *T. (?) incerta* and *T. (?) apiculata*; and other differences are also observable, and which may perhaps necessitate their removal from Hall's genus. The interior of these dorsal valves should be sought for.

24. TRIPLESIA INSULARIS, *d' Eichenwald*. Dav., Sil. Mon., Pl. XXXVII, figs. 8—15; Sil. Sup., Pl. VIII, figs. 17 to 22.

At p. 273 of my 'Silurian Monograph' I described the external characters of this species as an *Orthis*, being at that period unacquainted with its interior arrangements. Since then Dr. C. Callaway has been so fortunate as to discover at Ty-Isaf, in Wales, an almost perfect interior of the dorsal valve, and has suggested to me that its generic position would be with *Triplesia*. Some good internal casts were also procured by Mr. Parrott from the Caradoc or Bala Shales of Cerrig Coedog, south-east of Moel Ferna, Corwen, Merionethshire, as well as by Professor T. McKenny Hughes from the Lower Llandovery at Llettychydod, Llandovery, and these will enable me to describe and figure the interior of the dorsal valve. *Triplesia insularis* was also found by Mr. Robert Philip in the Upper Llandovery at Minsterley, in Shropshire, in company with *Pentamerus oblongus*, *P. rotundatus*, *P. undatus*, and a number of other species that are common to the Llandovery Rocks. No Wenlock Shales occur in the locality.

In the interior of the dorsal valve there exists, close under the incurved umbonal beak, a small projecting cylindrical cardinal process, broken at its extremity, so that it is impossible to say whether or not when perfect it presented two deviating branches, as in the American *Triplesia Ortoni* and *T. extans*.

At a little distance from the anterior portion of the cardinal process, and at a slightly lower level, are two small projecting tooth-like projections, these and the cardinal process leaving their corresponding holes or cavities in the internal cast. Under these three projecting processes there exists a wide **W**-shaped convex or swollen space, which at half its length is divided by a deep depression, furrowed by a narrow median indented line, bordered by wide protecting ridges. The quadruple adductor muscular impressions are arranged in pairs, and occupy the central part of the bottom of the valve. In the internal cast the convex space above described forms circular depressions, laterally bordered by projecting margins.

The ventral valve has a triangular area with a median fissure arched over by a pseudo-teldidium, leaving a small open space close to the hinge-line for the passage of a peduncle.

25. *TRIPLESIA WENLOCKIENSIS*, Dav. Sil. Sup., Pl. VIII, fig. 23.

Shell small, transversely oval; dorsal more convex or deep than the ventral valve, with a prominent angular fold commencing at about half the length of the valve and widening as it nears the front; ventral valve convex, with a deep, wide, angular sinus, also commencing at about half the length of the valve; beak prominent, slightly incurved; area triangular, fissure arched over by a narrow deltidium; surface smooth; interior not known.

Length $3\frac{1}{2}$, breadth 4 lines.

Obs.—Dr. Callaway informs me that he found one specimen only of this species at Wenlock, in Shropshire. It is, however, somewhat remarkable that out of upwards of fifty or sixty thousand specimens of Brachiopoda obtained by Mr. George Maw from his extensive washings of Wenlock Shales in Shropshire, as well as from his many hand-pickings from the old Wenlock Quarries, not a single specimen of this *Triplesia* was discovered. I consequently give its position on Dr. Callaway's authority, and it is very desirable that the locality should be searched for more specimens.

Triplesia is usually found in rocks a little older than the Wenlock, but Dr. Hinde assures me that he procured a specimen of a species nearly related to *Triplesia insularis* from a rock of Wenlock age in the Island of Anticosti (Canada).

26. *TRIPLESIA GRAYÆ*, Dav. Sil. Mon., Pl. XXIV, figs. 31—32; Pl. XXV, figs. 9—11; and Sil. Sup., Pl. VIII, fig. 32.

The exterior of this remarkable species was fully described at p. 198 of my 'Silurian Monograph.' Mrs. R. Gray informs me that notwithstanding the most diligent search, not more than half a dozen complete specimens had previously been found in the Girvan district. A few bivalve examples had been collected at Craighead, and detached valves in the Balclutchie conglomerate in Strata of Upper Llandeilo age.

No specimens showing the interior of the valves nor any internal casts have yet been discovered. They should be sought for in the localities where the shell occurs.

27. *TRIPLESIA* (?) *APICULATA*, *Salter and Forbes*, sp. *Dav.*, *Sil. Mon.*, Pl. XXV, fig. 6.

ATRYPA? *APICULATA*, *Salter*. *Dav. Sil. Mon.*, p. 202, 1869.

In my 'Silurian Monograph' I placed this small shell with much uncertainty in the genus *Atrypa*. It is evidently not a spiral-bearing Brachiopod, and may possibly be a form of *Triplesia*. I regret not to have been able to examine more specimens, and am unacquainted with its internal arrangements.

28. *TRIPLESIA* (?) *INCERTA*, *Dav.* *Sil. Mon.*, Pl. XXIV, fig. 30; Pl. XXV, figs. 7 and 8; and *Sil. Sup.*, Pl. VIII, figs. 24 to 29.

ATRYPA? *INCERTA*, *Dav.* *Sil. Mon.*, p. 203, 1869.

When describing this species at p. 203 of my 'Silurian Monograph' I was acquainted with the exterior only of the ventral valve. Since then Mrs. R. Gray and Dr. Callaway have collected numerous specimens of the shell, some with both valves, which will enable me now to complete its description, as well as to give figures of the interior of the ventral valve.

In external shape the shell is marginally obscurely subpentagonal, and about as wide as long; ventral valve deeper than the dorsal one, very convex, with or without a more or less developed mesial fold; beak either nearly straight or moderately incurved; area large, triangular, with a wide fissure arched over by a roof-shaped deltidium, divided along the middle by a narrow convex ridge; the area measures two or three lines in width, the extremity of the beak sometimes tapering to an acute, narrow, and slightly twisted termination; dorsal valve convex at the umbo and lateral portions of the valve, becoming gradually concave at a short distance from the umbo, and widening and deepening as it nears the front. In the interior of the ventral valve the beak is, in some specimens, much thickened, and more or less hollowed out in others. Two small converging dental plates, in a specimen excavated by Mr. John Young, extend to the end of the beak, when they diverge and continue to a short distance along the bottom of the valve; two pairs of muscular impressions, longitudinally parallel to each other and separated by a short median groove, occupy a portion of the rostral portion of the interior of the valve, and do not measure more than about two lines in length. We unfortunately know nothing of the interior of the dorsal valve. The shell was in all probability not provided with calcified lamellæ for the support of the labial appendages. It is not a

very rare fossil in the Upper Llandoverly at Cuddystone Glen, and at Penkil, in Ayrshire, where interiors or internal casts of the dorsal valve should be sought for.

Examples collected by Mrs. Gray measured 11 lines in length by $11\frac{1}{2}$ in breadth. It does not appear to have much exceeded those proportions, and usually does not attain them. It differs notably from typical species of *Triplesia* in having a mesial sinus in the dorsal valve and a fold in the ventral one. It is provisionally classed with *Triplesia*.

29. TRIPLESIA (?) SPIRIFEROIDES, *M' Coy*, sp. Dav. Sil. Mon., Pl. XXXVII, figs. 3—7; Sil. Sup., Pl. VIII, fig. 30.

ORTHIS SPIRIFEROIDES (M'COY), *Dav.* Sil. Mon., p. 275, 1871.

When describing this important and well-marked species at p. 275 of my 'Silurian Monograph' I said, "I feel greatly puzzled as to the genus to which this abnormal form should be referred. It is certainly neither a *Strophomena* nor a *Leptaena*, and I question very much if it be an *Orthis*." In external shape it does not differ so very much from *Spirifera*, but as not a trace of spirally-coiled lamellæ has ever been discovered in it, I presume it had none. Dr. Callaway is of the opinion that it should be classed with *Triplesia*, but of this I am not yet entirely satisfied, as some of its internal characters seem to differ from those observable in the interior of *Triplesia extans*, *Ortoni*, and *insularis*. In Pl. XXXVII of my 'Silurian Monograph' I have, I believe, fully illustrated all the characters belonging to the species, and nothing I have since seen has thrown additional light upon the subject. I add a figure of a finely-preserved internal cast of the dorsal valve from a specimen found by Mrs. Gray in the Upper Llandeilo at Ardmillan Brae, Girvan, Ayrshire. This species has been obtained also by the same lady in the Upper Caradoc at Thraive in the same county.

Mr. D. C. Davies informs me that *Triplesia* (?) *spiriferoides* occupies in North Wales a well-defined horizon in the Bala or Caradoc Limestone. At 120 feet below the summit of this limestone, or rather more than half the way from its base, it constitutes a bed about one foot thick, which is made up almost entirely of casts and impressions of this species mixed with fragments of Trilobites and Corals. This arrangement prevails over a large portion of North Wales, and he does not think that it occurs in any degree of abundance above this horizon.

Dr. Callaway believes to have found in the Lower Caradoc, at Green Wood, Salop, a variety of *T. spiriferoides*, or a distinct species resembling it, with numerous small ribs crossed with fine equidistant concentric ridges or lines of growth. The specimens he has found are not sufficiently complete to warrant us describing it as new.

30. TRIPLESIA (?) MONILIFERA, *M' Coy*, sp. Sil. Mon., Pl. XXV, figs. 3—5; Sil. Sup., Pl. VIII, fig. 31.

A specimen of this small species has been found by Mrs. R. Gray in the Middle Llandovery at Woodland Point, Girvan, Ayrshire, and is the first Scottish specimen hitherto discovered. We unfortunately know nothing as to its internal characters, nor of those belonging to the *Triplesia? Maccoyana*, Dav., sp.

Genus—LEPTOCÆLIA, *Hall*, 1857.

(*Etym.*, *leptos*, slight; *koiia*, belly; in allusion to the shallow visceral cavity.)

31. LEPTOCÆLIA HEMISPHERICA, *J. de C. Sow.*, sp. Dav. Sil. Mon., Pl. XIII, figs 23—30.

In p. 136 of my 'Silurian Monograph' I left this species with much uncertainty with *Atrypa*, where Sowerby had classed it in 1839. It is fully described in my Monograph; and, as all the researches I have made to discover in it spiral appendages have led to no result, I think it will be preferable to class the shell with *Leptocælia*. It is a very common fossil in certain rocks and localities. It occurs generally in the condition of internal casts, and is plentiful in rocks of the Llandovery period at Penkill, and Newlands, in Ayrshire. Complete examples with the shell are extremely rare in our Scottish Silurian rocks. See also above, p. 133.

Genus—RHYNCHONELLA, *Fischer*, 1809.

(See also above, p. 134.)

Since describing the species referable to this genus at p. 163 of my 'Silurian Monograph,' several new forms have been discovered, especially from the Upper Llandeilo of Scotland. Better material has also been obtained of a few of the described species, which will enable us to add some details to those already published. Of some of the species the material has not been sufficiently perfect or abundant to enable me to feel quite certain as to their distinctive character, but I have thought it preferable to give them provisional names, in the hope that more specimens will be sought for.

A table is here appended showing the range of the British Silurian species of the

genus with which we are at present acquainted, but it is highly probable that when better understood the number of so-called species will have to be reduced.

* The species so marked have been found in Scotland.		Ludlow.	Wenlock.	Llandoverly.	Caradoc.	Llandello.
*	<i>Rhynchonella nucula</i> , <i>Sow.</i>	×	×	×	?	?
*	— <i>Wilsoni</i> , <i>Sow.</i>	×	×	?	?	?
	<i>var. Davidsoni</i> , <i>M'Coy</i> .....	×	×	...	...	...
	— <i>neglecta</i> , <i>Sow.</i> .....	...	...	×	...	...
*	— <i>borealis</i> , <i>Schl.</i> .....	×	×	×	...	...
*	— <i>sub-borealis</i> , <i>Dav.</i> .....	...	...	...	...	×
	— <i>decemplicata</i> , <i>Sow.</i> .....	...	...	×	...	...
*	— <i>Llandoveriana</i> , <i>Dav.</i> .....	...	...	?	...	...
	— <i>Lewisii</i> , <i>Dav.</i> .....	...	×	×	...	...
*	— <i>Weaveri</i> , <i>Salter</i> .....	...	...	×	...	×
	— <i>tripartita</i> , <i>Sow.</i> .....	...	...	×	×	...
	— <i>cuneata</i> , <i>Dal.</i> .....	...	×	×	?	?
*	— <i>Thomsoni</i> , <i>Dav.</i> .....	...	...	...	...	×
*	— <i>Dayi</i> , <i>Dav.</i> .....	...	×	...	...	...
*	— ? <i>Pentlandica</i> , <i>Haswell</i> .....	×	...	...	...	...
*	— <i>Salteri</i> , <i>Dav.</i> .....	...	...	...	×	×
*	— <i>cemula</i> , <i>Salter</i> .....	...	...	...	×	×
*	— <i>nasuta</i> , <i>M'Coy</i> .....	...	...	...	...	×
	— <i>Beltiana</i> , <i>Dav.</i> .....	...	×	...	...	...
*	— <i>Portlockiana</i> , <i>Dav.</i> .....	...	...	...	×	×
	— <i>Edgelliana</i> , <i>Dav.</i> .....	...	...	...	...	×
	— <i>nana</i> , <i>Salter</i> .....	...	...	...	×	...
	— <i>diodonta</i> , <i>Dal.</i> .....	...	×	...	...	...
	— <i>bidentata</i> , <i>Sow.</i> .....	...	×	...	...	...
*	— <i>Balcletchiensis</i> , <i>Dav.</i> .....	...	...	...	...	×
*	— <i>Lapworthi</i> , <i>Dav.</i> .....	...	...	...	...	×
	— <i>Callawayana</i> , <i>Dav.</i> .....	...	×	...	...	...
	— <i>Glassii</i> , <i>Dav.</i> = <i>Atr. depressa</i> , <i>Sow.</i> .....	...	×	...	...	...
*	— <i>Shallockiensis</i> , <i>Dav.</i> .....	...	...	...	...	×
*	— <i>Girvaniensis</i> , <i>Dav.</i> .....	...	...	...	...	×
	— <i>deflexa</i> , <i>Sow.</i> .....	...	×	...	...	...
*	— <i>Jackii</i> , <i>Dav.</i> .....	...	...	...	×	...
*	— <i>Maccoyana</i> , <i>Dav.</i> .....	...	...	...	×	...
	— <i>Stricklandii</i> , <i>Sow.</i> .....	...	×	...	...	...

32. RHYNCHONELLA BOREALIS, *Schloth.*, sp. *Dav.*, *Sil. Mon.*, Pl. XXI, figs. 14—27;
Sil. Sup., Pl. X, figs. 25, 25a.

The careful and prolonged hand-pickings from the detritus of the old Wenlock Limestone Quarries of Benthall Edge, Lincoln Hill, and Wenlock, as well as the extensive Wenlock Clay washings carried out by Mr. G. Maw in Shropshire, have brought to hand a very large number of specimens of *R. borealis*, showing all its modifications in shape and stages of growth. These have enabled me to ascertain beyond doubt that its young

and adult conditions are essentially different from those of *Rh. (Ter.) bidentata*, Hisinger, as well as from those of *Rh. (Ter.) diodonta* of Dalman. The two last-named species therefore require to be removed from the synonyms of *Rh. borealis* given at p. 174 of my 'Silurian Monograph.' Salter was evidently unacquainted with the true young stages of Schlotheim's species when he wrote that the shell was conspicuous, even in the young state, by the two raised dorsal ribs and the deep furrow in the ventral valve with its single rib; and I was myself, at that period, not well acquainted with the young of the shell under description, although I did not fail to say, "I am not certain whether *T. bidentata* of Dalman (not of Sowerby) may be a distinct species or not, and therefore must leave this as an open question."

Mr. Maw's operations having placed into my hands so many specimens of the true *Rh. bidentata* of Hisinger and Dalman, I found that this last-named shell was always a small, sharply-marked species, both in the young and the adult condition, our specimens agreeing in every respect with those from Sweden described and figured by both Hisinger and Dalman.

Rhynchonella diodonta is a larger shell than is the true *Rh. bidentata*, with a very deep sinus and larger number of ribs. It is true that some adult examples of *Rh. borealis* have but two ribs on the mesial fold, but that is the exception, and they do not show the deep sinus so characteristic of either *Rh. diodonta* or *Rh. bidentata*. *Rhynchonella crispata* and *R. lacunosa*, Sow. ('Sil. Syst. '), are certainly synonyms of *Rh. borealis*, and the species is correctly described at p. 175 of my 'Silurian Monograph.' It is a large shell, at times exceeding an inch in length and more in breadth; it varies also very much in shape, as well as in the number and size of its ribs. The young is marginally triangular, depressed, the valves being very slightly convex and the fold and sinus scarcely defined; the ribs on the fold are sometimes bifurcate, as may be seen in 'Sup.,' Pl. X, fig. 25. With age the valves become much more convex, and the fold and sinus well developed. Mr. Salter quotes *Rh. borealis* from the Llandovery Rocks of Saugh Hill, Girvan, Ayrshire, where it is associated with *Pentamerus oblongus*, *Leptocelia hemispharica*, and other species belonging to that period.

33. RHYNCHONELLA SUB-BOREALIS, *Dav.* Sil. Sup., Pl. X, figs. 5, 6.

Shell marginally transversely oval, wider than long; dorsal valve very convex, longitudinally divided into three almost equal portions; fold with three angular ribs, of which the central one is usually the smallest and least elevated; lateral slopes of the fold wide and flat; lateral portions of the valves marked by about seven strong angular ribs, with a tendency here and there to bifurcate as they approach their marginal extremities; hinge-line long and nearly straight; ventral valve convex; mesial sinus deep and broad,

with two or three ribs, and five or six strong ones on each side of the lateral portions of the valve; beak moderately incurved, leaving between the beak, ridges, and the hinge-line a well-defined narrow area; foramen circular, and situated under the extremity of the beak.

Length 7, width 9, depth 7 lines.

Obs.—For a long time I felt undecided whether this *Rhynchonella* was more than a variety of *R. borealis*, to which it is closely allied. It differs, however, from Schlotheim's species in being more transversely oval, and especially by its long and nearly straight hinge-line and area.

Rh. sub-borealis was found by Mrs. R. Gray in the Upper Llandeilo at Craighead, Girvan, Ayrshire. *Rh. borealis* proper is an Upper-Silurian fossil.

34. RHYNCHONELLA BIDENTATA, *Hisinger*, sp. Dav., Sil. Mon., Pl. XXI. fig. 22; Sil. Sup., Pl. X, fig. 3, 3 a, b.

TEREBRATULA BIDENTATA, *His.* Vet. Acad. Hand., p. 323, tab. viii, fig. 5, 1826.
Anteckningar Physik och Geognosi, vol. iv, tab. vii, fig. 5, 1828.

— — *Dalman.* Vet. Acad. Handl., p. 142, tab. vi, fig. 5, 1828.

— — *Hisinger.* Icon. Petref. Svec., tab. xxiii, fig. 7, 1837.

— BOREALIS, *Quenstedt.* Handbuch der Petrefactenkunde, p. 35, fig. 36 a, b, 1851.

— — VAR. INDENTATA, *Dav.* Sil. Mon., p. 174, pl. xxi, fig. 22, 1866.

Shell small, sub-pentagonal, wider than long; dorsal valve convex, with eight strong radiating ribs, of which the two central ones are close together; fold large, slopes wide and flat; the fold occupies one third of the breadth of the shell; three large ribs on each of the lateral portions of the valve; ventral valve moderately convex, sinus large and deep, divided longitudinally by a narrow rib; surface of the valves and ribs intersected by numerous equidistant, scabrose, concentric, projecting ridges; beak tapering, very slightly incurved, with a circular foramen under, or slightly truncating the extremity of the beak, and separated from the hinge-line by a small deltidium.

A large specimen measured: length 4, width $4\frac{1}{2}$, depth 3 lines; but most specimens do not exceed $2\frac{1}{2}$ lines in length by 3 in width and $\frac{1}{2}$ in depth.

Obs.—This is apparently always a very small shell, never attaining anything like the dimensions of either *Rh. borealis* or *sub-borealis*, or *R. diodonta*. *Hisinger* and *Dalman*'s descriptions and figures of this shell agree in every respect with the specimens we find in England. "Terebratula pusilla testa triangulari, apice rotundata, radiatim plicata, lævi; valvæ majoris sinu unicastato apice bifido; in Gottlandia ad Djupviken"

(Hisinger). At all ages it presents the same appearance, and is a well-marked species. It occurs in the Lower Ludlow, but is more plentiful in the Upper-Wenlock Shales of Shropshire, where many examples were procured by Mr. G. Maw from his washings of Wenlock Shales from under Benthall Edge, and from above Tickwood and Farnley Dingle. It occurs also in the Wenlock Limestone at Dudley, and in Wenlock Shales at Falfield near Totworth. It is a most beautifully sculptured shell.

It is probable that Sowerby's *Ter. bidentata* ('Sil. Sys.,' pl. xiii, fig. 13 a) has been drawn from a large example of Hisinger's *T. bidentata*, but of this I am not certain. In most specimens of the shell the two median ribs in the dorsal valve come very close to each other. The small shell figured by Quenstedt in pl. xxxv of his 'Petrefactenkunde' is certainly Hisinger's *T. bidentata*, and not a young *Rh. borealis*.

35. RHYNCHONELLA DIODONTA, *Dalman*, sp. Dav., Sil. Sup., Pl. X, fig. 4.

TEREBRATULA DIODONTA, *Dalman*. Vet. Akad. Handl., p. 142, pl. vi, fig. 4, 1828.

— — — *Hisinger*. Icon. Petref. Svec., p. 81, pl. xxiii, fig. 6, 1837.

In external shape and general appearance this species (?) much approaches to that of *Rh. bidentata*, of which some Palæontologists would consider it to be the adult. At one time I was myself inclined to follow in the same view, but after having had so many specimens of the true *Rh. bidentata* under examination, I began to doubt the propriety of considering it the same as Hisinger's species.

Dalman describes his shell:—"T. testa radiatim profunde plicato-sulcata, sulcis transversim undulato-striatis; valvæ majoris sinu profundo, unicostato, apice incumbente, bifido."

It measures: length 6, width 7, depth 4 lines, and is consequently very much larger than the largest specimens of *Rh. bidentata* that have come to my notice. Then it has five ribs on each lateral portion of its valves, instead of the three comparatively larger ones in *Rh. bidentata*.

Rh. diodonta occurs in the Wenlock Shales near Dudley, and in other places; and is quoted by Dalman and Hisinger from the Upper Silurian of Gothland and Klinteberg.

36. RHYNCHONELLA DECEMPPLICATA, *Sow.* Dav., Sil. Mon., Pl. XXIII, figs. 20—24, Sup., Pl. XI, fig. 27.

This is another small form, distinct though allied to *Rh. bidentata* and *Rh. diodonta*. It is well described and figured at p. 177 of my 'Silurian Monograph.' It has two large

median ribs on the fold, but differs from the two species above named by having a larger number of smaller ribs on the lateral portions of its valves. It occurs in the Llandoverly or May-Hill Sandstone.

37. *RHYNCHONELLA DAYI*, *Dav.* Sil. Sup., Pl. X, figs. 2, 2 *a b*.

RHYNCHONELLA DAYI, *Dav.* The Geol. Mag., New Ser., vol. viii, p. 151, pl. v, fig. 9, 1881.

Obtusely deltoid or sub-pentagonal, wider than long; valves moderately convex, and divided into three almost equal lobes. Ventral valve not quite as deep as the dorsal one, divided by a broad, well-defined, mesial sinus; beak small, showing a small, circular foramen margined by a deltidium; surface of valves ornamented with some fourteen or sixteen angular ribs, of which four form a well-defined mesial fold, the ribs being slightly bent upwards at the front; lateral margins of fold wide and flat.

Length $5\frac{1}{2}$, width 6, depth $3\frac{1}{2}$ lines.

Obs.—This small species is well distinguished from young specimens of *Rh. borealis* of the same age, with which it has been sometimes confounded, by its less triangular shape, as well as by the ribs of its fold being bent upwards close to the frontal extremity. In size and in number of ribs, *Rh. Dayi* somewhat resembles small examples of the Jurassic *Rh. tetraëdra*.

This small species was found by Mr. George Maw in the Wenlock Limestone of Benthall Edge, as well as in the Wenlock Shales underlying the limestone. I have had much pleasure in naming it after the Rev. H. Day.

38. *RHYNCHONELLA CUNEATA*, *Dalman* and *Hisinger.* *Dav.*, Sil. Mon., Pl. XXI, figs. 7—11; Sil. Sup., Pl. X, figs. 9, 9 *a*, 10, 10 *a*.

Since describing this species at p. 164 of my 'Silurian Monograph,' Prof. James Hall has, at p. 166 of the 'Twenty-eighth Annual Report of the New York State Museum of Natural History' (1879), proposed a new genus, *RHYNCHOTRETA*, for the reception of Dalman's species. Prof. Hall characterises his new genus as follows:—"Shell triangular, surface with angular plications. Ventral beak straight, produced beyond the dorsal beak, extremity perforate, the foramen with an elevated margin; space between the foramen and hinge-line occupied by a deltidium in two pieces, being divided by a longitudinal suture,

and transversely striated. Valves articulated by two slender curving teeth, proceeding from a broad curving hinge-plate in the ventral valve, which fit into corresponding sockets in the dorsal valve. Crura rising from near the dorsal beak, and curving into the ventral cavity, and thence recurved towards the dorsal side, and probably uniting, as shown in fig. 4, p. 167 (of his work). Structure fibrous and apparently very minutely punctate."

From the above and what follows it is evident that Prof. Hall has not seen the short Terebratula-shaped loop represented in his restored figure No. 4, for he says in his description "and probably uniting, as shown in fig. 4," and in the explanation of his figure 4 he adds, "the additional features of the loop represented in this fig. 4 have not yet been satisfactorily determined."

In order, if possible, to ascertain the internal characters of this species, I asked the Rev. Norman Glass to develop the interior of some specimens of *Rh. cuneata*; and, having experimented on a number of them from the Wenlock Limestone of Benthall Edge, he found that all of them showed only two curved lamellæ rising from the hinge-plate and not attaining a third of the length of the valve (as in *Rhynchonella*); and in no instance did Mr. Glass see any indication of a loop.

I would, therefore, leave Dalman's species with *Rhynchonella* until, on positive evidence, it can be shown to be generically separable. The beak in *Rh. cuneata* is more or less elongated and attenuate; its extremity is truncated by a circular foramen more or less separated from the hinge-line by a deltidium.

In the interior of the dorsal valve of a specimen of *Rh. cuneata* from the Upper Llandovery of Speakes Rough, in Shropshire, or rather in an impression of the interior taken in gutta-percha from an internal cast (Sup., Pl. X, fig. 10 a), we find along the bottom of the valve, from under the hinge-plate to two thirds of its length, a narrow mesial septum. The cardinal process is small; and on either side the hinge-plate presents two slightly concave pear-shaped plates.

Rh. cuneata occurs plentifully in the Upper-Silurian rocks of England and Sweden, and in the Upper Llandovery of the neighbourhood of Minsterley. It has also been found by Mrs. R. Gray in a brown ferruginous gritty sandstone of Middle Llandovery age at Newlands, in the Girvan district of Ayrshire, also in the Lower Llandovery at Mullock Hill, in the same county.

According to Mr. Salter, it occurs likewise in a yellow sandstone at Lower Thraive, in Ayrshire, in a rock attributed by Prof. Lapworth to the Upper Caradoc. Specimens also that cannot be satisfactorily distinguished from *Rh. cuneata* have been founded by Mrs. R. Gray in the Upper Llandeilo of Craighead, Balclatchie, and Ardmillan Brae, Ayrshire; but this point will require further confirmation.

From the above it appears that this species, with slight variations in shape, was represented from the Caradoc (?) to the Wenlock or even the Ludlow period.

39. RHYNCHONELLA LAPWORTHI, *Dav.* Sil. Mon., Pl. X, fig. 7.

Shell triangular, broadest and rounded anteriorly, tapering posteriorly, slightly wider than long; ventral valve moderately convex, with a wide, shallow sinus; beak incurved, flattened laterally; dorsal valve rather more convex than the ventral one, slightly flattened along the middle, posterior margins bent inwards, somewhat abruptly on each side of the umbo; fold very slightly defined. Surface of valves ornamented with about fourteen strong angular ribs, of which four or five compose the fold, three or four the sinus.

Length 6, width 7, depth 5 lines.

Obs.—Of this species Mrs. R. Gray collected six specimens of about the same size and character from the Upper Llandeilo Limestone at Craighead, in Ayrshire. They are easily distinguishable from *R. cuneata* by their beak, which is incurved and not straight, as in the last-named species.

40. RHYNCHONELLA, sp. ? Sil. Sup., Pl. X, figs. 8, 8 a.

Two single dorsal valves of a *Rhynchonella* not sufficiently complete for specific identification were found by Mrs. R. Gray in the Upper Llandeilo or Balcletchie Conglomerate at Balcletchie, in Ayrshire; and of these I have given a figure in order that better and more complete examples may be sought for, so as to permit of a more complete identification.

41. RHYNCHONELLA SHALLOCKIENSIS, *Dav.* Sil. Sup., Pl. X, figs. 19, 19 a.

Marginally sub-pentagonal, slightly broader than long; dorsal valve very gently convex and much flattened; surface ornamented with about nine strong ribs, with interspaces of about equal breadth, three of these ribs forming a scarcely raised fold; ventral valve moderately convex; beak incurved.

Length 3, width 4, depth 2 lines.

Obs.—Of this species Mrs. R. Gray obtained one perfect specimen from the Upper Llandeilo at Shallock Hill, Girvan, Ayrshire. It is so different from the other *Rhynchonellæ* which we meet with in our Silurian rocks that I have ventured to give it a specific name.

42. *RHYNCHONELLA GIRVANIENSIS*, *Dav.* Sil. Sup., Pl. X, figs. 26, 26 a.

Shell almost circular or as wide as long; dorsal valve convex and ornamented with about thirteen angular ribs, of which the three largest form the mesial fold.

Length 3 lines by a little more in breadth.

Obs.—Of this small species Mrs. R. Gray unfortunately found only one dorsal valve in the Upper Llandeilo or Balcletchie Conglomerate of Balcletchie, in Ayrshire. It somewhat approaches to *Rh. nucula*. I have given it a name for reference, as all the species from the Upper Llandeilo are important to recognise.

43. *RHYNCHONELLA GLASSII*, *Dav.* Sil. Mon., Pl. XII, figs. 11—15; and Pl. XIII, fig. 6; Sup., Pl. X, figs. 22, 22 a.

ATRYPA DEPRESSA, *Sow.* Sil. Syst., p. 629, pl. xiii, fig. 6, 1839.

RHYNCHONELLA DEPRESSA, *Morris.* Catal. Brit. Foss., 2nd edit., p. 146, 1854.

ATHYRIS ? (RHYNCHONELLA), *Salter.* Siluria, p. 524, pl. xxii, fig. 17, 1859.

— — *Dav.* Sil. Mon., p. 123, pl. xii, figs. 11—15, and pl. xiii, fig. 6, 1866.

Morris, Salter, and M'Coy were correct when they referred the so-called *Atrypa depressa*, *Sow.*, to *Rhynchonella*, but they were not acquainted with its interior, and I myself felt very uncertain as to the genus to which Sowerby's shell should be referred. Having received some typical examples from the Woolhope Limestone and road between Alfrick and Crew Hill, Malvern, the Rev. N. Glass was able to develop their interiors, and to clear away all uncertainty as to the generic position of the shell, for it has the two short curved lamellæ of the genus *Rhynchonella*, as may be seen from the figure, drawn from one of Mr. Glass's worked specimens, in Pl. X, fig. 22 a.

As Sowerby had in 1825 applied the name *depressa* to a Cretaceous *Rhynchonella* ('Min. Con.,' vol. v, p. 165, tab. 502), we are compelled to give a new name to the Silurian form, and could not find a more appropriate one than that of *Glassii*, as the Rev. N. Glass was the first to show that the shell was possessed of the internal characters of the genus *Rhynchonella*. See also above, page 134.

44. *RHYNCHONELLA DEFLEXA*, *Sow.*, sp. *Dav.*, *Sil. Mon.*, Pl. XXII, figs. 24—27, and *Sil. Sup.*, Pl. X, fig. 23.

Since publishing my description of Sowerby's *Terebratulæ deflexa*, at p. 178 of my 'Silurian Monograph,' the Rev. N. Glass has developed for me the interior of a typical specimen which shows that it possessed the two short curved lamellæ of the genus *Rhynchonella*.

45. *RHYNCHONELLA WILSONI*, *Dav.* *Sil. Mon.*, Pl. XXIII, figs. 1—9.

This variable and important species has been fully described and illustrated at p. 167, and Pl. XXIII of my 'Silurian Monograph.' Since then, at p. 193 of his "Die Brachiopoden" ('Petrefactenkunde Deutschlands,' 1871), Professor Quenstedt proposed to create a new genus, *WILSONIA*, for *Rh. Wilsoni* and similar species. Again, in the magnificent volume of plates for the 'Explications de la carte géologique de France,' vol. iv, Atlas, 1878, Professor Bayle gives the generic name *UNCINULUS* to *Rh. Wilsoni*, *sub-Wilsoniani*, *Ehlerti*, *imperator*, &c., but does not describe or state on what characters he founds his genus. At p. 690 of his 'Handbuch der Paläontologie,' Professor Zittel refers to Quenstedt's genus *WILSONIA*, adding Bayle's generic name as a synonym, but does not admit either, and retains the old name *Rhynchonella*. Mr. Ehlert informs me also that Bayle has stated to him that the deep, excavated, muscular depressions in the ventral valve was one of the principal characters that urged him and Quenstedt to propose a distinct genus for the reception of *Rh. Wilsoni* and other similarly characterised species. I am not, however, quite satisfied that the greater or lesser excavation of the muscular area would be sufficient to warrant the creation of a new genus for such shells as *Rh. Wilsoni*, *Rh. sub-Wilsoniani*, &c., nor have the proposers of the genera described its characters.

In the 'Annals and Magazine of Natural History' for April, 1852, I referred to the characters of the genus *Rhynchonella*, and gave complete figures of the interior of both valves of *Rh. Wilsoni*, *Rh. sub-Wilsoniani*, *Rh. lacunosa*, *Rh. Boueti*, and *Rh. psittacea*, to show how variable is the depth or excavation of the muscular scars in the ventral valves of those species, and how similar are the interior of the dorsal valves.

46. RHYNCHONELLA NUCULA, *Sow.*, sp. *Dav.*, *Sil. Mon.*, Pl. XXIV, figs. 1—7; *Sup.*, Pl. X, figs. 27 to 29.

At p. 181 of my 'Silurian Monograph' I described *Rh. nucula*, and now again refer to the subject in order, if possible, to point out the small differences by which the shell under description and *Rh. Llandoveriana* are distinguishable.

Rh. nucula is a very abundant fossil in the Upper Silurian, but varies considerably in the number of its ribs; these average from twelve to eighteen in different individuals, while in *Rh. Llandoveriana* they are comparatively smaller, and number from eighteen to thirty-six. In *Rh. nucula* usually four strong ribs occupy the fold, six to eight in *Rh. Llandoveriana*. When the ribs are few in number, those on the lateral portions or lobes of the shell are comparatively larger, and more nearly equal, than those that cover the fold.

As already stated, *Rh. nucula* abounds in the Ludlow, Wenlock, and Upper Llandovery. The variety with few ribs, if we are correct in our identification, has been found by Mrs. R. Gray in the Middle Caradoc at Shallock Mill, Girvan ('*Sup.*,' Pl. X, fig. 31), for we are unable to distinguish those Ayrshire specimens from others that occur in the Upper Llandovery at Minsterley in Shropshire. Another variety (?) ('*Sup.*,' Pl. X, figs. 30, 30 *a*) has also been procured by the same indefatigable lady in the Upper Llandeilo, or Balcletchie Conglomerate, at Balcletchie, Ayrshire; at least, so similar are they in shape to the typical forms of the species that we have not been able to discover characters by which they might be distinguished, and I have therefore thought it preferable to leave them provisionally with *Rh. nucula* than to give them a separate name.

47. RHYNCHONELLA LLANDOVERIANA, *Dav.* *Sil. Mon.*, Pl. XXIV, figs. 8—13 and 14 (?); *Sil. Sup.*, Pl. X, figs. 32 to 37.

We have already alluded to the differences which seem to distinguish *Rh. Llandoveriana* from *Rh. nucula*. We sometimes meet with elongated specimens in which the posterior half of the shell tapers more than is usual in the larger number of individuals, and this leads me to suspect that the so-called *Rh. Weaveri*, Salter, from the Upper Llandovery is only an elongated form of *Rh. Llandoveriana*. In some specimens of the last-named shell the ribs are very small and numerous.

Rh. Llandoveriana was found by Mr. R. Philip in the Upper Llandovery at Speakes

Rough, near Minsterley, in Shropshire, where it is well characterised. It was also procured by Mrs. R. Gray in a formation of a similar age at Camregan Wood, in the Girvan district in Scotland.

48. *RHYNCHONELLA WEAVERI*, *Salter*. Dav., Sil. Mon., Pl. XXIV, fig. 14; Sil. Sup., Pl. X, figs. 24, 24 a.

This species (?) from the Upper Llandovery is described at p. 185 of my 'Silurian Monograph.' In the Upper Llandeilo, at Craighead, Ayrshire, Mrs. R. Gray collected eight specimens of a *Rhynchonella* which, notwithstanding its great difference in stratigraphical position, I have ventured to class provisionally with *Rh. Weaveri*.

In external shape it is somewhat sub-trigonal, six lines in length, by about five in breadth, broadest anteriorly, tapering posteriorly; dorsal valve moderately convex, and ornamented with from eighteen to nineteen angular ribs, of which six form a slightly raised mesial form; ventral valve convex, with a shallow sinus; ribs seventeen or eighteen in number, of which five occupy the sinus; beak incurved; foramen small.

49. *RHYNCHONELLA JACKII*, *Dav.* Sil. Sup., Pl. IX, figs. 30 a, b.

Shell ovate, elongated oval, longer than wide; valves almost equally convex; dorsal valve biplicated, fold large, slopes wide; three ribs on each of the lateral lobes of the valves, commencing at about the middle of the shell and extending to the front; ventral valve with a wide sinus divided by a narrow central elongated rib, commencing at about half the length of the valve and extending to the front; three ribs on each of the lateral lobes of the valve; beak small, incurved.

Length 8, width 7, depth 5 lines.

Obs.—Only one internal cast of this well-marked species was procured from the Caradoc at Dunterleugh Burn, Wanlock Water, Leadhills district, Dumfriesshire. I am assured that this is the specimen incorrectly identified as *Meristella angustifrons* at p. 15 of the Explanation of Sheet 15, 'Memoirs of the Geological Survey of Scotland,' and it was kindly lent to me out of the Museum of the Geological Survey of Scotland (Specimen M, 893).

I have named this species after Mr. R. L. Jack, now conducting the geological survey of Queensland, who was the discoverer of the fossiliferous bands in the Leadhills district of Scotland.

Associated with *Rh. Jackii* in the Leadhills district we find *Leptæna sericea* and

var. *rhombica*, M'Coy, *Lept. tenuicincta*, *Strophomena grandis*, *St. arenacca* (?), *St. expansa*, *St. corrugatella*, *Orthis protensa*, *O. calligramma*, *O. biforata*, *O. crispa*, *O. elegantula*, and *O. testudinaria*, forms that characterise the Caradoc. They occur in the shape of casts in a coarse conglomerate with quartz pebbles. I found none of those Llandoverly and Wenlock forms such as *Spirif. plicatella*, *Pentamerus oblongus*, *Meristella* (?) *angustifrons*, *Atrypa marginalis*, *Orthis Boubhardi*, or *Stroph. pecten*, quoted in the Explanation of Sheet 15, above noticed. Besides Dunterleugh Burn and Black Burn, Wanlock Water, Dumfriesshire, the Leadhills species have been collected at Glentrip Burn, Wallace's Cast, and Snar Water, in Lanarkshire. The specimens from all these localities have been kindly forwarded to me for examination by order of the Director-General of the Geological Survey of Great Britain.

50. *RHYNCHONELLA CALLAWAYIANA*, Dav. Sil. Sup., Pl. X, figs. 18, 18 *a, b, c*.

Shell small, elongated oval, much longer than wide; dorsal valve evenly convex to about half its length, fold biplicated, lateral slopes of fold large, one or two rudimentary, rounded ribs on the lateral portions of the valve near the margin; ventral valve convex, sinus wide and shallow, with a short single mesial rib; beak small, incurved.

Length 4, breadth 3, depth 3 lines.

Obs.—Of this well-marked species one specimen only was procured by Dr. C. Callaway from the Wenlock Limestone at Walsall; and it is with much pleasure I name it after its discoverer. It differs by its shape from all the other British Silurian *Rhynchonella* hitherto discovered.

51. *RHYNCHONELLA PORTLOCKIANA*, Dav. Sil. Mon., Pl. XXIV, figs. 23—25; Sil. Sup., Pl. X, figs. 12, 13, 14.

Since publishing the description of this species at p. 189 of my 'Silurian Monograph,' Mrs. R. Gray has found several specimens of the shell in the Upper Llandeilo at Balelethie, Girvan, Ayrshire. These specimens agree in shape with those from the Caradoc of the Chair of Kildare in Ireland.

52. *RHYNCHONELLA BALCLETCHIENSIS*, *Dav.* Sil. Sup., Pl. X, figs. 15, 16.

Shell sub-pentagonal, about as wide as long, broadest anteriorly, tapering posteriorly; dorsal valve regularly convex to about half its length, fold very wide, large, sub-angular, with a short, shallow, longitudinal groove along its middle; lateral slopes of fold large; anterior portions of the valve convex, forming a short, rounded rib at the base of the fold; ventral valve most convex near the beak. At about half its length commences a large, deep sinus, divided in the middle by a short, rounded rib; beak incurved.

Length 5, width 5, depth 3 lines.

Obs.—This is a very remarkable species with a wide biphlicated fold and a large triplicated sinus; the two lateral ribs forming the margin of the sinus commence at about one third of the length of the valve and then deviate. The mesial rib is small.

Rh. Balcletchiensis was found by Mrs. R. Gray in the Upper Llandeilo, at Craighead, and at Balcletchie, Girvan, Ayrshire.

53. *RHYNCHONELLA ŒMULA*, *Salter*, MS. *Dav.*, Sil. Mon., Pl. XXIV, fig. 21; and Sil. Sup., Pl. X, fig. 17?

Of this remarkable species several good examples were found by Mrs. Robert Gray in the Upper Llandeilo at Craighead. In my description of the species at p. 188 of the 'Silurian Monograph,' it is quoted from the 'Caradoc' of Craighead, but subsequently the limestone in that locality was attributed by Prof. Lapworth to the Upper Llandeilo. All the species in my 'Silurian Monograph,' quoted from Craighead, will consequently be of Upper Llandeilo age and not Caradoc.

54. *RHYNCHONELLA NASUTA*, *M' Coy*. *Dav.*, Sil. Mon., Pl. XXIII, fig. 19; Sil. Sup., Pl. X, figs. 20, 21?

Since describing this species at p. 173 of my 'Silurian Monograph,' I have been able to examine a number of specimens of the shell collected by Mrs. R. Gray from the Upper Llandeilo at Craighead and Balcletchie. These examples show that the shell was not always elongate as described and figured by M' Coy; the larger number of specimens are not much longer than wide. It is evidently a very variable shell, some twenty-six ribs may be usually counted on each valve, but as many as thirty-two are sometimes observable. The ribs on the lateral lobes of the shell are smaller than those that occupy the fold and sinus.

55. *RHYNCHONELLA* ^P *MACCOYANA*, *Dav.* *Dav.*, *Sil. Mon.*, Pl. XXV, figs. 17, 18, 19 (not 16 or Pl. XXVI, figs. 1—3); *Sil. Sup.*, Pl. VIII, fig. 33.

At p. 195 and in Pl. XXV and Pl. XXVI of my 'Silurian Monograph,' two distinct species have, I believe, been described and figured under the name of *Porambonites intercedens*, Pander. The one, Pl. XXV, fig. 16, and Pl. XXVI, figs. 1—3, may perhaps be referable to the Russian genus and species, but the form from the Caradoc Limestone of Wrae, in Peebleshire, Pl. XXV, figs. 17, 18, 19, has all the appearance of being a *Rhynchonella*. This was the feeling entertained by Mr. Salter and myself at the time, and I did not hesitate to observe in p. 196 that we could not feel entirely satisfied as to the correctness of the identification. It will therefore be necessary to describe the Wrae species under a separate designation.

Shell transversely subpentagonal, wider than long, greatest breadth about the middle, sides convex; dorsal valve more convex than the ventral one, fold broad, moderately rounded and of small elevation; ventral valve convex, with a wide, moderately-deepened mesial sinus; beak small, incurved; surface smooth.

Length 13, breadth 17, depth 11 lines.

In addition to the specimens which I have seen in the Woodwardian Museum, several other examples from the Wrae Limestone have been lent to me out of the Museum of the Geological Survey of Scotland. These were obtained from Glencotho Quarry, near Broughton, in the same county, and bear a still more striking general resemblance to some Carboniferous species of *Rhynchonella* such as to *Rh. acuminata*, var. *platyloba*.

Some similar examples have been found by Mrs. R. Gray in the Middle Caradoc at Shallock Mill, Girvan.

Genus—*PENTAMERUS*, *Sow*, 1813.

Some Swedish examples of *Pentamerus* (*P. tenuissimastricata*), Walmstedt, have measured $5\frac{3}{4}$ inches in length by nearly 4 inches in breadth. British specimens of *P. Knightii* have attained those proportions.

56. *PENTAMERUS OBLONGUS*, *J. de C. Sow.* *Dav.*, *Sil. Mon.*, Pl. XVIII, figs. 1—12; Pl. XIX, figs. 1, 2.

This species has been fully described and illustrated at p. 151 of my 'Silurian Monograph.' It seems, as far as I am aware, restricted to rocks of the Llandovery period. It

abounds in the Penkill Limestone at Penkill (Upper Llandovery) and at Cuddiston Glen in Ayrshire. Some specimens or fragments of the fossil have also been found by Mrs. R. Gray in the Middle Llandovery at Newlands in the Girvan district. It is not positively known to occur lower down, although a fragment of some fossil has been quoted as such in the Explanation of Sheet 15 of the Geological Map of Scotland, and as having been found in the Caradoc of Leadhills. I made every effort to obtain a sight of the specimen, but it had been lost or mislaid, and I hesitate to believe in its existence in the rock or locality alluded to.

An example of *Pentamerus oblongus* was found by Mr. R. Philip in shales forming the uppermost portion of the Upper Llandovery at Minsterley in Shropshire. The Upper-Llandovery Limestone at Norbury in the same county is literally a mass of internal casts and impressions of the exterior of the species under description: many examples measured upwards of 3 inches in length by 2 inches and 8 lines in breadth.

57. PENTAMERUS UNDATUS, *J. de C. Sow.* Dav., Sil. Mon., Pl. XIX, figs. 4—9; and Sil. Sup., Pl. IX, figs. 10 to 20.

Since describing this well-characterised and abundant fossil at p. 155 of my 'Silurian Monograph,' I have been able to examine a very large number of better specimens derived from several localities. There appear to exist two well-defined *Pentamerus*-zones in the Llandovery rocks of the Girvan district; for, whilst *Pentamerus oblongus* is most abundant in the Upper Llandovery and scarce in the Middle Llandovery, it is in the last-named horizon that *Pentamerus undatus* is prevalent. The shell is found occasionally with both valves, and they are very convex and even at times gibbous, with the fold in the dorsal valve wide and moderately convex. The sinus in the ventral valve is in some specimens exceedingly broad and shallow with a narrow, median, longitudinal rounded rib; its margins are bordered likewise by a rounded rib especially observable in many Ayrshire individuals (Pl. IX, figs. 12, 14). The beak of the ventral valve is often so much incurved as to almost come into contact with the umbo of the dorsal valve, leaving space only for a narrow area. In external shape this shell bears some resemblance to a *Spirifera*, but it is a chambered and not a spiral-bearing species. The surface of both valves is smooth and marked only by concentric lines of growth. The largest example I have seen measured 16 lines in length by 21 in breadth and 12 in depth.

Pentamerus undatus is very common in the Middle Llandovery at Woodland Point, in the Girvan district; but bivalve examples are rare, the fossil being generally found in separate valves. It occurs also at the same horizon in the Newland Beds of the same district, in the condition of internal casts in a light yellow rock.

58. PENTAMERUS ROTUNDUS, *J. de C. Sow.* Dav., Sil. Mon., Pl. XV, figs. 9—12; Sup., Pl. IX, figs. 6 to 9.

Since this species was described at p. 150 of my 'Silurian Monograph,' a number of specimens have been obtained by Mrs. R. Gray from the Upper Llandovery at Penkill, in Ayrshire. They occur seemingly more often in separate valves, but sharply-defined internal casts, showing the inner surface of both valves, have sometimes been met with in the same locality; these show the septa and chambers, as well as the muscular impressions, in a very beautiful and clear manner, as may be seen by a glance at the figures in Pl. IX of this Supplement.

The dorsal was more convex than the ventral valve, at about half its length the mesial fold commences to rise, and is generally composed of four strong ribs with wide slopes. On the lateral lobes of this valve are two or three short, slightly projecting ribs observable near the margin. In the ventral valve the sinus commences at about half the length of the valve and is of moderate depth. Three ribs usually occupy the sinus.

The largest specimens I have seen from Ayrshire did not exceed 1 inch in length and breadth by 8 or 9 lines in depth. *P. rotundus* has also been found by Mr. R. Philip in the Upper Llandovery at Minsterley, in Shropshire; where it is associated with *Pentamerus oblongus* and *P. undatus*.

59. PENTAMERUS GLOBOSUS, *J. de C. Sow.* Dav., Sil. Mon., Pl. XIX, figs. 10—12; Sup., Pl. IX, figs. 21 to 24.

This species is described at p. 156 of my 'Silurian Monograph.' Since then a large number of specimens of the fossil have been collected by Mrs. R. Gray from the Upper Llandovery at Penkill, in Ayrshire. The shell is often nearly circular, globose, and as wide as long. Many examples show neither fold nor sinus, while others possess a rounded fold of small elevation in the dorsal valve, beginning to rise at about half the length of the valve.

P. globosus does not appear to have much exceeded 7 lines in length by about 8 in breadth and 5 or 6 in depth, it is more nearly allied to *Pent. linguifer* than to any other species of the genus occurring in our Silurian rocks. The shell has also been found by Prof. T. M'Kenny Hughes in the Upper Llandeilo at Penlan, Llandovery.

60. PENTAMERUS GALEATUS, *Dal.* sp. *Dav.*, *Sil. Mon.*, Pl. XV, figs. 13—23; *Sup.*, Pl. IX, figs. 25, 25 *a*.

This well known Upper-Silurian fossil is fully described at p. 146 of my 'Silurian Monograph.' It is not an abundant species in the Llandovery Rocks; some badly preserved examples were, however, found by Mrs. R. Gray at Penkill, in Ayrshire.

61. PENTAMERUS ? SHALLOCKIENSIS, *Dav.* *Sil. Sup.*, Pl. IX, figs. 26, 26 *a*.

Shell nearly circular or about as wide as long; ventral valve convex, with a wide mesial fold; beak much incurved; surface of valve covered with numerous radiating ribs; dorsal valve not known.

Length and breadth 15 lines.

Obs.—I am very uncertain with respect to the genus to which this fossil should be referred, only one specimen, a ventral valve, having been procured by Mrs. R. Gray from the Middle Caradoc at Shallock Mill, Girvan. It is provisionally classed with *Pentamerus*, as it bears resemblance to some foreign, similarly-shaped forms of the genus.

Genus—STRICKLANDINIA, *Billings*, 1859.

The characters of *Stricklandinia* are fully described and illustrated by Mr. Billings in vol. ii, p. 78, of the 'Palæozoic Fossils, Geological Survey of Canada,' 1874. He says there that, whilst studying the species in the Canadian Collection, he observed that nearly all those with short plates in the dorsal valve differed in general from those with long plates; he therefore proposed a new genus for their reception, and stated that the main differences between *Pentamerus* and *Stricklandinia* consisted in the internal structure of the valves discovered by Mr. Salter, and in the general form first pointed out by himself.

Stricklandinia abounds in some of the Canadian rocks, and attains there to considerable dimensions, *Stricklandinia Gaspensis*, *Bill.*, measuring 4 inches in length by 3 in width; of this a figure is given by Mr. Billings at p. 83 of the Canadian work above referred to. Mr. Billings states likewise that neither *Stricklandinia lirata* nor *St. lens* have been hitherto discovered in Canada.

62. *STRICKLANDINIA LIRATA*, *J. de C. Sow.* Dav., Sil. Mon., Pl. XX, figs. 1—13; and Sup., Pl. IX, fig. 1.

This remarkable species having been fully described at p. 159 of my 'Silurian Monograph,' all I would add is that an incomplete specimen was found by Mrs. R. Gray in the Middle Llandovery at Woodland Point, Ayrshire, in company with *St. lens*. Specimens identical with the English have been described and illustrated by Angelin and Lindström in pl. xvii of their fine work, 'Fragmenta Silurica,' 1880. Specimens from the Wenlock series of the Island of Gothland measure $4\frac{1}{2}$ inches in length by $4\frac{1}{4}$ inches in breadth.

Internal casts of *Stricklandinia lirata* have been collected by Mr. W. J. Harrison in the Drift at Moseley, near Birmingham. Llandovery quartzite rocks *in situ* with *P. liratus* were likewise found by the same geologist at the north-east side of the Lickey Hills.

63. *STRICKLANDINIA LENS*, *J. de C. Sow.* Dav., Sil. Mon., Pl. XIX, figs. 13—23; Sup., Pl. IX, figs. 2 to 5.

At p. 161 of my 'Silurian Monograph' this species has been fully described, and I would here merely allude to the shell having been discovered by Mrs. R. Gray to occur in great abundance, and with much variation in shape, in the Middle Llandovery at Woodland's Point, Ayrshire. In some examples the hinge-line is much longer than in others, and is sometimes almost straight. One specimen measured $2\frac{1}{4}$ inches in length by $2\frac{1}{2}$ inches in breadth. It is, however, very difficult to procure complete examples, most of the specimens being either crushed out of shape, or otherwise imperfect. The species varies also much in form, being either longitudinally oval or as broad as long. The dorsal is not as deep as the ventral valve, but both are sometimes very convex; the beak of the ventral valve is in some examples so much incurved that it touches the umbone of the dorsal valve, and the area, which is visible in some specimens, can hardly be seen in others. In the ventral valve there exists a shallow sinus, with sometimes a rounded rib on either side; and some examples have quite the exterior shape of a Spirifer.

64. *STRICKLANDINIA* (?) *BALCLETCHIENSIS*, *Dav.* Sil. Sup., Pl. IX, figs. 27 to 29.

Shell marginally sub-pentagonal, longer than wide ; ventral valve moderately convex with about six angular ribs, commencing at about one third of the length of the shell, and occupying the central third of the breadth of the valve ; lateral portions or lobes smooth ; beak incurved ; fissure triangular, large ; dorsal valve not known.

Length $1\frac{1}{4}$ inches, breadth 1 inch.

Obs.—Of this remarkable species Mrs. R. Gray has found nine fragmentary or incomplete ventral valves only. They all presented exactly the same character. The internal cast of the ventral valve shows a small **V**-shaped chamber. The dorsal valve not having been found, and nothing being known of its interior arrangement, this form is provisionally classed with *Stricklandinia* on account of its small **V**-shaped chamber, although no species of the genus is known to occur so low down in the geological scale.

The specimens were all procured from the Balcletchie conglomerate, or Upper Llandeilo, at Balcletchie in Ayrshire.

Genus—*LEPTENA*, *Dalman*, 1827.

The species composing this genus are elegant in shape and delicate in sculpture. Some ten or twelve British species have been described. They are far less specifically numerous than are those classed under *Strophomena*, but they enjoyed a similar and even more extended vertical range. Some of the species are so variable in shape that they are difficult to distinguish, and several of them seem almost to pass one into the other.

65. *LEPTENA SEGMENTUM*, *Angelin* var. *cornuta*, *Dav.* Sil. Sup., Pl. XII, figs. 1, 2, 3.

Shell small, concavo-convex, wider than long, transversely sub-pentagonal, broadest at the hinge-line ; cardinal extremities prolonged and angular ; dorsal valve convex, and divided into three parts or lobes by two large angular ribs, projecting beyond the anterior semi-circular curve of the valve ; the central lobe is either uniformly convex or divided by a median rounded rib of much smaller size than the lateral ones ; beak much incurved, area narrow, divided by a small fissure partly arched over by a deltidium.

On the surface of both valves from four to six narrow, thread-like rays radiate at about equal distances, and between them the surface is very finely longitudinally striated; dorsal valve concave, divided into three parts by divaricating grooves corresponding to the two large ribs in the ventral valve; hinge-line narrow; interior not known.

Length 2, breadth nearly 6 lines.

Obs.—While sorting some specimens of *Leptæna segmentum* obtained by Mr. G. Maw from the washings of upwards of a ton weight of Middle-Wenlock Shale from Coalbrook-Dale Station, and half a mile from Buildwas Abbey in Shropshire, my attention was drawn to several very remarkable shells which differed so much from the great bulk of specimens of *L. segmentum* derived from the Buildwas or Lower-Wenlock Shales, that I felt uncertain whether these abnormal shells might not be malformations of Angelin's *L. segmentum*; but, as the same character was regularly reproduced on several of the specimens, I considered it desirable to give them a separate varietal designation.

Leptæna segmentum, Angelin, is a small, regularly semi-circular shell, rarely exceeding 3 lines in length by 6 in breadth; its ventral valve uniformly convex and marked by seven or eight principal, thread-like radii, with interspaces finely longitudinally striated. Between the principal radii there is often a shorter riblet, and very rarely, but occasionally, a tendency in some specimens to slight marginal undulation, and to the formation of two or three larger rounded ribs, but to a much smaller extent than in the specimens of the variety *cornuta* figured in my plate. I believe that the extreme variation observable between *L. segmentum* proper and the variety *cornuta* may be connected by intermediate or passage forms.

Mr. Maw's washings placed within my hands some 2000 specimens of *Leptæna transversalis* and *Lept. segmentum*, and I found the two forms always easy to separate. *Lept. transversalis* is a much larger species than *L. segmentum*, and its length is greater in proportion to its breadth than in Angelin's shell; the beak also of *L. segmentum* is very small and hardly visible beyond the area, whilst in *L. transversalis* it is comparatively larger and much incurved. The thread-like radii are likewise much more numerous and close in Dalman's than in Angelin's species.

Leptæna segmentum was found by Mrs. R. Gray at Cuddyston Glen in the Upper Llandovery, and at Woodland Point in the Middle Llandovery, both in the Girvan district of Ayrshire. *Lept. transversalis* was also found by Mrs. R. Gray in the Upper Llandovery at Penkill, and in the Middle Llandovery at Woodland Point, also in Ayrshire. The shell occurs in the Ludlow Shales of the Pentland Hills.

66. *LEPTENA YOUNGIANA*, Dav. Sil. Mon., Pl. XLVII, figs. 19, 20; Sil. Sup., Pl. XII, figs. 14—16.

At p. 320 of my 'Silurian Monograph,' this shell is described as a variety of *Lept. transversalis*. Since then I have been able to examine a large series of fine examples of its exterior and interior, and am disposed to consider it specifically separable from the Upper-Silurian *L. transversalis*. It varies very much in shape as may be seen from the figures. Two fully-developed examples from the Upper Llandeilo of Craighead, in the collection of Mrs. R. Gray, measure—one, length 12, breadth 12 lines; the other, length 12, breadth 9 lines.

The one being almost circular, the other elongated oval. The ventral valve is very convex, beak large and much incurved, area narrow; dorsal valve concave, following the curves of the opposite one. Hinge-line less than the breadth of the shell. The larger number of specimens are nearly circular and about as broad as long; the radii and striæ that cover the surface of the valves are also exceedingly fine and often hardly visible.

67. *LEPTENA TENUICINCTA*, M' Coy. Sil. Mon., Pl. XLVII, figs. 7—18; Sup., Pl. XII, figs. 17—21.

I have nothing to add to the description I have given of this well-marked species at p. 326 of the 'Silurian Monograph.' It is, however, an extremely variable shell as to length and breadth. I have in my possession two internal casts from the Caradoc of Cynwyd, near Corwen, in Merionethshire, measuring, respectively, length 13, breadth 6 lines, and length 9, breadth 12 lines, and every possible intermediate dimension and relative proportion as to length and breadth may be collected. In Scotland it has been found by Mrs. R. Gray in the Caradoc at Shallock Mill, in Ayrshire, and by the Geological Survey of Scotland in rocks of a similar age at Wrae and Kilbucho (near the church), two and a quarter miles west of Culter, in Peebleshire. At Dunterleugh Burn, Wanlock Waters, Leadhills District in Dumfriesshire, and at Glentrip Burn, Wanlock, in Lanarkshire. In the Upper Llandeilo it is abundant at Ardmillan Brae, Craighead, and Balcletchie, in the Girvan district, Ayrshire. The English and Irish localities have been already recorded.

68. *LEPTÆNA SERICEA*, *Sow.* Dav., Sil. Mon., Pl. XLVIII, figs. 10—19; Sup., Pl. XII, figs. 8—10.

This abundant, long-lived, and widely-spread species has been fully described and illustrated at p. 323 of my 'Silurian Monograph.' It takes the place of the Upper-Silurian *Lept. transversalis* in the Lower-Silurian rocks. It is, however, sometimes difficult to separate the two shells, although they differ internally, as well as by the very slight general incurvature of the beak in the form under description.

Leptæna sericea occurs in the Lower-Llandovery, Caradoc, and Llandeilo formations. In Scotland Mrs. R. Gray found it to abound in the Upper Caradoc at Thraive, in the Middle Caradoc at Shallock Mill, in the Upper Llandeilo at Ardmillan Brae, Doularg, Craighead, and Balcletchie.

The Geological Survey of Scotland have collected specimens from the Caradoc at Glencotho Quarry, near Broughton, at Kilbucho, near the church, one mile and a quarter west of Culter, in Peebleshire, at Dunterleugh Burn, Wanlock Water, Leadhill District, Dumfriesshire, and at Snar Water, near the Leadhills, in Lanarkshire, also at Gipsy Point, in Kirkcudbrightshire.

69. *LEPTÆNA SERICEA*, var. *RHOMBICA*, *M' Coy.* Dav., Sil. Mon., Pl. XLVIII, figs. 20—22; Sup., Pl. XII, figs. 4—7.

I have described this variety at p. 325 of my 'Silurian Monograph,' and I still feel uncertain whether it should or not be considered specifically distinct from the much smaller *Leptæna sericea*. Some specimens that have passed through my hands have measured fully 1 inch in length by more than 1 inch 3 lines in breadth. Very large and fine examples have been found by Mrs. R. Gray in the Upper Llandeilo at Balcletchie in Ayrshire; and the Scottish Geological Survey has a very fine specimen, or rather internal cast, obtained at Dunterleugh Burn, Wanlock Water, Leadhills, Dumfriesshire. It occurs there in a conglomerate with quartz pebbles along with other Caradoc species.

70. *LEPTÆNA QUINQUECOSTATA*, *M' Coy.* Dav., Sil. Mon., Pl. XLVIII, figs. 23—27; Sup., Pl. XII, figs. 13, 13a, b.

I have nothing to add to what I stated with respect to this species at p. 322 of my 'Silurian Monograph,' further than that Mrs. R. Gray collected specimens of the shell

from the Upper Llandovery at Penkill, the Middle Llandovery, at Woodlands Point, the Middle Caradoc, at Whitehouse Bay and Shallock Mill, in the Upper Llandeilo, at Ardmillan Brae and Batcletchie in Ayrshire. It varies much in the number of its principal thread-like radii, some specimens show only three, others four, five, and six. Whether it is more than a variety of *Leptæna sericea* has still to be determined.

71. *LEPTÆNA ETHERIDGEI*, Dav. Sup., Pl. XII, figs. 11, 12.

Shell marginally semicircular, tapering slightly anteriorly; hinge-line long, straight, slightly less than the breadth of the shell. Ventral valve evenly convex, area narrow; beak small and slightly incurved; dorsal valve concave, following the curves of the opposite one; hinge-area narrow, fissure small. Surface marked by very fine radiating lines and a few indistinct thread-like radii.

Length 5, width 6 lines.

In the interior of the dorsal valve the muscular area occupies half the length and one third of the breadth of the valve, these scars form two wide, elongated, oval-shaped impressions, much raised anteriorly, especially from the bottom of the valve; these impressions are separated by an intervening concave space, along the centre of which there is a narrow median septum. The cardinal process is small, and there is a wide convex ridge all round the interior margin of the valve. The interior of the ventral valve is not known.

Obs.—This small species is much more circular and less transverse than *L. sericea*, and seems to differ from it by the shape of its muscular impressions. Several specimens were found by Mrs. R. Gray in the Upper Llandeilo at Craighead, in Ayrshire. I have named it after Mr. R. Etheridge, F.R.S., to whose labours science is much indebted.

72. *LEPTÆNA SCISSA*, Salt. Dav., Sil. Mon., Pl. XLVII, figs. 21—25; Sil. Sup., Pl. XII, fig. 22.

Two very finely preserved internal casts of this well-marked species were found by Mr. R. Philip in grit at the top of the Upper Llandovery at Minsterley, in Shropshire, and forming part of that formation.

73. *LEPTÆNA GRAYÆ*, Dav. Sil. Sup., Pl. XII, figs. 23—25.

Shell marginally semi-circular, widest at the hinge-line; ventral valve moderately convex, and longitudinally keeled along the middle; beak not projecting; area triangular, bent back at nearly straight angles to the plane of the valve; fissure triangular, partly arched over by a small deltidium; dorsal valve moderately plano-concave, or flattened laterally, and concave longitudinally along the middle; hinge-area narrow; surface of the valves covered with thread-like radii, the interspaces between them being occupied by one or two shorter radii.

Length 7, width 11, depth 2 lines.

Obs.—This is a well-marked species, differing from *Leptæna transversalis* and *L. sericea*, and other forms of the kind, by the shape of its valves. The dorsal valve is usually plano-concave, or is formed of three parts or lobes, that is to say, the lateral ones are nearly flat, while the central lobe is concave, or, in other words, the median depression commencing at the umbo gradually widens until it reaches the front, and corresponds with the keeled part in the ventral one. The radii are often all of about equal breadth. It is also a thicker shell than *Lept. sericea*.

L. Grayæ occurs in the Upper Llandeilo at Craighead, Girvan. I name the species after Mrs. Robert Gray, of Edinburgh, who has devoted so many years of her life to the careful study and collecting of fossils in the Girvan district of Ayrshire. This species is generically and specifically distinct from the small shell to which I gave the name of *Leptæna Grayii* in 1849, and which was subsequently discovered to be a synonym of Sowerby's *Chonetes (Lept.) minima*.

74. *LEPTÆNA LLANDEILOENSIS*, Dav. Sil. Sup., Pl. XII, figs. 26—29.

Shell marginally semi-circular; ventral valve evenly convex, area narrow, fissure arched over with a small deltidium; beak slightly incurved; dorsal valve very gently concave, sometimes almost flat; hinge-line linear, surface of valves covered with thread-like radii, with a shorter one interpolated between the longer pair. In the interior of the dorsal valve, and at about a little more than half its length, there exists an elevated semi-circular ridge, of which the margin is anteriorly much excavated and indented in the middle, much scooped out posteriorly, and longitudinally divided into two large saucer-shaped depressions by an elevated median ridge. On either side of the cardinal process a prominent transverse ridge encircles the pits for the insertion of the articulating teeth of the ventral valve; under these and close on either side of the central ridge are situated

the muscular depressions or scars. In the interior of the ventral valve there exists likewise, at about half its length, a raised, semicircular ridge, similar to the one in the dorsal valve, but not indented in front nor divided into two parts, but forming a regular concave space between its raised margin and the hinge-line. On either side of the fissure are the articulating teeth, with a four-lobed muscular space with raised angular margins. The interior surface of both valves is marked with finely-indented radiating lines.

Length 9, breadth 13 lines.

Obs.—In 1867 my attention was called by Mr. J. Young, of Glasgow, to a fine interior of the shell under description. For a long time I felt uncertain as to the genus to which it should be referred. Subsequently four more examples were handed to me by Mrs. R. Gray, and I am now disposed to consider them as probably belonging to a new species of *Leptæna*. These were obtained by Mrs. R. Gray from the Upper Llandeilo at Craighead and Ardmillan Brae in Ayrshire.

In the Explanation of Sheet 3 of the Geological Map of Scotland this species is referred to *Leptæna scissa*, but in *scissa* we do not find the very remarkable and characteristic elevated ridges peculiar to *Leptæna Llandeiloensis*, and I now question whether any true *L. scissa* has been discovered as low down as the Llandeilo. *Lep. scissa* is a Llandovery form, but is said to have been found likewise in the Caradoc in Ireland, but this will require further confirmation. One small internal cast, showing the interior of both valves, and which I take to be a young *L. Llandeiloensis* from Ardmillan Brae, has enabled me to determine the characters of the ventral valve.

Genus—STREPTORHYNCHUS, *King*, 1850.

75. STREPTORHYNCHUS NASUTUS, *Lindström*. *Dav.*, *Sil. Mon.*, Pl. XXV, figs. 1 and 2.

STROPHOMENA NASUTA, *Lindström*. 1860.

CYRTIA ? NASUTA, *Dav.* *Sil. Mon.*, p. 201, 1869.

STREPTORHYNCHUS NASUTUS, *Lindström*. *Fragmenta Silurica*, p. 28, pl. xvii, figs. 7—10, and tab. xix, figs. 17, 18, 1880.

For a long time past much uncertainty has prevailed respecting the genus to which this small species should be referred. In my 'Silurian Monograph' (p. 201) I doubtfully referred it to *Cyrtia* on account of its very spirifer-like appearance. Since then Professor Lindström has been so fortunate as to procure interiors of the shell, which show that its proper place is with *Streptorhynchus*.

This curious little species is apparently very rare in our British Silurian Rocks, for

as yet only three examples of it have been discovered. The Rev. H. G. Day picked up one specimen from among the *débris* of the old Wenlock-limestone Quarry at Benthall Edge, and another at Dudley, and liberally placed them both in my collection for safe keeping. It is remarkable that, although Mr. Maw had some eighteen tons weight of Wenlock Shale, taken from different horizons and localities carefully washed, and had the old Wenlock quarries carefully hand-picked, not another specimen of the shell could be discovered.

In Sweden it occurs at the same geological horizon, and does not appear to be so very rare there. Professor Lindström quotes the fossil from Lansaant, Lutterhorn, Färo, Likershamm, and Wisby (Gothland).

Genus—SKENIDIUM, *Hall*, 1860 = *Mystrophora*, *Kayser*, 1871.

76. SKENIDIUM (ORTHIS) LEWISII, *Dav.* Sil. Mon., Pl. XXVI, figs. 4—9.

At p. 208 of my 'Silurian Monograph' I described the exterior and interior of this pretty little species under the name of *Orthis Lewisii*, and then pointed out that it differed much from its congeners by the internal characters of its dorsal valve. I described and figured the elevated triangular septum with converging saucer-shaped hinge-plates, and intimated that in the Devonian rocks of Ferques there occurs another small, similarly-characterised species, to which Mr. Bouchard had given the manuscript name of *Orthis Deshayssi*.¹

In 1860 Professor Hall proposed a new genus, *Skenidium* for my so-termed *Orthis Lewisii* and similarly-organised forms, giving as his type *Skenidium insignis*, Hall, an American species.²

In his 'Beschreibung Eifel. Brachiopoden,' p. 217, 1853, Professor Schnur describes as my *Orthis Lewisii* a much larger Devonian species, to which the name of *Orthis areola* was subsequently given by Quenstedt in 1871; and in the same year Dr. Kayser proposed for it and for my *O. Lewisii* the generic name of *Mystrophora*.³

We are, therefore, at present acquainted with several closely-allied forms of the genus, both in the Silurian and Devonian formations.

'Thanks to Mr. Maw's extensive washings, I have been able to examine a large number of perfect specimens of my Wenlock type. It is always a small shell, and never, so far

¹ See also E. Rigaux's paper, "Description de quelques Brachiopodes du terrain devonien de Ferques," 'Bull. de la Soc. Académique de Boulogne,' vol. i, fig. 10, 1872.

² 'Thirteenth Annual Report of the Regents of the State Cabinet,' p. 70, 1860.

³ "Die Brachiopoden des Mittel- und Ober-Devon der Eifel," 'Zeitsch. Deutsch. geol. Gesellschaft,' p. 614, 1871.

as I am aware, exceeded some $3\frac{1}{2}$ lines in length by about the same in breadth and 3 in depth; whilst the Devonian *Skenidium areola* is a much larger shell, sometimes exceeding 5 lines in length by 6 in breadth and 4 in depth. *Skenidium Lewisii* occurs also in the condition of internal casts, and impressions of the exterior, in the Ludlow Shales at the North Esk section in the Pentland Hills, near Edinburgh.

77. SKENIDIUM LEWISII, var. WOODLANDIENSE, Dav. Sil. Sup., Pl. XI, figs. 1, 2.

In the Middle Llandovery, at Woodland Point, Girvan District, Ayrshire, occurs what I take to be a large variety of *Skenidium Lewisii*. The specimens collected by Mrs. R. Gray partake of all the essential characters of the Wenlock type, differing from it in size only, being nearly twice as large, and in this particular intermediate between it and the *Sk. areola*. Perhaps all three may be after all varieties of a single type, but of this we have not at present any positive evidence. Two examples of the Woodland variety measured, length 3, width 5 lines, and length 3, width 4, depth 2 lines.

78. SKENIDIUM LEWISII?, var. HUGHSHI, Dav. Sil. Mon., p. 254, Pl. XXXVIII, fig. 26.

This may be another and still older variety of *Skenidium Lewisii*, since it is found in the Coniston Grit at Helmside Dent; so that it is possible that the same species, under slight variation in size, may have continued to be represented from the Caradoc up to the Middle Devonian.

79. SKENIDIUM?, SHALLOCKIENSE, Dav. Sil. Sup., Pl. XI, figs. 6, 7.

Shell somewhat subpentagonal, slightly truncated in front, hinge-line straight and equal to the greatest breadth of the shell, extremity acutely angular; ventral valve pyramidal with a longitudinal sinus extending from the extremity of the beak to the front; area large, triangular, slightly curved, fissure triangular; surface ornamented with numerous small ribs which radiate from the extremity of the beak to the margin. Dorsal valve not known.

Length $3\frac{1}{2}$, breadth $6\frac{1}{2}$ lines.

Of this species I am acquainted with three ventral valves only, so that the identification

and description is necessarily incomplete. Knowing nothing of the interior of the dorsal valve, I cannot say whether it possessed the internal character of the genus to which it is provisionally referred. It bears, however, much resemblance to other species of *Skenidium*. The shell was found by Mrs. R. Gray in the Middle Caradoc at Shallock Mill, Girvan.

80. *SKENIDIUM GRAYLE*, *Dav.* Sil. Sup., Pl. XI, figs. 3, 4, 5.

Shell nearly circular and about as wide as long, ventral valve conical, uniformly convex without sinus, beak nearly straight and bent back at a very obtuse angle to the plane of the valve. Area large, fissure triangular; surface of valves covered with numerous fine riblets, shorter ones being interpolated between each principal pair. In the interior of the ventral valve a mesial septum supports a comparatively large saucer-shaped dental-plate, concave, and divided into two portions by a narrow ridge; dorsal valve not known.

Length 7 lines by about the same in breadth, and $4\frac{1}{2}$ lines in depth.

Obs.—Of this species Mrs. R. Gray found an impression of the ventral valve, from which the exterior of the valve has been reproduced by the means of gutta-percha; also an internal cast of the same valve, which also I moulded in gutta-percha. These specimens were procured from the Middle Caradoc at Thraive, Girvan, Ayrshire. If my generic identification proves to be correct, this is the largest species of the genus with which we are at present acquainted. Until the dorsal valve has been discovered the description and identification must be considered as incomplete and provisional.

Genus—*ORTHISINA*, d'Orbigny. 1849.

81. *ORTHISINA ADCENDENS*, *Pander*, sp. *Dav.*, Sil. Mon., Pl. XLIX, figs. 27—29; *Sup.*, Pl. XVI, figs. 16, 17, 18.

Since the describing and figuring of this species at p. 278 of my 'Silurian' Monograph, better specimens have been collected by my zealous friend, Mr. John Parrott, from the Upper Caradoc or Bwlch-y-gassi Beds, near Cynwd; and these have enabled me to add figures of the external and internal surfaces of the dorsal valve. This valve is either nearly flat or very slightly convex, with a feebly marked longitudinal depression. The shell itself had not been hitherto found in our British rocks, but excellent impressions and casts of both valves are not uncommon, so that by the means of white gutta-percha the exterior and interior of both valves can be easily reproduced.

Genus—ORTHIS, Dalman. 1827.82. ORTHIS LAPWORTHI, *Dav.* Sil Sup., Pl. XIII, figs. 9, 10.

Shell small, semicircular, wider than long, hinge-line straight, a little shorter than the breadth of the shell; dorsal valve moderately convex with a broad mesial sinus commencing at the umbo, widening and deepening as it extends to the front, surface ornamented with from ten to thirteen angular ribs; ventral valve very convex, beak nearly straight, very slightly incurved, area large, triangular, and bent backwards at right angles to the plane of the valve, fissure open, surface ornamented with from eleven to fourteen ribs, of which the central one is the largest and most prominent, and with a shorter one on each side of it. The surface of the valves is closely marked with equidistant, concentric, projecting, scale-like laminae.

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

Obs.—This little species was found by Mrs. R. Gray in the Llandeilo, or Balelethie Conglomerate, and in the Middle Caradoc at Shallock Mill, in Ayrshire. A similar shell was also obtained by Mr. D. Brown from the Caradoc, in Peebleshire.

I have named it after Prof. C. Lapworth, F.G.S., to whom we are indebted for an excellent memoir on the 'Geology of the Girvan District of Ayrshire.'

83. ORTHIS CRISPA, *M' Coy.* *Dav.*, Sil. Mon., Pl. XXXVIII, figs. 5—10; Sil. Sup., Pl. XIII, figs. 7, 8.

This species is fully described at p. 256 of my 'Silurian Monograph,' and my reason for referring to it again is to say that the shell was found by Mrs. R. Gray in the Llandeilo at Ardmillan Brae, and in the Upper Caradoc at Thraive, both in the Girvan District of Ayrshire. It was also collected by the Geological Survey of Scotland in the Caradoc or Wrae Limestone at Kilbucho, near the church, two and a quarter miles west of Culter, in Peebleshire; likewise in the same formation at Snar Water, Leadhills District, Lanarkshire. A fragment of this shell was erroneously referred to *Orthis Bouchardi* in p. 15 of the Explanation of Sheet 15 of the Geological Map of Scotland.

84. ORTHIS BALCLETHIENSIS, *Dav.* Sil. Mon., Pl. XXVI, fig. 23; Sil. Sup., Pl. XIII, figs. 12—14.

Shell transversely semi-circular or obscurely pentagonal, slightly indented in front, hinge-line straight, slightly less than the breadth of the shell; ventral valve very

convex, deeper than the dorsal one, and longitudinally depressed along the middle; beak obtusely angular, moderately incurved, and bent back at an almost obtuse angle to the plane of the valve; area large, triangular, fissure open; dorsal valve moderately convex, longitudinally depressed along the middle, cardinal extremities acutely angular. Surface of valve ornamented with a variable number of small radiating ribs with shorter ones interpolated between the principal pairs. Surface of valves crossed with equidistant, prominent, scale-like, concentric lines or ridges.

Length 6, breadth 7, depth $4\frac{1}{2}$ lines.

Obs.—For a long time I felt uncertain whether this Llandeilo fossil was more than a variety of the Wenlock *Orthis Bouchardii*, but after much comparison I find it presents peculiarities which, added to the great difference in stratigraphical position, make it desirable to obtain for it a distinct specific name. It is closely allied to *Orthis Bouchardii*, but is slightly larger and possesses a greater number of ribs. The mesial depressions in both valves is less deep than in *O. Bouchardii*.

At p. 210 of my 'Silurian Monograph' it is erroneously referred to the Lower-Llandoverly or Caradoc of Penwhapple Glen, near Girvan. It was subsequently ascertained by Mrs. R. Gray that its true position is the Llandeilo at Craighead and Balclatchie, in Ayrshire.

85. *ORTHIS NINA*, *Dav.* Sil. Sup., Pl. XIII, fig. 11.

Shell minute, semi-circular, or obscurely subpentagonal, wider than long; dorsal valve moderately convex, longitudinally divided by a somewhat angular or roof-shaped mesial fold; ventral valve convex and divided longitudinally by a moderately deep and somewhat angular sinus; beak gently incurved, area triangular, moderately large and divided by an open fissure. Surface of valves marked with numerous narrow, thread-like radii and wide interspaces, along the middle of which is a shorter riblet.

Length 1, breadth $1\frac{1}{2}$ lines.

Obs.—This minute species of *Orthis* seems abundant in the Middle Caradoc at Whitehouse Bay, near Girvan, but Mrs. R. Gray states it to be rarely found in good preservation.

86. *ORTHIS UNGUIS*, *Sow.* Sil. Mon., Pl. XXXVII, figs. 16—22; Sil. Sup., Pl. XIII, fig. 28.

I am very uncertain whether this species really occurs in Scotland. I have figured in Plate XIII of this Supplement a specimen from the Llandeilo of Craighead, which seems identical with some typical examples from Gretton in England. The identification will, however, require to be confirmed by the discovery of better examples.

87. *ORTHIS RUSTICA*, *Sow.* Dav., Sil. Mon., Pl. XXXIV, figs. 13—22.

This fine species has been fully described and illustrated at p. 238 of my 'Silurian Monograph,' and all I desire to record here is that it has been found by Mrs. R. Gray in the Upper Llandovery or Penkill Beds in Penwhapple Glen, Ayrshire, also in the same formation at Cuddyston Glen. The variety *rigida* has been likewise collected by the same lady in the Middle Llandovery at Woodland Point, in Ayrshire.

88. *ORTHIS SOWERBYANA*, *Dav.* Sil. Mon., Pl. XXXV, figs. 27—31.

I have nothing to add to the description I have given of this species at p. 247 of my 'Silurian Monograph,' further than that the fossil was found by Mrs. R. Gray in the Upper Caradoc at Thraive, and in the Middle Caradoc at Shallock Hill, near Girvan. Some specimens likewise, which I cannot distinguish from it, were also procured by Mrs. R. Gray from the Llandeilo at Craighead and Balcletchie, in Ayrshire. If these last are really referable to the species under description, the shell must have ranged from the Llandeilo to the Lower Llandovery.

89. *ORTHIS ELEGANTULA*, *Dalman.* Dav., Sil. Mon., Pl. XXVII, figs. 1—9.

This well-known species appears to have had a considerable vertical range. In Scotland it was found by Mrs. R. Gray in the Llandeilo or Balcletchie Conglomerate, near Girvan, in the Middle Caradoc at Shallock Mill, in the Upper Caradoc at Drummuck, in the Middle Llandovery at Woodland Point, and at Penkill and Bargany-Pond Burn in the Upper Llandovery, all in the Girvan District of Ayrshire. It is plentiful also in the Wenlock series of the Pentland Hills, near Edinburgh. This shell may sometimes be confounded with imperfectly preserved examples of *Orthis testudinaria*.

90. *ORTHIS TESTUDINARIA*, *Dalman.* Dav., Sil. Mon., Pl. XXVIII, figs. 13—24, Vol. IV (Bud. Salt. Mon.); Pl. XLII, fig. 26; Sil. Sup., Pl. XIII, figs. 30, 31.

Specimens which I cannot distinguish from Dalman's types have been found by Mrs. R. Gray in the Llandeilo at Balcletchie and Craighead, Girvan, in the Middle Caradoc

at Shallock Mill, in the Upper Caradoc at Thraive, all in Ayrshire. It was likewise collected by the Geological Survey of Scotland in the Caradoc at Snar Water, Leadhills District, Lanarkshire.

91. *ORTHIS*? *CROFTI*, *Dav.* Sil. Sup., Pl. XIII, figs. 18, 19.

I am by no means certain as to the genus to which this minute fossil should be referred, and the material at command is not sufficient to clear away the uncertainty. Its interior reminds one of that of some species of the genus, to which, however, it can scarcely belong; and it is here recorded to draw attention to the fossil, so that more abundant material may be sought for. In external shape it is marginally somewhat longitudinally oval, broadest anteriorly, slightly tapering posteriorly, trilobed, with a short, rounded mesial fold in the dorsal valve. Surface smooth.

Length 2, breadth $1\frac{1}{2}$ lines.

Obs.—This small fossil was found by Mr. C. Croft, of Manchester, in the Caradoc at Ty-isaaf, Llansiantffraid. I have named it after its discoverer.

92. *ORTHIS* *POLYGRAMMA*, *Sow.*, var. *PENTLANDICA*. *Dav.*, Sil. Mon., Pl. XXIX, figs. 1—10; Sil. Sup., Pl. XIII, figs. 15, 16.

Mrs. R. Gray found several dorsal valves, agreeing entirely with those that occur in the Pentland Hills, in the Upper Llandovery at Penkill, Girvan. The species is fully described at p. 219 of my 'Silurian Monograph.'

93. *ORTHIS* *FLABELLUTUM*, *Sow.* *Dav.*, Sil. Mon., Pl. XXXIV, figs. 1—12; Sup., Pl. XIII, figs. 3—6 and 20, 21.

Perfectly characterised specimens of this species have been collected by Mrs. R. Gray from the Upper Caradoc at Thraive and Middle Caradoc at Whitehouse Bay, in Ayrshire, also from the Llandeilo at Ardmillan Brae. Some large examples were likewise obtained by the same lady at Craighead.

94. *ORTHIS BILOBA*, *Linné*. *Dav.*, *Sil. Mon.*, Pl. XXVI, figs. 10—15.

This well-known shell is abundant in the Pentland Hills, Ludlow Rocks, but is apparently very rare in Scotland in lower beds. Mrs. R. Gray found two examples of the fossil in the Middle Caradoc at Shallock Mill, in Ayrshire.

95. *ORTHIS CONFINIS*, *Salter*. *Dav.*, *Sil. Mon.*, Pl. XXXVI, figs. 1—4.

This species is fully described and illustrated at p. 266 of my 'Sil. Mon.' It is a most abundant fossil in the Llandeilo of Scotland, and besides at the place assigned to it by Mr. Salter it has been found by Mrs. R. Gray at Doularg, Ardmillan Brae, Craighead, Minuntion, all in the Llandeilo of Ayrshire; bivalve specimens are not, however, very abundant, the shell being usually found in separate valves. I am not certain whether the fossil has been found either in the Caradoc or Llandovery, although some specimens from the Lower Llandovery of Mullock Hill have been attributed to it.

96. *ORTHIS REVERSA*, *Salter*. *Sil. Mon.*, Pl. XXIX, figs. 11—13; *Sil. Sup.*, Pl. XVI, fig. 13.

A specimen of this species was found by Mrs. R. Gray in the Upper Llandovery, or Penkill Beds, at Penwhapple Glen, Girvan.

97. *ORTHIS MULLOCKIENSIS*, *Dav.* *Sil. Mon.*, Pl. XXIX, figs. 14—18; *Sil. Sup.*, Pl. XVI, figs. 14, 15.

At p. 221 of my 'Silurian Monograph' this fossil has been described as a variety of *Orthis reversa*, Salter, but it may be specifically distinct on account of the marked sinus and fold in its valves. In Scotland it is an extremely abundant fossil in the Lower Llandovery at Mullock Hill, three miles north-north-east of Girvan, and it was found by Mrs. R. Gray in the Upper Caradoc at Thraive, in the same district of Ayrshire.

98. *ORTHIS SAGITTIFERA*, *M'Coy*. Dav., Sil. Mon., Pl. XXXVI, figs. 18—23; Sil. Sup., Pl. XIII, fig. 29.

A specimen closely resembling M'Coy's figure was procured by Mrs. R. Gray from the Lower Llandovery at Mullock Hill, in Ayrshire.

99. *ORTHIS BIFORATA*, *Schloth.* Dav., Sil. Mon., Pl. XXXVIII, figs. 11—25.

This variable species is not rare in the Llandeilo at Craighead, in Ayrshire, and was found by the Geological Survey of Scotland in the Caradoc at Duntercleugh Burn, Wanlock Water, Leadhills, Dumfriesshire.

100. *ORTHIS CALLIGRAMMA*, *Dav.* Sil. Mon., Pl. XXXV, figs. 1—24; Pl. XXXVII, fig. 2; and Sil. Sup., Pl. XIII, figs. 23—26.

This very important and far spread Upper- and Lower-Silurian fossil has been fully described at p. 240 of my 'Silurian Monograph.' It varies very much in shape as well as in the number of its ribs. Its ribs are all straight and simple; and in this particular is distinguished from *Orthis plicata*, whose ribs are more numerous and with shorter ones interpolated between the longer pair. If Mr. Salter is correct in considering the *O. plicata* as a variety of *O. calligramma*, the distinction between it and Dalman's species would be unfounded. Under the prevailing uncertainty it is, I think, preferable to maintain *O. calligramma* and *O. plicata* as distinct species.

In Scotland, undoubted examples of *O. calligramma* have been found by Mrs. R. Gray in the Llandeilo at Craighead, Ardmillan Brae, Balcletchie, in the Girvan district. In the Middle Caradoc, at Shallock Mill; at Thraive in the Upper Caradoc; at Shallock Forge, in the Upper Llandovery; and at Mullock Hill, in the Lower Llandovery of the same district. Again, it occurs in vast numbers and of large size in the Penkill Limestone at Penwhapple Glen, Girvan. It has been collected by the Geological Survey of Scotland in the Caradoc at Glencotho Quarry, near Broughton, in Peebleshire; at Duntercleugh Burn, Wanlock Water, and Black Burn, Leadhills District, Dumfriesshire; also in same formation at Snar Water, in Lanarkshire; and under the name of *O. Davidsoni* is found in the Wenlock Limestone, near Walsall, in Staffordshire, so that its vertical range extends from the Llandeilo up to the Weniock inclusive. The var. *scotica* is only a form of *calligramma*.

101. *ORTHIS Plicata*, *Sow.* Sil. Mon., Pl. XXXV, figs. 25, 26; and Pl. XXXVII, figs. 1, 2; Sil. Sup., Pl. XIII, fig. 27.

This species has been collected by Mrs. R. Gray from the Middle Llandoverly at Woodland Point and from the Llandeilo at Ardmillan Brae, in Ayrshire. It occurs likewise in the Caradoc.

102. *ORTHIS CARAUSII*, *Salter.* Dav., Sil. Mon., Pl. XXXIII, figs. 1—7; and Sil. Sup., Pl. XIV, figs. 21—26.

ORTHIS CALLIGRAMMA, var., *Salter.* Appendix to Ramsay's Memoir on the Geology of North Wales, p. 258, pl. xxii, fig. 1, 1866.

— *CARAUSII*, *Salter*, MS. Davidson, Geol. Mag., vol. v, p. 315, pl. xvi, fig. 23, 1868.

— — , *Salter.* A Catalogue of the Collection of the Cambrian and Silurian Fossils in the Museum of the University of Cambridge, p. 24, 1873.

At p. 229 of my 'Silurian Monograph' I described and figured a series of specimens to which Mr. Salter had given the MS. names of *O. Carausii* and *O. Hicksii*. Since then it has been suggested by Prof. T. McKenny Hughes that the two above-named fossils were one and the same species. In his first paper on the "Geology of Anglesey," 'Quart. Journ. Geol. Soc.,' vol. xxxvi, p. 238, 1880, Professor Hughes refers to *O. Carausii* as a characteristic Tremadoc Fossil, and adds, in his second paper on the geology of the same locality, 'Quart. Journ. Geol. Soc.,' vol. xxxviii, p. 26, 1882, that "these species both belong to the *O. Actoniae* group, differing from the *O. calligramma* group in the relative shallowness of the dorsal valve, being almost plano-convex, and from *O. flabellulum* type in having the ventral valve the more convex. It will be observed from the descriptions in Davidson that the two species agree in every particular till we come to the absolute size, the relative length and width, and the number and arrangement of the ribs. From the specimens exhibited it will be seen that the relation of length to width is not constant, that the size is a question of age, and also that in respect to the number and arrangement of ribs, every intermediate form between *O. Hicksii* and *O. Carausii* is represented in the specimens procured from one and the same bed in Anglesey; therefore we must put this down as an early form of *Orthis* following the receding shore in the Cambrian times through the long ages that elapsed between the deposition of the rocks known as Menevian and that of the beds called Arenig." I much regret that I cannot coincide with Prof. Hughes in the views he has expressed relative to the two species under discussion.

Soon after the publication of the above-named paper, Prof. Hughes kindly sent me a large series of the specimens of *Orthis Carausii* which he had collected at Bone, Tyhen, E. of Treiowerth, Prysowenfach, and Caervan in Anglesey, adding that these specimens were procured from the basement bed of the Cambrian of Anglesey, and that it is only a few feet above Archæan (Pre-Cambrian). All the specimens occur in the condition of impressions of the exterior of the shell and of internal casts of both valves, and are in a very good state of preservation. It was therefore quite easy by the means of softened white gutta-percha to reproduce the exterior and interior of both valves, and which for descriptive purposes are quite as good as if the shell itself had been preserved. These specimens agree well with the figures published by Salter in pl. xxii of the 'Geology of North Wales.' They occur in immense numbers in a light or dark yellow, brownish or dark grey sandstone or grit in the Anglesey localities, and both rocks and casts are exactly similar to those that had been previously collected by Dr. Hicks from similar light yellow and dark earthy flags and flaggy sandstones in the Lower Tremadoc group at Tremanhire, St. David's, in Pembrokeshire, and from which the figures 1 to 5 and 7 of Pl. XXXIII of my 'Silurian Monograph' were taken.

After a most careful study of the casts and impressions of *O. Carausii* sent to me by Prof. Hughes and Dr. Hicks, I could discover but one type of *Orthis*, all the specimens being referable to a single species, none of the specimens belonging to *Orthis Hicksii*. None of the examples of *O. Carausii* exceed some 7 lines in length by 9 in breadth, most of them being of smaller dimensions. Some individuals were more transversely semicircular than others, and the hinge-line is as long as or shorter than the breadth of the shell. In all the specimens of the exterior of both valves *the ribs were simple and without any intervening shorter rib*. These ribs varied in number in different individuals; thus in a specimen measuring 9 lines in breadth, fifteen strong ribs could be counted with concave interspaces of about equal breadth; in another specimen, 5 lines in length by 7 in breadth, the ribs were eighteen in number; the whole surface of both valves being likewise intersected at close intervals by fine equidistant, concentric, projecting lines.

I have nothing to add to what I stated in my 'Monograph' with respect to the interior of the valves, but I have given enlarged figures of internal casts from specimens sent to me by Prof. Hughes. The ventral valve of *O. Carausii* is evenly convex and deep, the dorsal one but slightly convex, with a shallow, longitudinal depression along the middle.

It was rightly observed by Prof. Hughes that Salter, in 1866, and at p. 258 of the 'Memoirs of the Geological Survey of Great Britain, refers the *Orthis* under description from Treiowerth, Anglesey, to a dwarf variety of *O. calligramma*, and it was only subsequently that he gave to the shell the distinctive MS. name of *Carausii*. This he did when he discovered that the rock containing the fossil was of a much greater age than that of the Caradoc, where he had placed it, and which discovery was due to Dr.

Hicks, who, in his able researches in the neighbourhood of St. David's, had found that *O. Carausii* was one of the characteristic fossils of the Tremadoc Group.

Mr. Salter was not, however, very far wrong when he considered *Orthis Carausii* to be a dwarf variety of *O. calligramma*, for it is nearly related to Dalman's species, and certainly is referable to the *O. calligramma* group and not to the *O. Actoniæ* group, although differing from Dalman's species sufficiently to make it desirable to retain for the Tremadoc fossil a distinctive specific designation. It is also a smaller shell, and its dorsal valve slightly less convex than in true *O. calligramma*. It shows a slight mesial longitudinal depression in the dorsal valve, but this feature is also observable to a greater or lesser extent in *O. calligramma*.

103. ORTHIS HICKSII, *Salter*. *Dav.*, *Sil. Mon.*, Pl. XXXIII, figs. 13—16.

ORTHIS HICKSII, *Salter*. A Catalogue of the Collection of the Cambrian and Silurian Fossils in the Museum of Cambridge, p. 8, 1873.

As already stated, Prof. Hughes has expressed the opinion that *Orthis Carausii* and *O. Hicksii* were referable to a single species. After a careful examination of some specimens of *O. Hicksii* sent to me by Dr. Hicks in 1868, I arrived at the conclusion that they were specifically separable from *O. Carausii*, an opinion I still maintain. *O. Hicksii* is a smaller shell when adult, and has a comparatively fewer number of ribs; the surface of each valve is ornamented with about ten principal ribs, with very often a short intermediate rib, and this is a good distinctive character between it and *O. Carausii*. While alluding to this species in the 'Cambridge Museum Catalogue,' Mr. Salter says: "Very like *O. Carausii*, Salter, but with a short hinge." Mr. Salter has evidently overlooked its real distinctions, namely, that of possessing a short intermediate rib between the longer ones.

Dr. Hicks, who has seen almost all the specimens of this shell that have been collected, and who has again recently visited the Menevian Beds, in the Porthyrhau Valley, St. David's, to obtain more specimens, writes me that, in his opinion, it and *O. Carausii* are distinct species; and that, as they come from very distinct horizons and are associated with faunas separated by several thousands of feet of strata, without a single species in common, it seems hardly likely that they are the same. *Orthis Hicksii* at St. David's occurs in the upper part of the Menevian group, *O. Carausii* in the Tremadoc group; these two groups being separated by the whole of the Lingula-flags (including the Maentwrog, Dolgelly, and Ffestiniog groups, each with distinct faunas).¹ It is consequently a much older species than is *O. Carausii*. Unfortunately *O. Hicksii* is a scarce fossil, and it is

¹ See Dr. Hicks' paper, "The Classification of the Eozoic and Lower Palæozoic Rocks of the British Isles," 'Popular Science Review,' new series, vol. v, 1882.

almost impossible to obtain good specimens. The rock is of a dark-grey colour and exceedingly tough and hard, and the specimens it contains are in a very fragmentary condition, chiefly casts or impressions. We have no evidence of the presence of *O. Hicksii* in Anglesea.

104. ORTHIS RETRORSISTRIA, *M'Coy*. Dav., Sil. Mon., Pl. XXXVI, figs. 39—42; and Pl. XXXI, figs. 2, 4, 5, and 6, belong to *O. retrorsistria*; 1, 3, and 7 to *O. alternata*, Sil. Sup., Pl. XIV, figs. 7—16.

ORTHIS RETRORSISTRIA, *M'Coy*. Pal. Foss., p. 224, pls. i, figs. 12, 13, 1852.

— ALTERNATA, *Salter* (not of Sowerby). Memoirs of the Geol. Survey of Great Britain, p. 340, 1866.

— — *Salter* (not Sow.). A Catalogue of the Collection of Cambrian and Silurian Fossils in the Museum of the University of Cambridge, p. 60, 1873.

When writing my 'Silurian Monograph,' I was acquainted with *M'Coy's O. retrorsistria* from that author's description and figures only, and so had to limit myself to the reproduction of his description and illustrations. Blindly coinciding in the mistaken view entertained by Mr. Salter, I described *Orthis retrorsistria* as a variety of *O. alternata*, and in Pl. XXXI figured under the last name specimens of the two species.

In January, 1880, T. McKenny Hughes, Professor of Geology in the University of Cambridge, having in the most liberal manner forwarded for my inspection the extensive series of specimens of *O. alternata* and *O. retrorsistria* in the Cambridge Woodwardian Museum, I arrived, after a searching and careful examination, at the conclusion that Sowerby's and *M'Coy's* species were specifically distinct.

Salter, at p. 340 of the 'Memoirs of the Geological Survey of Great Britain,' 1866, considers *O. retrorsistria* a synonym of *O. alternata*; and at p. 60 of the Cambridge Catalogue, above quoted, when alluding to *O. alternata*, Sow. ('Siluria,' 2nd ed., pl. 6, fig. 5), says: "There can be no doubt the Welsh fossil *O. retrorsistria* is the dwarf form of the common Horderley species."

I have, however, now had the advantage of being able to study several hundred specimens of all ages and shapes of *O. retrorsistria*, which abounds in many localities, so abundant, indeed, that on a slab in the Cambridge Museum, measuring about eighteen inches by twelve, from the Middle-Caradoc Shale of Cerrig-y-Druidion, more than a hundred specimens can be counted on its surface, and in an excellent state of preservation, although in some instances slightly out of shape; and Mr. Salter says it occurs there in millions. Specimens identically similar are also in the Cambridge

Museum from the Middle Caradoc of Pen-y-Gaer Druidion, Haford Evan, Milltet Carrig; Pentre Cwmdu, Broch Llandeillo; west side of Garn Bryn; Tan-y-Bulch-y-groes, Llandrillo; Alt-yr-Anker, Meifod Cefn-y-coedog, Llangedwgn, and several other places.

In dimensions, none of the specimens of *Orthis retrorsistria* seem to have quite attained 9 lines in length by 11 in breadth; and it is consequently a smaller shell than *Orthis alternata*, Sow., which attained, and at times exceeded 10 lines in length by 14 in breadth, the measurement of Sowerby's type specimens. There exists also a difference in the shape and dimensions of the muscular impressions in the interior of the valves of *Orthis alternata*, and it was because Mr. Salter had confused the two species that, in following him, I said, at p. 266 of my 'Silurian Monograph,' "that the internal details of *Orthis retrorsistria* are so like those in *O. alternata* that they need not be repeated." The shell is also, as seen in specimens from Horderley, in the Woodwardian Museum, flatter, and the ribs more numerous, or somewhat more finely marked than in M'Coy's *O. retrorsistria*, and therefore, as above stated, I am disposed to regard *O. alternata* and M'Coy's species as distinct.

Orthis retrorsistria is marginally semi-circular and generally a little broader than long, the hinge-line slightly shorter than the greatest breadth of shell, the ventral valve moderately convex, the area not exceeding a line in breadth at the widest part. Dorsal valve almost flat, with a very slight median depression, not observable, however, in every specimen, hinge-area narrow; surface marked with very numerous radiating, thread-like, raised striæ, with one or two or three smaller or shorter ones between the larger pair, and assuming a divaricating curve at the sides towards the cardinal margin. In the interior of the ventral valve the muscular area is large and in the shape of two very elongated, sub-parallel, slightly deviating spaces margined by a narrow ridge, and divided from one another by a free space of somewhat lesser breadth. In the interior of the dorsal valve a small cardinal process is situated between two prominent processes, beyond which are small, deep pits for the reception of the teeth of the opposite valve, these lie close to the narrow hinge-area of the valve. Under the cardinal process commences a very prominent widish ridge which extends to upwards of four or five fifths of the length of the valve, which curving round forms a prominent convex ridge following closely, but at a little distance from the margin of the shell. On each side of this median ridge are seen the muscular depressions and which occupy a little less than a third of the breadth of the shell as well as of its length. The vascular impressions are plainly seen, also becoming often bifurcated and especially so near the margin of the valves.

As we have already observed, the shell or the impressions left by it are very often out of shape and distorted to one side or to the other. In Pl. XXXVI, figs. 39—42, I have represented M'Coy's original figures, and in Pl. XIV of this Supplement I have given a series of drawings carefully selected from the best and most typical specimens of the species in the Woodwardian Museum.

105. *ORTHIS ALTERNATA*, Sow. Dav., Sil. Mon., p. 264, Pl. XXXI, figs. 1—3, 8 (not 2, 4, 5, 6) ; Sil. Sup., Pl. XIV, figs. 1—6.

In describing a species we are bound to take as our type the form described by its proposer. Mr. Sowerby describes his species as follows :—“ Transversely obovate, finely radiated, one valve convex, the other flat or concave ; radii extremely numerous, of unequal fineness, and increasing in number towards the edge ; hinge-line shorter than the width of the shell ; length 10 lines, width 13 lines. Loc Whittingstow, Soudley, and each flank of the Caradoc. Alt-yr-Anker and Maen Maifod, Lower Lickey Ridge, east flank of Berwyns Mandinan Llandovery ” (‘ Sil. Syst., 1839 ’).

I have in Pl. XIV of this Supplement reproduced Sowerby’s original figure and given some additional illustrations from specimens taken from the Middle Caradoc at Horderley, and now in the Woodwardian Museum, Cambridge. It is a larger shell than *Orthis retrorsistria*.

106. *ORTHIS TURGIDA*, *M’ Coy*. Dav., Sil. Mon., p. 258, Pl. XXXII, figs. 12—20 ; and Sup., Pl. XIV, figs. 17 to 20.

This is a good and well-defined species, but it is difficult to procure specimens with both valves in place. Perfectly preserved bivalve individuals show that the ventral valve was deep and more often evenly convex, its beak gently incurved, with a large, triangular area divided in the middle by an open fissure. The dorsal valve, less convex or deep than the ventral one, is longitudinally slightly flattened or depressed along the middle. Salter, in his catalogue of the Cambrian and Silurian Fossils in the Cambridge Museum, p. 61, 1873, when treating of *O. turgida*, says : “ One of the most convex of species. The space between the great muscles of the dorsal valve usually occupied by a low ridge is here a sharp one.” In Scotland it has been found by Mrs. R. Gray in the Llandeilo at Craighead and Balclatchie. It is quoted by Salter from the Middle Bala or Caradoc group and even from the Upper Llandovery. A specimen in Mrs. R. Gray’s collection from the Penkill Limestone of Penwhapple Glen bears much resemblance to those from the Llandeilo ; but this identification will require confirmation.

107. *ORTHIS* vel *STROPHOMENA* ? *KILBUCHOENSIS*, *Dav.* Sil. Sup., Pl. XIII, figs. 1—2.

The Geological Survey of Scotland obtained from the Caradoc or Wrae Limestone at Kilbucko, near the church, and two and a quarter miles from Culter in Peebleshire, two magnificent internal casts of an *Orthis*?, of which the species is not known to me. These casts are marginally semi-circular, nearly flat, wider than long, with a long straight hinge-line, and show the muscular impressions, central ridge, ovarian spaces, and vascular ramifications in a wonderfully fine state of preservation.

Not being acquainted with the exterior I cannot describe the species, but have given it a provisional name and added correct drawings of the two specimens in the hope that a search in the locality may be made for more specimens. The figures I have given are enlarged; one of the specimens measured—length 6, breadth 9 lines; the other, length 9, breadth 14 lines. The largest drawing shows the real interior drawn from an impression in white gutta-percha taken from the cast.

108. *ORTHIS PHILIPPI*, *Dav.*, Sil. Sup., Pl. XI, figs. 13—14.

Shell small, marginally semi-circular, wider than long, indented in front; hinge-line straight, dorsal valve moderately convex and divided into two lobes by a deep median sinus. Surface ornamented with numerous thread-like, radiating radii, with wide interspaces dotted over with small pits. Ventral valve not known; length $2\frac{1}{2}$, breadth 4 lines. In the interior of the dorsal valve the hinge-area is narrow, the valve being divided into two lobes by a wide, roof-shaped ridge. Cardinal process small, situated between two curved brachial processes or plates. Close under the hinge-area and near to the plates are situated the sockets, and on either side of the central ridge are the adductor muscular impressions.

Obs.—The ventral valve not having been discovered, it is not possible to give a complete description of this remarkable little species. It was found by Mr. C. Croft, of Manchester, in the Caradoc at Ty-isaf, Lansantffraid, in Montgomeryshire. Mr. Croft writes me that he has worked the locality thoroughly, and that he collected not less than two hundred species of different classes and all from one small quarry. I have named the fossil after Robert Philip, Esq., of Minsterley, in Shropshire, who has devoted so much attention to the Llandeilo and Llandovery beds and fossils that occur in his locality.

109. *ORTHIS? HIRMANTENSIS*, M'Coy. Dav., Sil. Mon., Pl. XXXII, figs. 5—9; and Sup., Pl. XI, figs. 8—11.

When treating of this species at p. 261 of my 'Silurian Monograph,' I had not seen any specimens of the fossil, and M'Coy's figures were not satisfactory, so that all I could do was to reproduce the original description. Subsequently, thanks to my friend, Mr. J. Parrott's exertions, I have been able to study several good examples of the species which he had collected from the Caradoc or Bala shales above the Hirnant Limestone at Aber Hirnant, near Bala. The fossil is abundant in the locality, and occurs in the conditions of impressions of the exterior and of internal casts, but no specimens showing the two valves in position, or the area, have yet been discovered, so that I cannot feel quite certain whether it should be classed with *Orthis* or *Strophomena*. The specimens are also more often distorted or out of shape from the effect of cleavage. When marginally perfect the shell is semi-circular; the hinge-line is as long as or very slightly shorter than the greatest breadth of the shell, and this does not seem to have much exceeded 8 or 9 lines in length by 10 or 12 in breadth. The ventral valve is moderately convex, the dorsal one very slightly so or nearly flat. The surface of both valves is covered with numerous thread-like radiating radii, some bifurcating, while a shorter riblet is interpolated between the larger ones. The new figures I have given in Pl. XI of this Supplement show all I know about the fossil.

110. *ORTHIS SARMENTOSA*, M'Coy. Dav., Sil. Mon., Pl. XXXVI, figs. 35—38.

While reproducing Prof. M'Coy's description of this so-termed species, I had never seen any specimens of the fossil. At p. 60 of his 'Catalogue of the Collection of Cambrian and Silurian Fossils in the Geological Museum of the University of Cambridge,' Mr. Salter states that *O. sarmentosa*, M'Coy, is *O. testudinaria* in a crushed condition. I question, however, that the Cambridge specimen is a crushed example of *O. testudinaria*, Dalman; indeed, I feel convinced that it is not so. Mr. Salter has quite misunderstood the characters of Dalman's species, and what he refers to it in the 'Memoirs of the Geological Survey of Great Britain,' vol. 2, p. 371, figs. 5—10, belong to an entirely different species and in no way resemble Dalman's type. I know nothing of M'Coy's *O. sarmentosa*, and therefore am unable to pass any opinion as to its specific value.

111. ORTHIS ACTONLÆ, *Sow.* Dav., Sil. Mon., Pl. XXXVI, figs. 5—17; Sil. Sup., Pl. XI, fig. 12.

This well-characterised species is described at p. 252 of my 'Silurian Supplement.' Mr. Salter observes, in his 'Cambridge Museum Catalogue,' that it is a shell easily distinguished from its associate *O. flabellulum* by having the opposite valve convex, the concave one being the dorsal one. I have added to this supplement a figure of a finely preserved concave dorsal valve obtained by Mr. J. Parrott from the Caradoc of Gelli Goin, near Bala.

Mr. D. C. Davis informs me that *O. Actoniæ* is most abundant in the upper portion of the Bala Limestone, thirty yards or so above the bed containing *Triplesia? spiriferoides*.

112. ORTHIS JONESI, *Dav.* Sil. Sup., Pl. XI, figs. 15, 16.

Shell small, slightly broader than long, dorsal valve semi-circular, hinge-line a little shorter than the greatest breadth of the shell, surface nearly flat or slightly concave at the umbo, afterwards abruptly bent upwards to the margin; ventral valve geniculated; beak small, incurved, very little produced, area not very broad, fissure triangular, open. Surface of valves covered with numerous radiating, thread-like radii, with a shorter riblet interpolated between the larger ones. Interior not known.

Length 4, breadth $4\frac{1}{2}$ lines.

Obs.—I have seen several specimens of this little well-marked species. It was collected by Dr. Hicks at the Paper Mills, Haverfordwest, where it is found in company with *Leptaena sericea*, *Strophomena rhomboidalis*, and one or two more Brachiopoda. It was also obtained by Mr. J. Parrott at Corwen, North Wales, in a rock attributed to the Caradoc. Its geniculated valves make it easily distinguishable from its congeners.

I have named this fossil after my old and valued friend Prof. T. Rupert Jones, F.R.S., &c., to whom I am deeply indebted for all the kind trouble he has taken during so many years while revising the sheets of this Monograph for publication.

113. ORTHIS RANKINI, *Dav.* Sil. Sup., Pl. XI, figs. 17—19.

ORTHIS TESTUDINARIA, *Salter* (not of Dalman). Memoirs of the Geol. Survey of Great Britain, vol. ii, part 1, p. 373, pl. xxvii, figs. 5—10, ? 1848.

ORTHIS TESTUDINARIA, *Dav.* (not of Dalman). Sil. Mon., p. 227, pl. xxviii, figs. 13—24, 1868.

Shell marginally semicircular, hinge-line a little shorter than the breadth of the shell, lateral margins broadly rounded, slightly indented in front; dorsal valve moderately convex and longitudinally divided into two lobes by a median depression, cardinal angles either rounded or angular, slightly auriculated; ventral valve evenly convex or with a small median longitudinal elevation, beak slightly incurved, area narrow, fissure triangular. Surface of both valves covered with numerous fine, thread-like radii, with one or two shorter ribs interpolated between the larger rays.

Length 8, breadth 9 lines.

Obs.—I believe this is the shell which has been erroneously referred to *O. testudinaria* by Salter in vol. 2 of the 'Memoirs of the Geological Survey,' and by myself at p. 226 of the 'Silurian Monograph.' At that period neither Salter nor myself had seen Dalman's types and did not understand his species. When preparing the manuscript relating to the Devonian and Silurian Brachiopoda that occur in the Triassic pebble-bed of Budleigh Salterton, Vol. IV, p. 329 and 358, I had some correspondence with Prof. Lindström with respect to Dalman's species, and, with his usual amiability, he at once forwarded for my inspection Dalman's own specimens and types out of the Stockholm Museum. I figured the Swedish type in Vol. IV, Pl. XLII, fig. 26, of my 'Monograph,' and found it to be entirely different to the one figured by Salter and myself in the works already alluded to. I was then and am still uncertain whether the true *O. testudinaria* and my *Orthis Budleighensis* may not be the same; but, as Dr. Lindström seemed uncertain and undecided about the matter, after having compared a number of specimens of the Budleigh Salterton fossil with the Swedish form, it was determined to retain them provisionally as distinct.

Orthis Rankini is a very much larger form than *O. testudinaria*, and much more transverse. Dalman's species is a small, almost circular shell, very slightly wider than long, and not much exceeding some 7 lines in length by $7\frac{1}{2}$ in breadth, and 3 or $3\frac{1}{2}$ in depth. In order to get rid of the confusion that has taken place, I have thought it preferable to give to the form under description a separate designation, and have named it after my valued friend the late Dr. Rankin, of Carlisle, who afforded me so much help while working out the Scottish Carboniferous Brachiopoda.

O. Rankini was found by Mrs. R. Gray in the Llandeilo, at Ardmillan Brae, and in the Star-fish Beds, or Upper Caradoc, at Thraive Dyke, in Ayrshire. It is also quoted by Mr. Salter from Pont-brennaraeth, Pont Dwn, Panblewin, Llwychgwyn, and Llandeilo.

Genus—STROPHOMENA, Rafinesque. 1820 or 1825 ?

Very little new has been discovered with respect to the species belonging to this genus since the publication of my 'Silurian Monograph,' but some additional details have been gleaned in connection with some of those already described and which occur in Scotland.

114. *STROPHOMENA RHOMBOIDALIS*, *Wilckens*, sp. Dav., Sil. Mon., Pl. XXXIX, figs. 1—21; and Pl. XLIV, fig. 1.

This well-known and far-spread species has, in Scotland, been found to range from the Llandeilo to the Ludlow inclusive. Mrs. R. Gray obtained it from the Llandeilo, at Craighead; the Middle Caradoc, at Shallock Mill; from Thraive, in the Upper Caradoc; at Mulloch Hill, in the Lower Llandovery; in the Middle Llandovery, at Newlands and Woodland Point; in the Upper Llandovery or Penkill Beds, at Penwhapple Glen; all in Ayrshire. It has also been found in the Wenlock and Ludlow rocks of the Pentland Hills.

115. *STROPHOMENA CORRUGATELLA*, *Dav.* Sil. Mon., p. 301, Pl. XLI, figs. 8—14; Sup., Pl. XV, figs. 23—26.

This beautifully sculptured species has been collected in Scotland in the five following horizons:—In the Llandeilo, at Balcletchie; in the Middle Caradoc, at Shallock Mill; at Drummock, in the Upper Caradoc; at Benan Craig, in the Lower Llandovery; and at Woodland Point, in the Middle Llandovery; all in Ayrshire. It has also been obtained by the Geological Survey of Scotland at Black Burn, Wanlock Water, Leadhills District, Dumfriesshire.

Strophomena corrugatella attains largest dimensions at Woodland Point, in the Girvan district, and shows strongly-marked wrinkles near the cardinal edge.

116. *STROPHOMENA SHALLOCKIENSIS*, *Dav.* Sil. Sup., Pl. XI, figs. 20, 21; Pl. XII, fig. 30; and Pl. XVI, fig. 8.

Semicircular, wider than long, hinge-line straight, about as long as the breadth of the shell; dorsal valve uniformly and gently convex, hinge-area narrow; ventral valve

gently concave, area narrow but wider than that of the opposite valve, fissure partly arched over by a small pseudo-deltidium. Surface of valves finely radiatedly striated, with shorter ribs interpolated between the longer radii; valves crossed by a few concentric lines of growth. Two specimens measured

Length 12, breadth 18, depth $1\frac{1}{2}$ lines; length $11\frac{1}{2}$, breadth 17, depth $2\frac{1}{2}$ lines.

Obs.—Internal casts and impressions of the exterior were collected by Mr. J. Parrott from the Upper Caradoc or Cynwyd Beds, Trystion Valley, near Corwen, in Merionethshire. In this species the ventral valve is slightly concave, and the dorsal valve is convex. It is remarkably regularly semicircular.

Similar specimens with the shell preserved were also found by Mrs. R. Gray in the Middle Caradoc at Shallock Mill, in Ayrshire.

117. STROPHOMENA ANTIQUATA, *Sow.* Dav., Sil. Mon., Pl. XLIV, figs. 2—13, and 21, 22; Sil. Sup., Pl. XV, figs. 12—14.

In Scotland *Strophomena antiquata* is very abundant in the Middle Llandovery, at Woodland Point; also in the Upper Llandovery or Penkill Beds, at Bargany-Pond Burn, at Penkill; and at Penwhapple Glen, in Ayrshire. I give figures of some fine examples collected by Mrs. R. Gray in those localities; and, as we have stated elsewhere, it is found in the Wenlock series of the Pentland Hills.

118. STROPHOMENA CALLAWAYIANA, *Dav.* Sil. Sup., Pl. XVI, figs. 6, 7.

Shell longitudinally semicircular, longer than wide, hinge-line as long as the breadth of the shell; ventral valve geniculated, flattened portion traversed by concentric wrinkles, surface finely striated; dorsal valve following the curves of the ventral valve.

Length 13, breadth 10 lines.

Obs.—Of this species two examples were procured by Dr. C. Callaway from the Caradoc at Marsh Brook and Gretton.

119. STROPHOMENA ? BIPARTITA, *Salter.* Dav., Sil. Sup., Pl. XVI, figs. 9—12.

STROPHOMENA BIPARTITA, *Salter.* Quarterly Journal Geol. Soc., vol. x, p. 74, 1854.

Shell marginally transversely semicircular, wider than long, hinge-line as long as the breadth of the shell; dorsal valve gently convex, divided into two lobes by a deep angular

sinus; a wide central, elevated, roof-like fold in the ventral valve; area long and narrow. Surface of valves covered with a number of ribs of unequal size, arranged somewhat in clusters, or with a series of radiating riblets with wide interspaces filled up by shorter and smaller radii. No good interiors have been collected.

Length 5, breadth 8 lines.

Obs.—This well-marked species was described, but not figured, by Salter in the paper by himself and W. T. Aveline "On the Caradoc Sandstone of Shropshire," and was found in that formation near Hope Bowdler and Cheney Longville, and abundantly in the thin flags of the Horderley section. I have seen examples of the shell from that district. A fine series of specimens, of which I give some figures, were lent to me by Dr. C. Callaway, who had obtained them from the Chatwall Sandstone (Middle Caradoc), south end of Ragleigh Hill, Velnick Stratton. Mr. C. Croft found the fossil likewise in the Caradoc at Ty-isaf, Llansantffraid.

120. STROPHOMENA PECTEN, *Linné*, sp. Dav., Sil. Mon., Pl. XLIII, figs. 1—11.

At p. 306 of my 'Silurian Monograph,' I quote *St. pecten* from the Wenlock series of the Pentland Hills; since then very fine examples of the species have been collected by Mrs. R. Gray from the Middle Llandoverly, at Woodland Point, Girvan, where the shell is large, abundant, and finely preserved. It was also found by the same lady at Newlands, in a light-yellow rock of Middle Llandoverly age, and in company with *Pentamerus undatus*, *Leptocælia hemisphærica*, and *Strophomena applanata*. An allied, but distinct species was also collected by Mrs. R. Gray from the Upper Llandoverly, at Cuddyston Glen, Penkill, and Bargany-Pond Burn, in Ayrshire. It is a common shell in the Wenlock series in many localities, and especially in the Pentland Hill.

121. STROPHOMENA EXPANSA, *Sow.* Dav., Sil. Mon., Pl. XLV, figs. 1—10; Sil. Sup., Pl. XV, figs. 1—5.

This species is fully described at p. 312 of my 'Silurian Monograph.' Its vertical range in Scotland is remarkable. Mrs. R. Gray found it abundantly in the Llandeilo, at Craighead, at Doularg, Bernan Burn, Minuntion, in Ayrshire; also in the Middle Caradoc, at Shallock Mill; in the Lower Llandoverly, at Mullock Hill; and in the Middle Llandoverly, at Woodland Point; all in the Girvan district, in Ayrshire. Mr. Salter, in his paper in vol. vii, p. 171, of the 'Quarterly Journal of the Geological Society,'

quotes *Strophomena pecten* and *S. filosa* from the Lower Llandovery, at Mulloch Hill. I believe, however, that the specimens so identified are really referable to *St. expansa*, a very abundant fossil in the district.

Strophomena expansa was collected by the Geological Survey of Scotland from the Caradoc, at Snar Water, near Leadhills, in Lanarkshire, also from the same formation at Black Burn, Wanlock Water, Leadhills district, Dumfriesshire.

122. STROPHOMENA GRANDIS, *Sov.* Dav., Sil. Mon., Pl. XLVI, figs. 1—3, and 5—6 ;
Sil. Sup., Pl. XV, fig. 6.

Although quoted elsewhere from Scotland, I am not quite certain that it has been collected in the Girvan District. A specimen from the Upper Caradoc at Thraive Glen, found by Mrs. R. Gray, may possibly belong to the species. Another was obtained by the Geological Survey of Scotland at Duntercleugh Burn, Wanlock Water, Leadhills district, Dumfriesshire ; but this identification requires confirmation. The internal cast of the dorsal valve has been found by Dr. C. Callaway in the Caradoc at Marsh Brook, and this has enabled us to complete the illustration of the species.

123. STROPHOMENA RETROFLEXA, *Salter.* Dav., Sil. Mon., Pl. XLII, figs. 15—17.

This species has been found by Mrs. R. Gray to occur in the Llandeilo, at Craighad, Balcletchie, and Ardmillan Brae, in Ayrshire.

124. STROPHOMENA WALTONI, *Dav.* Dav., Sil. Mon., Pl. XLII, fig. 11.

A specimen which I cannot distinguish from the typical form of the species was obtained by Mrs. R. Gray from the Upper Llandovery, at Cuddyston Glen, in Ayrshire.

125. STROPHOMENA IMBEX, var. SEMIGLOBOSA, *Dav.* Sil. Mon., Pl. XLI, figs. 1—4 ; and
var. SEMIGLOBOSINA, *Dav.* Sil. Mon., Pl. XLI, figs. 5, 6 ;
Sil. Sup., Pl. XV, figs. 9—11.

At p. 286 of my 'Silurian Monograph,' I described and figured several specimens of a shell from the Wenlock formation, measuring 25 lines in length by 29 in breadth, and which, although doubtfully referred to Pander's type, differed from it in having its valves

regularly concavo-convex and without geniculation. As far as I am aware, Pander's true type of *Strophomena imbrex* has not been hitherto discovered in our British Silurian rocks. I therefore proposed for our Wenlock fossil the varietal designation of *semiglobosa*, which could be made use of as a specific term should it be found that Pander's shell was specifically distinct. The var. *semiglobosa* varies considerably in the degree of convexity of its ventral valve. Some specimens form in profile an almost half circle; while others, on the contrary, are very gently or moderately concavo-convex, as is shown by two fine examples collected by Mr. J. Gray, and now exhibited at the British Museum.

Another much smaller variety, and which never seems to attain one quarter of the dimensions of the Wenlock fossil, has been found to occur abundantly in the Llandeilo, at Craighead and Balcletchie, in Ayrshire. We would propose to give to this last-named variety the name of *semiglobosina* to distinguish it from the far larger Upper-Silurian form. Its general shape, it is true, is much the same as that of the Upper-Silurian variety, and it varies also considerably in the degree of convexity of its ventral valve, also in the strength or coarseness of its thread-like radii. These rays are of almost equal width, and in different specimens are separated by interspaces of greater or lesser breadth, which are filled in with from three to five very fine longitudinal striæ, with here and there a shorter riblet. The interior of its dorsal valve, discovered by Mrs. R. Gray, shows differences sufficient to authorise us in separating it from the Wenlock form. The nature of the bottom of the sea may have had a good deal to do in relation to the coarseness or fineness of the radii. Where the sea-bottom was composed of a fine muddy substance, such as was the case at Craighead, the sculpture of the shell was finer and more delicate; while where the bottom was made up of a coarse material such as at Balcletchie (conglomerate), the ribbing became coarser. Then there exists a very considerable stratigraphical vertical difference in the habitats of the two varieties. The var. *semiglobosina* being found in the Llandeilo, the var. *semiglobosa* in the Wenlock. All things considered, it seems desirable to retain for the two forms distinct varietal designations. In Pl. XLI of my 'Silurian Monograph' I figured the two varieties. Figs. 1 to 4 represent the variety *semiglobosa*; figs. 5, 6, the variety *semiglobosina*. In Scotland we have not hitherto discovered the Wenlock variety.

126. STROPHOMENA ARENACEA, *Salter*. Dav., Sil. Mon., Pl. XLII, figs. 6—8; Sil. Sup., Pl. XVI, figs. 2—5.

Mrs. R. Gray has collected this species plentifully as internal casts, and impressions of the exterior, from the Upper Llandovery at Camregan Wood, in Ayrshire; also from the Middle Llandovery at Woodland Point, in the same district. Specimens which I cannot distinguish from it have also been procured from the Caradoc at Duntercleugh Burn, Dumfriesshire.

127. STROPHOMENA DELTOIDEA, *Conrad*. Dav., Sil. Mon., Pl. XLII, figs. 1—5; Sil. Sup., Pl. XV, figs. 16—22.

This species has been fully described and illustrated at p. 293, and in Pl. XLII of my 'Silurian Monograph.' Since then it has been suggested to me that our English specimens might perhaps be specifically distinct from Conrad's type. I therefore made further researches into the matter.

Mr. Whitfield, who is a very accurate and able worker, writes me that there are two shells in the Trenton rocks at Trenton Falls, Conrad's locality for his type ('American Report Geol. Survey of New York,' 1839), both of which would answer his description, which is as follows:—" *S. deltoidea*. Shell deltoid, with numerous radiating striæ and concentric rugose undulations, obsolete on the inferior half of the valves; inferior valve slightly concave above, gibbous, abruptly rounded and flattened at the base; striæ small and crowded, *one or two lines in the middle of the valve larger and more prominent than the others*; angles of the cardinal line slightly prominent. Length 1 inch. Locality, Trenton Falls." The sentence which Mr. Whitfield has underlined is the only one which gives any chance of distinguishing the shells by this description. The striæ of the form which Mr. Whitfield has generally identified with Prof. Safford's *S. incrassata*, Hall, comparing it with Tennessee specimens, are regularly alternate, larger and smaller, in fascicules, as in *S. alternata*, Conrad, only they are stronger in the middle section of the shell than on the sides. This leaves the middle one a little the strongest. Mr. Whitfield continues to say: "On the one which has the area on the concave valve, *S. deltoidea*, the striæ are not regularly alternate, but are irregular, and generally on the New York examples there are three or four, sometimes only two, strong striæ together, or with one or two finer ones between. The first shell, *S. incrassata*, Saff., is not described in the New York Reports from the Trenton, but from the Chazy, and I think it distinct from the Trenton form. It has the area on the convex valve. On the same page with the

description of *S. deltoidea*, there are descriptions of four other shells there given under *Strophomena*, all of which are mentioned as having the inferior valve convex, but no cardinal area is mentioned.

“Conrad undoubtedly included both the above under his *S. deltoidea*. The figure given by Vanuxem, ‘Geol. Rep.,’ Third District, New York Survey, p. 46, fig. 2, would do for either except the little beak projecting beyond the hinge. Hall has figured shells of *S. deltoidea*, but none of *S. incrassata*, vol. i, also *S. alternata*, fig. 3 *a*, *b*, and *c*, and *S. tenuistriata*, fig. 3 *a*, as *deltoidea*, so he has not cleared the matter away. Now, the one which I identify as *S. incrassata*, Safford (not Hall) is the same, I believe, as your *S. deltoidea*, Sil. Mon., Pl. XLII, figs. 1—5, and not the *S. deltoidea* proper.”

There evidently prevails among American geologists some uncertainty with respect to Conrad’s *Stroph. deltoidea*. Dr. C. Callaway, who has visited and collected at Trenton Falls, sends me, as Conrad’s species of *S. deltoidea*, two specimens, which are exactly similar to the British examples I have figured and described in my ‘Monograph.’ They agree likewise with a figure of *S. deltoidea* given by Hall in Pl. 31A, fig. 3 *f*, in vol. I of his ‘Palæontology of New York;’ Hall describes his figure as follows: “—A very perfect specimen in form and markings. This drawing is by Mr. Conrad from a specimen now in my possession. The striæ are a little stronger on the middle of the shell, and in some parts alternate with smaller ones.” Unfortunately, all Hall’s figures of *S. deltoidea* represent only the convex valves, and no area is given, but he tell us in his description that the dorsal valve (our ventral one) is convex.

Now, the specimens collected by Dr. C. Callaway at Trenton Falls agree with Conrad’s drawing of *S. deltoidea* figured by Hall, and have the ventral valve convex with area, the dorsal valve being the concave one, and the same striations as described by Conrad; consequently I am led to infer that Dr. Callaway’s two examples do really belong to Conrad’s *S. deltoidea*; and, as they agree with our British representative of the species, we will be justified, I think, in retaining them as such. The impressions taken from the American specimens of *S. incrassata* would not agree with ours. Dr. Callaway found another species of *Strophomena* in the Hudson-River group, Cincinnati, Ohio, and in this the ventral valve with area is the concave one; but it is evidently not the *S. deltoidea* of Conrad, although he sent me the specimens for examination with that name.

Strophomena deltoidea is stated by Hall to be very variable, and he says that it is often very difficult to draw the line of distinction between this species and *L. alternata*, and more particularly between this and *L. camerata*; and that, on the other hand, it approaches very close, in some of its forms, to the succeeding species (*L. tenuistriata*); but that these two, when well preserved, are clearly and decidedly distinct; also that the figures of *S. deltoidea* given by Mr. Vanuxem and Dr. Emmons scarcely show any concentric wrinkles, and approach more nearly to the nasute form of *L. alternata*.

British examples of *S. deltoidea* are also very variable in shape, the ventral valve being more or less strongly geniculated, while some, as in the case of the American

specimens scarcely show any concentric wrinkles. Some Scottish specimens figured in my 'Silurian Supplement' show them very strongly marked. Besides the English and Scotch localities already recorded, *S. deltoidea* has been collected by Mrs. R. Gray from the Llandeilo at Craighead, Balcletchie, and Ardmillan Brae, in Ayrshire, as well as in the Upper Caradoc at Drummuck, in the same county.

ADDITIONAL NOTES WITH RESPECT TO RHYNCHONELLA.

Since my descriptions of our Scottish Silurian species of *Rhynchonella* were put into type, Mrs. R. Gray has kindly forwarded for my examination a number of specimens she quite recently collected in Ayrshire, and this obliges me to refer once more to this very difficult and complicated subject.

In the Ayrshire Llandeilo both species and specimens of *Rhynchonella* are very abundant, and this is the more remarkable as representatives of the genus are very rare in the corresponding rock in other parts of Great Britain. Many more specimens of some of the forms of the genus will, however, require to be collected and compared before their characters can be fully determined, for they vary so much in shape and in the number of their ribs that one is often very seriously at a loss to know where to draw the line between two nearly allied so termed species.

Thus, from the Llandeilo of Ayrshire I provisionally determine, describe, and illustrate the following:

1. *Rhynchonella æmula*, Salter. 2. *Rh. Salteri*, Dav. 3. *Rh. nasuta*, M'Coy. 4. *Rh. Thomsoni*, Dav. 5. *Rh. Portlockiana*, Dav. 6. *Rh. Lapworthi*, Dav. 7. *Rh. sub-borealis*, Dav. 8. *Rh. Peachi*, Dav. 9. *Rh. Weaveri*?, Salter. 10. *Rh. Shallockiensis*, Dav. 11. *Rh. Scotica*, Dav. 12. *Rh. Girvaniensis*, Dav. 13. *Rh. Balcletchiensis*, Dav. 14. *Rh. cuneatella*; and one or two more forms approaching much in shape to *Rh. nucula* are probably specifically distinct. This number is very large and still I have not found it possible to reduce it with the material at my command, although two or three of them are uncertain, and only provisionally named, for the sake of reference.

RHYNCHONELLA BALCLETCHIENSIS, *Dav.* Sil. Sup., Pl. X, figs. 15, 16; and Pl. XI, fig. 23.

Since describing this well-marked species at p. 160 of this Supplement, Mrs. R. Gray has procured some remarkably perfect bivalve examples from the Llandeilo at Minunton, in Ayrshire.

In the dorsal valve the mesial fold commences to rise at a short distance from the umbo, is large, roof shaped, and more acute in some specimens than in others. In some examples it is simple and angular throughout, in others slightly bicipitated on its anterior third. The lateral lobes of the shell are either nearly smooth or with numerous small and but slightly prominent ribs. The ventral valve has been already described. Some of the Minunton specimens measured 6 lines in length by 7 in breadth.

128. RHYNCHONELLA CUNEATELLA, *Dav.* Sil. Sup., Pl. X, fig. 11.

Shell small, cuneiform or triangular, broadest anteriorly, tapering posteriorly, longer than wide; dorsal valve very moderately convex, slightly flattened, smooth to about two thirds of its length, anterior third with about six short, strongish ribs, of which four form a comparatively broad and slight prominent fold; ventral valve moderately convex, beak slightly incurved with a small circular foramen, surface smooth for two thirds of its length, with about five short ribs rising near the front.

Length 3, width $2\frac{1}{2}$, depth $1\frac{1}{2}$ lines.

Obs.—Since I alluded to this small shell in the last paragraph at p. 153 of this Supplement, as being perhaps referable to *Rh. cuneata*, Mrs. R. Gray has collected several more examples from the Balcletchie (Llandeilo) Conglomerate of Ayrshire, and they all were small and similar to the one figured in Pl. X of this Supplement. All the specimens were quite smooth to about two thirds or more of their length, and I am now satisfied that they cannot be looked upon as young ages of *Rh. cuneata*, which is at all ages ribbed throughout. I therefore propose to distinguish this small species by a separate name. In some examples of *Rh. cuneatella* the anterior short ribs are hardly visible. It is only by correcting and adding to descriptions of imperfectly made out species, when suitable material turns up, that we may hope ultimately to arrive at something definite.

129. *RHYNCHONELLA SCOTICA*, *Dav.* Sil. Sup., Pl. XI, fig. 26.

Shell marginally nearly circular, or about as broad as long; dorsal valve very convex, gibbous at the umbo, geniculated near the front and lateral margins, fold wide, commencing to rise at the anterior half of the valve; ventral valve convex with a wide mesial sinus, beak much incurved and coming almost in contact with the umbo of the opposite valve. Posterior half of both valves smooth. Anterior half of each valve covered with some twelve ribs, of which four occupy the fold, three the sinus. A dark line proceeding from the beak and umbo along the middle to the valves to some distance show that a septum is present in the interior of both valves.

Length 5, breadth 5, depth 4 lines.

Obs.—This is a globular little form, remarkable from the presence of a septum in both valves. It was procured by Mrs. R. Gray from the Llandeilo, at Craighead, in Ayrshire.

130. *RHYNCHONELLA PEACHI*, *Dav.* Sil. Sup., Pl. XI, fig. 25.

Shell marginally sub-pentagonal, longer than wide; valves moderately convex. In the dorsal valve a wide mesial fold begins to rise at about half its length. In the ventral valve the sinus also commences at about half the length of the valve. The posterior half of the valves are smooth, the anterior half of each valve is ornamented with nine angular ribs of which three occupy the fold, two the sinus.

Length 7, breadth $6\frac{1}{2}$, depth $5\frac{1}{2}$ lines.

Obs.—This form differs from *R. Scotica* in being larger, longer than wide, and subpentagonal in shape. It was procured by Mrs. R. Gray from the Llandeilo at Craighead, Girvan. I have named it after Mr. C. W. Peach of the Geological Survey of Scotland.

RHYNCHONELLA, sp. Sil. Sup., Pl. XI, fig. 24.

Obs.—Several specimens of this *Rhynchonella* have been collected by Mrs. R. Gray from the Llandeilo at Minunton, in Ayrshire. It has puzzled me much on account of its near resemblance to some Upper-Llandovery forms of *Rh. nucula* as well as of *R. Dayi*. I have preferred not to give it a name, and notice it here for the sake of reference, and as adding another form to the many that occur in the Llandeilo of Scotland.

RHYNCHONELLA DECEMPPLICATA, *Sow.* Dav., Sil. Mon., Pl. XXIII, figs. 20—24; Sil. Sup., Pl. XI, fig. 27.

This species is fully described at p. 177 of my 'Silurian Monograph,' and I refer to it again merely to say that Mrs. R. Gray has found the species in the Lower Llandovery or Mullock beds, at the head of Thraive Glen, in Ayrshire.

TRETENTERATA.

Genus—LINGULA, *Bruguère*, 1789.

131. LINGULA CANADENSIS, *Billings*?. Dav., Sil. Sup., Pl. XVII, fig. 1.

LINGULA CANADENSIS, *Billings*. Geol. Survey of Canada, Fossils, vol. i, p. 114, fig. 95, June, 1862.

— — ? *Dav.* Geol. Mag., new series, vol. iv, p. 16, pl. ii, figs. 4, 4 a, b, c, 1877.

Of this large and beautifully sculptured *Lingula*, Mrs. R. Gray has obtained one incomplete example. It was from the Breccia-conglomerate of Balcletchie, near Girvan, in Ayrshire. The conglomerate rests upon the compact dark-grey rock at Balcletchie, and both are considered by Prof. Lapworth to be of Llandeilo age.

It is not possible to describe this fine fossil in a complete manner, because the two anterior thirds of the valves are alone preserved. It, however, so nearly agrees in shape and sculpture with the fossil described and figured by Billings under the name of *L. Canadensis* from the Hudson-River group of Anticosti, that I have thought it preferable to leave it provisionally under that designation.¹

Lingula Canadensis is of a quadrate or sub-parallel elongated shape, posteriorly acuminate, broadest anteriorly, sides almost straight, front slightly curved, with broadly rounded angles; the smallest valve is much flattened anteriorly, and but slightly convex posteriorly or towards the beak; the larger valve is very much deeper and more

¹ I regret not to have been able to make a direct comparison of our Scottish shell with the Canadian type. No specimen of the Canadian species could be found in the Museum of the Geological Survey of Canada at Ottawa. Mr. Whiteaves kindly made every search but in vain, to discover the type.

convex. Surface of both valves covered with fine, longitudinal, radiating, thread-like radii, with shorter and narrower ones occasionally intervening between each of the larger pair, and especially so in the proximity of the front and lateral margins. From five to eight of these ridges occupy the breadth of a line. The interspaces between the longitudinal radii are about three times the width of each ridge. The surface of the valves are also covered with horizontal or concentric, narrow, rounded ridges with interspaces of about equal breadth, as may be seen in the enlarged drawing, fig. 1 *c*, of our Plate. The perpendicular and horizontal series of radii or ridges, produce on the surface of the valves a beautifully reticulated sculpture, to which the rows of bead-like projections at the points of intersection give additional prominence.

The size of Mrs. R. Gray's specimen, when complete, cannot have measured less than 1 inch and 9 lines in length by 1 inch and 3 lines in breadth. The bead-like projections recall those of *Lingula tenuigranulata*, M'Coy, a closely allied species, and which differs from the one under description by its much more finely and closely reticulate sculpture.

132. LINGULA QUADRATA, *Eichwald*. Dav., Sil. Sup., Pl. XVII, figs. 2, 3.

LINGULA QUADRATA, *Eichwald*. Zool. Specialis, vol. i, p. 273, pl. iv, fig. 2, 1829.

— — *De Verneuil*. Geol. of Russia, vol. ii, pl. i, fig. 10, 1845.

— — *d' Eichwald*. Lethæa Rossica, periode ancienne, vol. i, p. 917, 1859.

— — *Dav.* Geol. Mag., new series, vol. iv, p. 16, pl. ii, figs. 2, 3, 1877.

Shell longitudinally oval, tapering obtusely at the beaks, rounded in front, sides subparallel; valves moderately convex, surface marked with concentric lines of growth, and slightly indented longitudinal striæ along the middle of the shell.

Length $1\frac{1}{2}$ inches; breadth 1 inch 1 line.

Obs.—After comparing several Scottish specimens of this fine *Lingula* with Russian examples from Reval, given to me by Prof. F. Schmidt, I arrived at the conclusion that the specimens found by Mrs. R. Gray in the Llandeilo Limestone at Craighead Quarry, near Girvan, in Ayrshire, were referable to the Russian type of *Lingula quadrata*. In Russia the shell attains to dimensions equal to if not exceeding those of the shell we have described as *L. Canadensis*, but our Scottish examples do not quite attain those proportions.

133. *LINGULA BRODIEI*. Dav., Sil. Sup., Pl. XVII, fig. 4.

Some short time ago the Rev. P. B. Brodie forwarded for my inspection a large oblong-oval *Lingula* with subparallel sides, which he had obtained from the Woolhope Limestone at Little Hope Quarries, Woolhope. It is the largest British Upper-Silurian *Lingula* with which I am at present acquainted. It measures 1 inch 8 lines in length by 10 lines in breadth, and in general shape bears some resemblance to *L. Beechei*, Salter, from the Upper Llandovery of Marlos Bay. It can hardly be a large elongated form of *L. Lewisii*. I have given it the provisional name of *L. Brodiei*, but hardly dare, from the inspection of a single specimen, to determine whether it is new.

Mr. Brodie writes me that the Woolhope Limestone has some peculiar fossils, but that the great majority are well known in the Wenlock Limestone, that fossils, as a rule, are not very abundant in this peculiar deposit, and that it is very difficult to get out even fairly good specimens because the rock is very hard and breaks up badly.

134. *LINGULA LESUEURI*, *Ronault*. Dav., Sil. Mon., Pl. I, figs. 1—11; Sup., Vol. IV (Bud. Salt. Mon.), Pl. XL, figs. 16—20; and Sil. Sup., Vol. V, Pl. XVII, fig. 12.

<i>LINGULA LESUEURI</i> , <i>Dav.</i>	Budleigh-Salterton Brachiopoda, Supplement, vol. iv, p. 361, pl. xl, figs. 16—20.
— — —	Geol. Mag., new series, vol. vii, p. 341 pl. x, fig. 7, 1880.
— — —	Bullet. Soc. Linn. de Normandie, 3 ser., vol. v, pl. ii, figs. 2, 3, 1881.
— — —	Bull. Soc. Géol. de France, 3d ser., vol. ix, pl. vii, fig. 12, 1881.

I have already fully described and illustrated this very remarkable species, and revert to the subject once more in order to allude to the able researches by W. J. Harrison, F.G.S., and to his excellent and instructive memoir "On the Quartzite Pebbles contained in the Drift and in the Triassic Strata of England; and of their derivation from an ancient land-barrier in Central England."¹ *Lingula Lesueuri* has again been collected in some abundance by Mr. Harrison in quartzite pebbles from the Drift at Moseley, near Birmingham. The specimens or casts are sometimes found in a fine state of preservation, but, as far as I have seen, are much smaller in size than those that occur in similar pebbles at Budleigh-Salterton. It is the only species of Brachiopod from the lower portion of the Llandeilo or "Grès Armoricaïn" that has been hitherto obtained

¹ 'Proceedings of the Birmingham Philosophical Society,' vol. iii, p. 157, 1882.

from the Drift of the Midland Counties, and it is somewhat remarkable that no example of *Lingula Hawkei*, *Lingula? Salteri*, or *Dinobolus Brimonti*, which occur so plentifully with *L. Lesueurii* in the Budleigh-Salterton and Brittany localities, should have hitherto turned up in the Moseley or other Birmingham Drift localities. Along with the *Lingula Lesueurii* pebbles at Moseley and elsewhere Mr. W. Harrison found sandstone and quartzite pebbles of the age of the Caradoc or "Grès de May" with *Orthis Budleighensis* in great abundance, and in company with *Orthis Valpyana*, *O. elegantula*, ? *O. unguis*, *O. calligramma*, and *Leptaena sericea*. A few fragments also of Middle-Llandovery rock with *Stricklandinia lirata* have been collected; also Lower-Devonian pebbles, with *Spirifer Vernevili*, *Rh. Daleidensis*, *R. Valpyana*, *R. elliptica*, *R. Thebaulti*, *Orthis? laticosta?*, *O. Monnieri*, *Strophomena Edgelliana*, *Stroph. crenistria*, and one or two other species which owing to their bad state of preservation I was unable to determine.

No rock *in situ* has, however, been hitherto discovered in Great Britain containing *Lingula Lesueurii*.

Mr. Harrison remarks that "it seems perfectly clear that the quartzite pebbles which occur so abundantly in the Drift of the Midland Counties were derived from the pebbled or conglomerate which forms the middle member of the Bunter Sandstone or Lower Trias."

I have carefully examined and described the Brachiopoda from the Grès Armoricaïn of Brittany. It contains four species, viz. *Lingula Lesueurii*, *L. Hawkei*, *L.? Salteri*, and *Dinobolus Brimonti*. In the "Grès Armoricaïn" of Bagnoles, Département de l'Orne, I found *Lingula Lesueurii*, *L. Hawkei*, *L. Salteri* (very large and abundant), and *Dinobolus Brimonti* (rare). In the same rock and formation in the Département de la Sarthe are *Lingula Lesueurii* (small), *L. crumena* (abundant), and *L. Crici*, Dav. (very abundant); but in the Département de la Sarthe Mr. Guillier found no examples of *Lingula Hawkei* nor of *Dinobolus Brimonti*. At Budleigh-Salterton we have *Lingula Lesueurii*, *L. Hawkei*, *L. crumena*, *L. Salteri*, and *Dinobolus Brimonti*; so that the only species not found in our British quartzite pebbles is the *Lingula Crici*.

In a very instructive paper by the Rev. P. B. Brodie "On certain Quartzite and Sandstone Fossiliferous Pebbles in the Drift of Warwickshire," published in the 'Quarterly Journal of the Geological Society' for August, 1881, will be found many points of much interest relating to the possible source of derivation of the quartzite pebbles of the Midland Counties.

135. *LINGULA PHILIPI*, *Dav.* Sil. Sup., Pl. XVII, fig. 5.

Shell small, sub-quadrate, sides almost parallel, front rounded, beak obtusely acuminated; valves convex and slightly depressed along the middle; surface smooth, marked with a few concentric lines of growth.

Length 5, width 4 lines.

Obs.—This small shell was found by Mr. R. Philip in shales forming the highest portion of the Upper Llandovery at Minsterley, Salop. It differs from other Upper-Silurian species of the genus by its shape, and the comparatively great convexity of its valves.

I have named the fossil after Mr. R. Philip, who has afforded me much information with respect to the geology and palæontology of the Minsterley district.

136. *LINGULA ATTENUATA*, *Sow.* *Dav.*, Sil. Mon., Pl. III, figs. 18—27; and Sil. Sup., Pl. XVII, figs. 13—19.

Since describing this species at p. 44 of my 'Silurian Monograph,' a very large number of specimens of the shell from different localities have passed through my hands. It is an exceedingly abundant fossil in the Llandeilo at Ardmillan Brae and Balcletchie, in the Girvan district of Ayrshire, and has been collected also by the Geological Survey of Scotland in a rock of a similar age, situated three miles south of Broughton, in Peebleshire. It has also been found in abundance by Mr. R. Philip in the Upper Llandeilo at Meadow Town, Minsterley. The Rev. P. B. Brodie has procured the fossil from the Lower Caradoc of Horderley, Salop; and Mrs. R. Gray has found some in the upper zones of the same formation at Drummuck, in Ayrshire.

137. *LINGULA RAMSAYI*, *Salter.* *Dav.*, Sil. Mon., Pl. III, figs. 49—52; and Sil. Sup., Pl. XVII, figs. 6—11.

"A large pentagonal species," Salter.

This has been found by Mrs. R. Gray to occur in the Llandeilo at Craighead, Balcletchie, and Minuntion, in the Girvan District, Ayrshire, in company with *Lingula attenuata*. Though the larger number of specimens are decorticated or have lost their outer finely sculptured surface, yet this may be seen here and there on well-preserved examples. *L. Ramsayi* varies a good deal in shape, and is rarely met with in

a good state of preservation; the usual dimensions of the Balclutchie specimens is 7 lines in length by 6 in breadth. A well-preserved example from Minuntion measured 9 lines in length by 6 in breadth.

138. *LINGULA BREVIS*, *Portlock*. Dav., Sil. Mon., Pl. III, figs. 34—39; Sil. Sup., Pl. XVII, figs. 26—30.

This small fossil has been found by Mrs. R. Gray in the Llandeilo at Balclutchie, Girvan; but it is more plentiful in the Middle Caradoc at Whitehouse Bay and Shallock Mill in the Girvan District. The shell was also obtained by the Rev. P. B. Brodie from the Lower Caradoc at Horderley in Salop. None of the specimens that have passed through my hands exceeded some 3 or 4 lines in length. It is very ovate in shape.

139. *LINGULA GRANULATA*, *Phillips*. Dav., Sil. Mon., Pl. II, figs. 15—18; and Sil. Sup., Pl. XVII, figs. 20, 21.

“A fine square species, with granular line of growth, crossed by regular fine rays.”—Salter. “Cam. Cat.,” p. 34.

Several specimens, which I cannot distinguish from Phillips’ type, were found by Mrs. R. Gray in the Llandeilo at Ardmillan Brae, Girvan. On the internal cast of some specimens may be seen a small longitudinal depression, similar to that observable in some of the Dynevor Park examples. The Llandeilo in Scotland is very rich in forms of *Lingula*, no less than six species having been collected in the Girvan district by Mrs. R. Gray.

An uncertain specimen of *Lingula ovata?* has likewise been met with by Mrs. Gray at Drummuck in the upper zone of the Caradoc.

Genus—LINGULELLA, *Salter*, 1861:

“The earliest *Lingulæ* differed from modern ones in having a groove under the beak for the passage of the pedicle, and thus being more like *Obolus*.”—Salter. “Cam. Cat.,” p. 8.

140. *LINGULELLA PRIMÆVA*, *Hicks*. Dav., Sil. Sup., Pl. XVII, figs. 33, 34.

LINGULELLA PRIMÆVA, *Hicks*. Quarterly Journal Geol. Soc., vol. xxvii, p. 401,
 pl. xv, figs. 13, 14, 1871.
 — — — Popular Science Review, new series, vol. v, 1882.

Shell marginally elongate-oval, broadly and acutely acuminate posteriorly, rounded anteriorly. Valves very slightly convex, and marked at intervals with concentric lines of growth.

Length 7 lines by 3 or 4 in breadth.

Obs.—This very ancient fossil occurs in tolerable abundance at the base of the purple sandstones at Caerfai, Nun's Well, and Porthclair Harbour, on the south coast of St. David's—Upper Longwynds of Murchison or base of the Harlech (Lower Cambrian). This species was discovered by Dr. Hicks, and described and figured by him in 1871. Since then, in 1873, some slightly larger examples were collected by the same distinguished geologist, and I now give a figure of one of them. The shell is, however, usually found much out of shape; and it is very difficult to obtain specimens with their real form well preserved. *L. primæva* occurs in these ancient red rocks associated with *Lingulella ferruginea* and *Discina Caerfaiensis*. *L. primæva* is a larger shell than *L. ferruginea*, and may be easily distinguished from it. We have added a figure of a specimens from the purple rocks of Porthclair Harbour (Sil. Sup., Pl. XVII, fig. 35) to facilitate comparison.

According to Dr. Hicks, the *Caerfai Group* consists chiefly of conglomerates, sandstones, and purple and green slates and shales; remains of animal life are found throughout. The most important of these were discovered by him in 1868, in red slates near the base, and consist of a *Lingulella*, *Discina*, *Leperditia* (?), a doubtful head of a Trilobite, and abundant traces of Annelids. They are therefore the earliest animal remains with which we are at present acquainted in Great Britain.

141. *LINGULELLA NICHOLSONI*, *Callaway*. Dav., Sil. Sup., Pl. XVII, figs. 31, 32.

LINGULELLA NICHOLSONI, *Callaway*. Quarterly Journal Geol. Soc., vol. xxxiii, p. 668,
 pl. xxiv, figs. 11, 11 a, 11 b, 1877.

“This is a larger species than *L. ferruginea*, and its sides are not parallel. It closely resembles *L. lepis*, but *L. lepis* is wider towards the front, according to Davidson's figure. The Shineton Shales at Shineton, Mary-Dingle, Dryton, Cressage, Bull-Hill

Cottage, west of Harley, under Cound-Moor Quarry, and Pedwardine. Common." (Callaway.)

Length 5, breadth 4 lines.

The Shineton Shales form part of the Tremadoc Series. *L. Nicholsoni* is found associated with *Obolella Sabrinae*, Callaway.

Genus—DISCINA, *Lamarck*, 1819.

142. DISCINA CAERFAIENSIS, *Hicks*. Dav., Sil. Sup., Pl. XVII, figs. 37, 38.

DISCINA PILEOLUS? *Hicks*. Quarterly Journal Geol. Soc., vol. xxvii, pl. xv, figs. 12
12 a, 1871.

— CAERFAIENSIS, *Hicks*. Popular Science Review, new series, 1882.

Shell small, circular; upper valve conical; vertex situated at about a third of the length of the shell from the posterior margin. Surface marked with concentric lines of growth.

Length and breadth about 2 lines.

Obs.—Only one specimen of this small shell was obtained by Dr. Hicks from the red rocks at the base of the purple slates and shales or Middle Caerfai Group = Lowest Cambrian of St. David's, in Wales. It is the oldest species known to me of the genus, and is found in company with *Lingulella primæva* and *L. ferruginea*. Dr. Hicks, in 1871, did not describe his species, but gave two figures of the shell, and referred them with uncertainty to *D. pileolus*. In 1882 he distinguished it by the name of *Caerfaiensis*, and presented the type to the Woodwardian Museum, Cambridge.

143. DISCINA OBLONGATA, *Portlock*. Dav., Sil. Mon., Pl. VII, figs. 1—9; Sil. Sup., Pl. XVII, figs. 43—46.

This species has been found by Mrs. R. Gray to occur in great abundance in the Llandeilo at Balcletchie and at Ardmillan Brae, Girvan, Ayrshire. A specimen also, which I cannot distinguish from it, was found by the same lady in the Upper Caradoc at Drummuck, near Girvan.

144. *DISCINA PERRUGATA*, *M^cCoy.* Dav., Sil. Mon., Pl. V, figs. 19—24; Sil. Sup., Pl. XVII, fig. 47.

Discina perrugata is an abundant fossil in the Llandeilo at Craighead, and Balclechie, in Ayrshire. It is quoted in my Monograph as from the Caradoc of Craighead, but since then Prof. Lapworth has determined that the Craighead beds are of Llandeilo age.

145. *DISCINA?* *BALCLECHIENSIS.* Dav., Sil. Sup., Pl. XVII, figs. 41, 42.

Shell minute, about two lines in length by a trifle less in breadth. Marginally elongated-oval or quite circular; upper valve conical, very gently convex, with a submarginal apex, and a narrow, slightly convex rim or border all round the valves. Surface smooth, marked by fine concentric lines.

Obs.—This remarkable and very small fossil occurs by thousands in a black rock of Llandeilo age at Balclechie, Girvan, Ayrshire, where it was discovered by Mrs. R. Gray. It is more often found in the condition of casts, but sometimes it has its shell well preserved. Mrs. R. Gray has also found several specimens, exactly similar to those from the Llandeilo, in the Upper Caradoc at Thraive, Girvan.

I feel somewhat uncertain whether this small fossil is a *Discina* or even a Brachiopod. I have failed to detect any muscular or other impressions on the casts.

146. *DISCINA PORTLOCKII*, *Geinitz.* Dav., Sil. Sup., Pl. XVII, figs. 39, 40.

DISCINA PORTLOCKII, *Geinitz.* Die Graptolithen, pl. i, 1852.

— — — Swanston, Belfast Naturalist Field-Club, Appendix, pl. vii, fig. 22, 1876.

Shell small, elongate-oval, gently convex; apex submarginal; surface marked with fine concentric lines.

Length $2\frac{1}{2}$, breadth 2 lines.

Obs.—Of this small species I have never seen more than two examples, presented to me by Mr. Swanston, and which he had collected from black slates, referred by him to the

Caradoc, at Ballygrot, County Down, Ireland. He states that the fossil occurs also in the Hartfell Shales and Glenkiln Shales of the Moffat Series in Scotland. In general shape and dimensions it much resembles *Discina? Balclutchiensis* from the Llandeilo of the Girvan district, but is wanting of the raised ring-shaped margin which surrounds the valves of that species.

Genus—*OBOLELLA*, *Billings*, 1861.

147. *OBOLELLA SABRINÆ*, *Callaway*. Dav., Sil. Sup., Pl. XVI, figs. 27, 28.

OBOLELLA SABRINÆ, *Call.* Quart. Journ. Geol. Soc., vol. xxxiii, p. 669, pl. xxiv, fig. 12, 1877.

Shell small, transversely oval; upper valve conical; vertex submarginal; surface smooth. Slightly more than 1 line in length by nearly 2 in breadth.

Dr. Callaway remarks that "This species bears a close resemblance to *Obolella sagittalis*, Salter, of the Menevian Rocks, but is broader, and has the ventral valve more conical; the median ridge is larger and longer, and the valves are furnished with areas." Also that he "Originally described this form, from incomplete materials under the name of *Metoptoma Sabrinæ*; the conical ventral valve closely resembling a patelloid Gastropod." *O. Sabrinæ* occurs in the Tremadoc or Shineton Shales, Mary-Dingle, Dryton, one mile west of Cressage, west of Harley, under Cound-Moor Quarry, and where the fossil is common.

148. *OBOLELLA SAGITTALIS*, *Salter*. Dav., Sil. Mon., Pl. I, figs. 1—14; Sup. Pl. XVI, figs. 25, 26.

Since describing this species at page 339 of my 'Silurian Monograph,' the fossil has been collected by the Geological Survey of Scotland, along with *Discina Portlocki* (Geinitz), at Cairn Burn, Druidhill Burn, in Dumfriesshire. It is also quoted by Prof. W. C. Brogger, at page 45 of his fine work 'Die Silurischen Etagen 2 und 3 im Kristianiagebiet und auf Eker,' 1882, as occurring in Sweden, as well as by Dr. G. Linnarsson in the 'Sveriges Geologiska undersökning,' No. 35, pl. iii, figs. 45—49, 1879. It seems to be a good species and characteristic fossil.

Genus—DINOBOLOUS, *Hall*, 1871.149. DINOBOLOUS ? HICKSII. *Dav.*, *Sil. Sup.*, Pl. XVI, fig. 19.

DINOBOLOUS ? HICKSII, *Dav.* Hicks on the Succession of the Ancient Rocks in the Vicinity of St. David's, *Quart. Journ. Geol. Soc.*, vol. xxxi, p. 188, pl. x, fig. 6, 1875.

Shell marginally transversely oval; $1\frac{3}{4}$ inch in width, by about 1 inch in length; very slightly convex, and marked with concentric lines of growth.

One obscure example of this species was found by Dr. Hicks at Llanvirn Quarry in the Upper Arenig, and was with some uncertainty referred by myself to the genus *Dinobolus*. It most nearly resembles *Dinobolus transversus*, Salter, from the Wenlock Shales. If correctly identified, this is the earliest known species of the genus hitherto recorded. The type specimen was presented to me by its discoverer.

150. DINOBOLOUS DAVIDSONI, *Salter*. *Dav.*, *Sil. Mon.*, Pl. IV, figs. 30—39; *Sil. Sup.*, Pl. XVI, fig. 20.

I allude to this species once more, to say that a well-preserved example was discovered by Mr. W. H. Baily in the Lower Wenlock or Upper Llandovery at Ugool, near Ballaghadereen, County Mayo, and may be seen in the Museum of the Geological Survey of Ireland.

Genus—KUTORGINA, *Billings*, 1861.151. KUTORGINA CINGULATA, *Billings*. *Dav.*, *Sil. Mon.*, p. 342, Pl. L, fig. 25.

This species continues to be rare. Mr. Salter remarks that it is a very unusual form for the genus; one valve nearly flat, and with a straight hinge-line; the smaller valve convex.

Genus—ACROTRETA, Kutorga, 1848.

152. ACROTRETA NICHOLSONI, *Dav.* Sil. Mon., Pl. XLIX, figs. 30—34; Sil. Sup., Pl. XVI, figs. 21—23.

At p. 343 of my 'Silurian Monograph' I described and figured a series of specimens of this species from the black shales of the Upper Llandeilo beds of Dobbs Linn, near Moffat, in Dumfriesshire. Since then Mrs. R. Gray has found the same fossil in some abundance in the Llandeilo at Craighead, Ardmillan Brae, and Balclatchie, in the Girvan district of Ayrshire. The specimens are larger and the ventral valve deeper and more pyramidal than in those that have passed through my hands from Moffat. I have therefore added a series of figures to more fully illustrate the characters of the species. Mrs. R. Gray's largest examples of the ventral valve measured 5 lines in length by about the same in breadth.

In his paper on the "Silurian Rocks of the County Down, Ireland" ('Proceedings of the Belfast Natural History Club,' Appendix for 1876—77), Mr. W. Swanston states to have found *A. Nicholsoni* at Coal-Pit Bay, County Down, Ireland.

153. ACROTRETA? COSTATA, *Dav.* Sil. Sup., Pl. XVI, fig. 24.

Shell small; dorsal valve semicircular, $1\frac{1}{2}$ lines in length by about the same in breadth. Ventral valve pyramidal, 2 lines in length, extremely truncated by a small circular foramen, area triangular, large in proportion to the size of the specimen. Surface of valve bears a few comparatively strong ribs.

Obs.—One specimen only was found by Mrs. R. Gray in the Llandeilo at Balclatchie, Girvan, Ayrshire. It very nearly resembles *Acrotreta Nicholsoni* in size and shape but differs from it by its costæ or ribs.

Genus—ACROTHELE, Linnarsson, 1875.

In his valuable paper on the "Brachiopods of the Paradoxides-beds of Sweden" ('Bihang till k. Svenska Vet. Akad. Handlingar,' Band 3, 1876), also in his memoir 'Om Faunan i Kalken Sveriges geologiska Undersökning,' p. 25, pl. iii, 1870, Prof. G.

Linnarsson proposes a new genus, *Acrothele*. "Shell corneous, composed of several laminae, the inner smooth and polished, the outermost one rough and opaque. Ventral valve slightly conical, with excentric umbone pierced by a minute foramen, in front of which there are, at least in one species, two small wart-like protuberances. The field between the umbone and the posterior margin is usually a little flattened, thus forming a slight inclination of the false area. Dorsal valve with marginal umbone, consisting of two wart-like protuberances. In the interior of the dorsal valve there are two oblong, diverging, muscular scars close to the posterior margin, and two small, rounded scars near the middle. The muscular scars are separated by a longitudinal ridge" (Linnarsson). Prof. Linnarsson adds also that the most nearly related genera are, he thinks, *Obolella* and *Acrotreta*.

154. ACROTHELE GRANULATA, *Linnarsson*. *Dav., Sil. Sup., Pl. XVI, figs. 29, 30.*

ACROTHELE GRANULATA, *Linn.* *Bibang till k. Svenska Vet Akad. Handlingar, Band 3, pl. iv, fig. 51 (and 52 ?), 1876.*

— — *Swanston. Proc. of the Belfast Nat. Field-Club, pl. vii, fig. 20, 1876, 1877.*

"Shell almost circular, a little wider than long; ventral valve very slightly conical, umbone pointed, very excentric, the distance from the front being about four times that from the posterior margin. The shape cannot be exactly defined from the materials hitherto obtained.

"Of a false area there is hardly more than a slight trace, only a very narrow space between the umbone and the posterior margin showing a slight difference from the other parts of the shell. The anterior part of the valve is depressed. The inner shell-layers are smooth and polished, the outermost one opaque, granulated, and marked near the circumference by concentric lines of growth. The interior is unknown as well as the dorsal valve. The only specimen of the ventral valve measures length 8 millimètres, breadth 9." (Linnarsson.) From the Paradoxides-beds, Öland, Sweden.

I have reproduced Prof. Linnarsson's description, as our Irish examples agree well with it. The description and illustrations are, however, rather vague on account of the material in his and in our possession being very incomplete. We are still unacquainted with the interior of the valves.

Acrothele granulata was discovered for the first time in the British Isles by Mr. W. Swanston, who found several casts or impressions of the shell in a black, highly-indurated shale at Coal-Pit Bay, County Down, Ireland. The rock is referable to the Upper Llandeilo, and the shell under description is associated with *Acrotreta Nicholsoni* and *Discina Portlockii*. Our Irish specimen measures $2\frac{1}{2}$ lines in length by 3 in breadth. I think the species will be found to occur in Scotland.

Genus—CRANIA, *Retzius*, 1781.

155. CRANIA SILURIANA, *Dav.* Sil. Mon., Pl. VIII, figs. 19, 20; Sil. Sup., Pl. XVII, figs. 49—53.

Since this species was described at p. 82 of the 'Silurian Monograph,' Mr. John Gray, of Hagley, discovered several exteriors and a very fine interior of this species attached to a slab of Wenlock Limestone from Dudley. The specimen measured 5 lines in length and slightly over 5 in breadth. The flattened margin is broad, and four muscular scars are beautifully defined, the central pair being the largest.

Specimens, also, of the exterior of a *Crania* which I cannot distinguish quite from *Crania Siluriana*, were collected by Mrs. R. Gray in the Middle Llandovery at Woodland Point, and in the Lower Llandovery at Mullock Hill in Ayrshire.

156. CRANIA CROFTI, *Dav.* Sil. Sup., Pl. XVII, figs. 54—56.

Shell large, subquadrangular, or nearly circular, slightly indented anteriorly as well as posteriorly; upper or unattached valve conical and deep, with a deepest sinus or depression commencing at the extremity of the apex and occupying a large part of the anterior half of the shell. Surface of valve covered with fine irregular radial striæ; in the interior there is no flattened margin, the interior cavity sloping away rapidly from the outer edge; under the posterior or inner edge are two small, oval-shaped, slightly-projecting muscular prominences, separated by a short, rounded, longitudinal ridge, and further down, near the centre of the valve, are two rather larger projections, formed by the adductor muscle; from the centre of the posterior margin the shell becomes convex, this convexity corresponding to the depression on the exterior of the valve; lower or attached valve not known.

Two specimens measure—length 13, width 15, depth 7 lines; length 5, width 6, depth $3\frac{1}{2}$ lines.

Obs.—Of this fine large *Crania* Mr. C. Croft found two or three examples in the Caradoc at Ty-Isaf, Llansantffraid, in Wales. It is only slightly smaller than *Crania Rhychohtiana*, de Koninck, from the Lower Carboniferous Limestone of Ireland, the

internal cast, of which I have figured and briefly described for the sake of facilitating comparison.¹

I have named this large and fine Lower-Silurian *Crania* after its discoverer, C. Croft, Esq., of Manchester, who kindly sent me his specimens for description and illustration.

Genus—PHOLIDOPS, *Hall*, 1859.

157. PHOLIDOPS IMPLICATA, *Salter* sp. Dav., Sil. Mon., Pl. VIII, figs. 13—18; Sil. Sup., Pl. XVII, fig. 48.

This small species is fully described at p. 80 of my 'Silurian Monograph' as *Crania implicata*, Sow. sp. Since then I have considered it desirable to retain for it Hall's generic name "*Pholidops*." Although closely related to *Crania* it differs from it in some particulars, both valves being free. It is not a very rare Wenlock fossil. Mr. G. Maw obtained it through his washing operations in the Upper and Lower Ludlow, and in shales above the Wenlock Limestone in the neighbourhood of Benthall Edge and Bromley, more abundant in the Upper Wenlock Shales or Tickwood beds, near Tickwood, Salop; also, but less abundantly, in the Lower Wenlock Shales at Buildwas in the same county. It is also found in the Wenlock Limestone. In Scotland it occurs in the Wenlock series of the Pentland Hills, and Mrs. R. Gray has obtained it from the Middle Llandovery at Woodland Point as well as from the Penkill beds at Penwhapple Glen in Ayrshire. It has also been collected by Prof. Lindström in the Wenlock rocks of the Isle of Gothland.

¹ CRANIA RYCHOLTIANA, *de Koninck*. Dav. Carb. Monograph, pl. xlviii, figs. 15, 16, 17, and Sil. Sup., pl. XVII, fig. 57.

I have already described this fine species at p. 195 of my 'Carboniferous Monograph,' and have given figures of its exterior. Since then Mr. W. H. Baily, of the 'Geological Survey of Ireland,' found a large and very fine internal cast of the upper valve of this species in the Lower Carboniferous Limestone at Townland of Legilly, near Castlecaulfield, County Tyrone, Ireland, among the *débris* of an old quarry. The specimen belongs to the Museum of the Geological Survey of Ireland; it measures $14\frac{1}{2}$ lines in length by 15 in breadth and 5 in depth, and is almost circular and conical, with the apex at about the centre. The muscular and vascular impressions are clearly defined. The specimen is much less deep or conical than is the *Crania Crofti*, and does not possess the anterior sinus or depression characteristic of the Lower-Silurian form.

Genus—SIPHONOTRETA, *de Verneuil*, 1845.

158. SIPHONOTRETA SCOTICA, *Dav.* Sil. Sup., Pl. XVI, figs. 31—33.

SIPHONOTRETA SCOTICA, *Dav.* Geol. Mag., new series, vol. iv, p. 13, pl. ii, figs. 5, 6, 1877.

Shell oblong, oval, anterior half broadly rounded, posterior half tapering (in the ventral valve) into an acuminate beak, perforated at its extremity by a small, circular aperture; valves moderately convex and marked with numerous concentric ridges, from which fringes of closely-packed and adpressed spines take their rise. These tubular spines measure about 1 line in length, are straight and smooth.

Length of shell 7 lines by 6 in breadth.

Obs.—Some few years ago Mrs. R. Gray discovered in the Llandeilo at Craighead and Minuntion, in Ayrshire, several incomplete examples of a *Siphonotreta*, differing specifically from *S. anglica*, Morris, from the Upper Silurian or Wenlock Shale, and from *S. micula*, M'Coy, which abounds in the Llandeilo Flags of various English, Scottish, and Irish localities. We are therefore at present acquainted with three British species of *Siphonotreta*, two of which are characteristic of distinct geological horizons.

It is not, however, possible, from the crushed and fragmentary condition in which these specimens have been found, to give a complete description of the shell or to establish any satisfactory comparisons between it and the Russian or Bohemian species of the genus. We considered it, therefore, advisable in 1877 to give to the Scottish form a provisional separate name. Much still has to be discovered with respect to the interior characters of this remarkable genus. Some of its internal arrangements have, it is true, been carefully investigated, described, and illustrated by M. de Verneuil, Dr. Kutorga, Dr. d'Eichwald, myself, and others.¹

The questions relating to its affinities, muscular and other arrangements, present great difficulties, which the material in our possession does not allow us to solve in a satisfactory manner. The form and character of the perforated beak have been well described by Dr. Kutorga. During his visit to Brighton, in 1876, I asked Prof. F. Schmidt if he could procure me a sharply-marked and well-preserved internal cast of the Russian *Siphonotreta unguiculata*, and on his return to Reval, in his usual kind and

¹ 'Geol. Mag.,' new series, vol. iv, pl. 11, 1877.

obliging manner, he lost no time in sending me the much desired example. I published in vol. iv., new series, of the 'Geol. Mag.' for January, 1877, enlarged figures of this internal cast, which showed that the muscular scars occupied a small space in the umbonal portion of both valves. Although the impressions were tolerably well defined, neither Prof. King or myself could interpret them as clearly as we desired, and more material will be required before that can be satisfactorily achieved.

It is quite evident, however, that the genus belongs to King's division *Tretenterata*, or to that group of Brachiopoda, such as *Lingula*, which are destitute of an anal aperture, and it appeared to both of us that the specimen we have been able to examine favour the idea that *Siphonotreta* is more closely related to *Obolus* and *Discina* than to *Monomerella*, though the last genus may still lay some claim of being its kindred.

We all know that *Obolus* has a large muscular scar (*a*) close to, and at each end of, the edentulous hinge on both valves; each scar is separated from another (*b*), much elongated by a ridge (*c*). Professor King thinks the two ridges are present in the internal cast sent to me by Prof. F. Schmidt, and though the evidences on the valve are perplexing, there being appearances of two scars, or a compressed one situated at the origin of the ridge, the evidence is somewhat in favour of the scar belonging to or representing the scar *a* of *Obolus*. In *Obolus* the scar *a* is well pronounced, lying outside of, and distinctly separated from, the ridge. In *Discina* there are two posterior adductor muscles, leaving strong scars similarly situated, and these Prof. King considers to correspond to those of *a* in *Obolus*.

If this be a correct interpretation as regards the scars at the origin of the ridge in *Siphonotreta*, the affinities of this genus, as above stated, will be more on the side of *Obolus* and *Discina* than of *Monomerella*. *Monomerella*, as has been stated elsewhere by Prof. King and myself, does not appear to have posterior adductors; but they may have been atrophied, thus causing the genus to be a little more removed than *Siphonotreta* from *Obolus* and *Discina*. The muscular impressions in *Obolus* are more spread out than in either *Discina* or *Siphonotreta*, and Prof. King thinks that this difference appears to be explained thus: the latero-cardinal scars in *Siphonotreta* are more crowded together than they are in *Obolus*, and the central projecting portion of the undercut, "spectacle-like" impressions in *Obolus* advance more to the adductor margin of the valve than the corresponding impressions in *Siphonotreta*.

In *Siphonotreta scotica* the spines are very short and do not, any more than those figured by Kutorga, show that peculiar moniliform character so well described and figured by Morris in the much longer spines of *Siphonotreta anglica*.

Mr. J. F. Whiteaves, of the Geological Survey of Canada, has kindly sent for my inspection three specimens of *Siphonotreta* from the Lower Silurian (Utica Slate or upper part of the Trenton Limestone), near Ottawa City, Ontario, which in every respect agree with the shell I have described under the name of *Siphonotreta scotica* from the Llandeilo of Craighead, Girvan. The Canadian specimens measure 6 lines in length

by 5 in breadth, exclusive of the fringe of small spines, these spines being 1 line in length.

159. *ORTHIS ELEGANTULINA*, *Dav.*¹ Sil. Sup., Pl. XIII, fig. 17.

ORTHIS ELEGANTULINA, *Dav.* Geol. Mag., vol. viii, p. 152, April, 1881.

Shell small, nearly circular, and about as broad as long; dorsal valve moderately convex, divided longitudinally by a sinus of greater or lesser depth, hinge-area narrow; ventral valve deeper and more convex than the dorsal one, and slightly longitudinally keeled; hinge-line shorter than the breadth of the shell, beak small, incurved, area triangular, fissure small. Surface of both valves marked by strong raised striæ, bifurcating once or twice as they near the lateral and frontal portions of the valves.

Length 3, width 3, depth 2 lines.

Obs.—My attention was first drawn to this elegant small shell at the commencement of 1880 by Mr. J. E. Walker. It is much smaller than *Orthis elegantula* and more circular, its beak much less incurved and of smaller proportions, and its ribbing or striation is comparatively much stronger than in *O. elegantula*.

O. elegantulina swarms in the Lower Wenlock Shales of Buildwas in Shropshire, and was obtained in thousands by Mr. G. Maw from his washings of Lower Wenlock Shales. It is less abundant in the Upper Wenlock Shales.

NOTE.—Since the descriptions of the Silurian *Rhynchonella* were put into type it has been noticed that the specific name *Glassii* has been made use of for two distinct species. I will therefore alter the name *Glassii* at p. 155 (Pl. X, fig. 22) of this Supplement to that of *Glassiana (Atrypa depressa, Sow.)*.

¹ This description was inadvertently omitted at its proper place. It should have come in at p. 192 of this Supplement.

SCOTTISH SILURIAN BRACHIOPODA.

It has always been my desire throughout the preparation of the work 'On British Fossil Brachiopoda' to do all the justice within my power to the species of this class that occur in the fossiliferous rocks of Scotland; consequently from the very beginning until the end my endeavours have never relaxed, and no trouble has been spared, in the search for and study of all obtainable material.¹

At the commencement of my researches only a small number of Scottish Brachiopoda had been discovered and described, but as the work proceeded I was zealously assisted in the search for specimens by many kind and well-wishing Scottish geologists, among whom I would name Sir R. Murchison, Mr. Hugh Miller, Dr. Fleming, Dr. D. R. Rankin, of Carluke, Prof. H. A. Nicholson, Dr. J. Young, Dr. D. Bryce, Dr. R. S. Hunter, Mrs. R. Gray, Prof. A. Geikie, Prof. D. Page, Prof. C. Lapworth, Prof. J. Nicol, Mr. J. Young, of the Hunterian Museum, Glasgow, Mr. J. Armstrong, Mr. J. Thomson, Mr. J. Neilson, of Glasgow, Mr. R. Craig, of Beith, Mr. J. Smith, of Kilwinning, Mr. R. Slimon, of Lesmahago, Mr. J. C. Moore, Mr. G. Binney, Mr. A. Somervail, Mr. J. Henderson, Mr. G. C. Haswell, Mr. D. J. Brown, and Mr. C. W. Peach, of Edinburgh, Mr. Alex. Robertson, of Elgin, Mr. D. Robertson, of Glasgow, Rear-Admiral E. J. Bedford, R.N.; to all of these I am also indebted for much valuable information. I have likewise received important help from Prof. J. W. Judd, Mr. J. W. Salter, Mr. J. W. Kirkby, Mr. R. Etheridge, jun., and Dr. J. Gwyn Jeffreys, who had also devoted attention to Scottish recent and fossil forms. To all I would once again tender my grateful acknowledgments.

From all the Scotch materials that have passed through my hands for examination during the last thirty-three years, I have been able to determine, describe, and illustrate some 4 recent species, 2 Post-Tertiary, 17 Liassic and Oolitic, 59 Carboniferous, and about 134 Silurian, making a grand total of some 216 so-termed species. This is a large number from a country that had been so long considered as scarcely fossiliferous in this respect. And when it is borne in mind that it is only from the Jurassic, Carboniferous, and Silurian formations that Scottish Brachiopoda have been obtained, the number of species is certainly remarkable.²

¹ In 1835, or nearly forty-eight years ago, I began to collect Scottish Brachiopoda in the County of Midlothian, while assisting my friend Mr. R. J. Cunningham in the preparation of his Essay on the 'Geology of the Lothians.'

² We have, it is true, Tertiary, Cretaceous, and Devonian rocks *in situ* in Scotland, but none of these formations, otherwise fossiliferous, there have hitherto afforded us a single species of Brachiopoda. The

In his very valuable opening address to the Royal Physical Society of Edinburgh "On the Palæozoic Conchology of Scotland," 1881, Mr. R. Etheridge, jun., recapitulated, among other things, all that had been published with respect to the *Carboniferous* and *Silurian Brachiopoda*. In this able memoir Mr. Etheridge reminds his readers that the existence of Lower Palæozoic rocks in Scotland was first announced by Dr. James Hutton in the year 1795, and by his friend and fellow-labourer, Sir James Hall, speaking of "forms of cockles quite distinct and of great abundance in an Alpine limestone at Wrae Hill, in the Parish of Broughton in Peeblesshire;" also that fossils were found by Laidlaw, the friend of Sir Walter Scott, and that it is highly probable that some of the so-called "cockles" were Brachiopods. Mr. Etheridge states likewise that Thomas Steven, in a paper read before the Wernerian Society of Edinburgh on the 8th April, 1843, was the first to tell us that he had found shells at Little Ross, which appeared to belong to the genus *Terebratula*.

In 1844 Prof. J. Nicol gave a list of organic remains derived from the strata of Girvan, of which three were Brachiopoda. This communication was, in 1847, followed by another in vol. iv of the 'Quarterly Journal of the Geological Society,' and in this Mr. J. W. Salter described several Scottish Silurian Brachiopoda that had been obtained by the Earl of Selkirk and Sir R. Murchison. The same distinguished palæontologist alluded also in 1848 to five species collected by Professor J. Nicol in the Silurian rocks of the Valley of the Tweed; and he likewise communicated, as a short note to Mr. J. C. Moore's paper, "Descriptions of some Silurian Brachiopoda from the Stinchar River and Slates of Loch Ryan." Prof. M'Coy described a few Scottish Silurian Brachiopoda procured by the Rev. A. Sedgwick; and in the 'Annals of Nat. History' for 1850-52 alludes to some more. In 1851 a list of seventeen species of Brachiopoda from the Silurian rocks of Ayrshire, collected by and for Sir R. Murchison, was published by Mr. Salter. This was at that time a great advance in our knowledge of the subject; now, however, we are acquainted with 134 so-termed species from the same district.

In 1867 Mr. C. W. Peach found a Brachiopod in the Lower Silurian rocks of Sutherlandshire, and this at the time was looked upon as an important discovery.

In 1858 Prof. A. Geikie had been so fortunate as to discover in the Upper Silurian rocks of the Pentland Hills a species of Brachiopod; and this led to an active study of the beds and a careful and assiduous search for more specimens by Messrs. R. Gibb, J. Tertiary beds on the West Coast of the Island of Mull contain leaves of dicotyledonous plants, described by his Grace the Duke of Argyll in 1857.

Several species of *Cretaceous* Brachiopoda were found in Chalk-flints on the shore of Aberdeenshire, and I described and figured them in the 'Geologist' for December, 1862, but no rock *in situ* has been found to contain them. See also Salter and Fergusson, 'Quart. Journ. Geol. Soc., vol. xiii. p. 84, &c.

Devonian rocks are largely represented in Scotland by the "Old Red Sandstone," which Hugh Miller has rendered classical through his admirable works, entitled 'The Old Red Sandstone,' 'The Footprints of the Creator,' and others. Its wonderful fishes he admirably described; but, as he has often told me, no vestige of a Brachiopod was he ever able to discover.

Haswell, J. Henderson, J. D. Brown, and myself; hence resulted the discovery of twenty-seven species. Some of these were briefly described by the observers above named, but more fully by myself in the 'Transactions of the Geological Society of Glasgow' for the year 1868.¹ The few Llandeilo Brachiopoda of the Moffat series were discovered and collected by Mr. J. Stevens, and Profs. H. A. Nicholson and C. Lapworth, and will be found figured and described in my Monograph. Two species of Brachiopoda were also obtained by Messrs. Slimon and Page from the Upper Silurian rocks of Lesmahago and have been illustrated by myself in the 'Transactions of the Glasgow Geological Society.'

It is, however, to the able and indefatigable exertions of Mrs. Robert Gray, of Edinburgh, during the last twenty or more years, that the most important advance to our knowledge with respect to Scottish Upper- and Lower-Silurian Brachiopoda is due. Mr. and Mrs. Gray have collected in the Girvan district during a portion of each successive year since about 1860, carefully noting the horizons and localities from which each of their specimens had been obtained; and with great liberality they have placed their very large collections of Brachiopoda in my hands for description and illustration. Prof. C. Lapworth has likewise afforded me much valuable information and help by giving me the exact horizons from which Mrs. Gray's fossils have been obtained. Hence I have been able to describe and determine upwards of 100 species, of which a great number have proved to be quite new and special to the districts, and unknown from any other British formation or locality.

I must now mention with great praise the important and most useful 'Catalogue of the Western-Scottish Fossils,' prepared by Messrs. James Armstrong, John Young, and David Robertson, 1876. This valuable work, which reflects great credit on the gentlemen above named, contains lists of the Scottish Brachiopoda known to them up to the period of its publication: these lists, taken to a great extent from my Monograph, were forwarded to me for revision.

By order of Prof. A. Geikie, Director-General of the Geological Survey of Great Britain, Mr. B. N. Peach kindly forwarded to me for examination all the Brachiopoda collected by the Geological Survey of Scotland from several Scottish Counties, and I have therefore had the advantage of having been able to study nearly all the specimens of this class hitherto obtained in Scotland; and their descriptions and figures will be found in my 'Silurian Monograph' and its 'Supplement.'

The following eight Scottish Counties have furnished us with Silurian Brachiopoda, viz. *Midlothian, Lanarkshire, Peeblesshire, Dumfriesshire, Kirkcudbrightshire, Berwickshire, Sutherlandshire, and Ayrshire*. I feel also convinced that a larger number of species will, with time, be obtained from the Counties above named, and I hope that geologists will continue their search for fossils.

¹ A. Boué, who explored the Pentland Hills and North Esk locality in 1813, did not find a single fossil. In 1835 Mr. R. J. Cunningham and myself examined the same places, and did not find

I have followed, in this Supplement, the stratigraphical divisions of the Ayrshire Silurian deposits so ably propounded by Prof. C. Lapworth,¹ from which it will be observed that the species from the Craighead beds are now placed in the "Llandeilo" instead of the "Caradoc," to which they were supposed to belong at the time I was publishing my 'Silurian Monograph.' I have also considered it desirable to give two separate Tables in the first of which I include those species which have been obtained from Ayrshire; and in the second those that have been found in the seven other Scottish Silurian Counties. I have done this because it was not possible, in the present state of our information, to refer some of the species to their respective geological horizons with as much minuteness as had been done for Ayrshire. It is also true that in the Explanations of one or two Sheets of the Map of the Geological Survey of Scotland some species are recorded, in particular from the Leadhill district, that are not included in my second Table; but I have considered it desirable to omit them, as the specimens on which the determinations had been founded were lost or missing, and because I greatly doubted the correctness of their identification.

Some of our Scottish specimens and species will, however, still demand much further study before they can be definitely admitted. This, however, can only be effected in time by the discovery of more complete material; and there certainly remains very much to be worked out by future palæontologists, who, I feel certain, will not relax in their endeavours to complete and extend what has been so far achieved.

any. In 1838 Mr. C. Maclaren was more fortunate, as he found an *Orthoceras* there, but no Brachiopod, and it was not until 1858 that the first Brachiopod was discovered by Prof. A. Geikie.

¹ 'Quarterly Journal of the Geol. Soc.,' vol. xxxviii, p. 537, &c. 1882.

TABLE I.—*Scottish Upper- and Lower- Silurian Brachiopoda from the Girvan District, in the County of Ayrshire. Specimens collected by Mrs. R. Gray.*

GENERA AND SPECIES.	Lundlow.	Woollock.	Tennison.	Upper Llandovery.	Middle Llandovery.	Lower Llandovery.	Upper Caradoc.	Middle Caradoc.	Lower Caradoc.	Llandilo.	STRATIGRAPHICAL DIVISIONS BY PROF. C. LAEWORTH.	
											LOCALITIES FURNISHED BY MRS. R. GRAY.	
TRETENTERATA.												
1 LINGULA Canadensis, Billings										x	Baleletchie.	
2 — quadrata, Eichwald										x	Shallock Mill.	
3 — Ramsayi, Salter										x	Craighead.	
4 — granulata, Phillips										x	Craighead, Balcletchie, Minuntion.	
5 — attenuata, Sowerby						x	x			x	Ardmillan Brae, Dow Hill, Minuntion.	
											Drummuck.	
6 — ovata, M'Coy?						x	x			x	Shallock Mill, Whitehouse Bay.	
7 — brevis, Portlock						x	x			x	Penwhapple Glen.	
8 — Symonds, Salter	x										Balcletchie, Ardmillan Brae.	
											Drummuck.	
9 OBICULOIDEA Forbesi, Davidson							x				Shallock Mill, Whitehouse Bay.	
											Bargany Pond Mill.	
											Penkill.	
											Woodland Point.	
											Penkill.	
											Woodland Point.	
											Mullock Hill.	
10 DISCINA oblongata, Portlock										?	Drummuck.	
11 — perrugata, M'Coy										x	Ardmillan Brae, Balcletchie.	
12 — crassa, Hall?										x	Balcletchie, Craighead, Dow Hill, Ardmillan Brae.	
13 — ? Balcletchiensis, Dav.										x	Whitehouse Bay, Shallock Mill.	
14 — rugata, Sow.										x	Penwhapple Glen.	
15 SIPHONOTRETA Scotica, Dav.										x	Thraive.	
16 — micula, M'Coy										x	Balcletchie.	
17 CRANIA Siluriana, Dav.										x	Balgary-Pond Burn.	
18 PHOLIDOPS implicata, Sow.										x	Craighead, Minuntion.	
19 ACROTRELA Nicholsoni, Dav.										x	Balcletchie.	
20 ? costata, Dav.										x	Newlands' beds.	
										x	Mullock Hill.	
										x	Penkill beds, Penwhapple Glen, Woodland Point.	
										x	Craighead, Balcletchie, Ardmillan Brae.	
										x	Balcletchie.	
CLISTENTERATA.												
21 SPIRIFERA plicatella, var. radiata, Sow.										x	Balgary-Pond Burn, Penkill.	
22 CYRTIA exporrecta, Wahlenberg										x	Penkill.	
23 NUCLEOSPIRA pisum, Sow.										x	Balgary-Pond Burn.	
24 WHITEFELDIA tumida, Dalman										x	Balgary-Pond Burn.	
25 MERISTELLA ? angustifrons, M'Coy						x				x	Mullock Hill, Head of Thraive Glen, Auld Thorns.	
26 ATHYRIS sp. ?										x	Thraive.	
27 GLASSIA obovata, Sow.?										x	Whitehouse Bay.	
28 MERISTA ? cymbula, Dav.										x	Penkill.	
29 ATREPA reticularis, Linnaeus										x	Thraive, Drummuck.	
										x	Penkill, Penkill Limestone, Penwhapple Glen.	
										x	Woodlands Point.	
										x	Mullock Hill.	
30 — imbricata, Sow.										x	Penkill, Bargany-Pond Burn.	
31 ? Scotica, M'Coy										x	Woodland Point.	
32 TRIPLESIA ? Grayi, Dav.										x	Mullock Hill.	
33 ? spiriferoides, M'Coy										x	Craighead, Balcletchie Conglomerate	
										x	Thraive.	
										x	Ardmillan Brae.	

GENERA AND SPECIES.		Lanlow.	Weepleck.	Traonon.	Upper Llandovey.	Middle Llandovey.	Lower Llandovey.	Upper Caradoc.	Middle Caradoc.	Lower Caradoc.	Llandelo.	STRATIGRAPHICAL DIVISIONS BY PROF. C. LAPWORTH.	
												LOCALITIES FURNISHED BY MRS. R. GRAY.	
	<i>ORTHIS calligramma</i> var. <i>Scotica</i> , <i>Dav</i>											x	Craighead.
	var. <i>virgata</i> , <i>Salter</i>											x	Minunton, Balcletchie, Doularg, Bourgany, and Knockdolan.
77	— <i>plicata</i> , <i>Sow</i>				x								Woodland Point.
78	— <i>Mullockensis</i> , <i>Dav</i>					x							Ardmillan Brae, Aldons. Mullock Hill, Head of Thraive Glen, Auld Thorns. Thraive.
79	— <i>confinis</i> , <i>Salter</i>					x	?						Mullock Hill. x Craighead, Ardmillan Brae, Doularg, Minunton, Baugany, and Knockdolan, Formitchell.
80	— <i>vespertilio</i> , <i>Sow</i>						x						Thraive. Shallock Mill.
81	— <i>unguis</i> , <i>Sow</i> ?							x					x Ardmillan Brae, Craighead, Doularg. x Craighead.
82	— <i>intercostata</i> , <i>Portl</i>												x Craighead, Aldons, Balcletchie Cong.
83	— <i>tricinaria</i> , <i>Conrad</i>							x					Piedmont Glen (according to Salter and Thomson).
84	— <i>Lapworthi</i> , <i>Dav</i>								x				Shallock Mill. x Balcletchie Cong.
85	— <i>testudinaria</i> , <i>Dal</i>							x					Thraive. Shallock Mill. x Craighead, Dow Hill, Minunton.
86	— <i>fiabellulum</i> , <i>Sow</i>							x					Thraive. Whitehouse Bay. x Craighead, Minunton.
87	— <i>crispa</i> , <i>M'Coy</i>							x					Thraive. Shallock Mill. x Craighead, Ardmillan Brae.
88	— <i>Sowerbyana</i> , <i>Dav</i>							x					Shallock Forge. Thraive. Shallock Mill.
89	— <i>sagittifera</i> , <i>M'Coy</i>								x				x Craighead, Balcletchie Cong. Mullock Hill.
90	— <i>elegantula</i> , <i>Dal</i>			x									Bargany-Pond Burn. Woodland Point. Mullock Hill.
91	— <i>nina</i> , <i>Dav</i>								x				Drummuck. Shallock Mill. x Craighead, Balcletchie.
92	— <i>rustica</i> , <i>Sow</i>			x									Whitehouse Bay. Cuddystone Glen, Penkill, and Penkill beds, Penwhapple Glen.
	var. <i>rigida</i> , <i>Sow</i>				x								Woodland Point.
	var. <i>Walsallensis</i> , <i>Dav</i>			x									Penkill.
93	— <i>Actonia</i> , <i>Sow</i> ?							x					Thraive.
94	— <i>reversa</i> , <i>Salter</i>				x								Penkill beds, Penwhapple Glen.
95	— <i>protensa</i> , <i>Sow</i>				x								Benan Crag.
96	— <i>Rankini</i> , <i>Dav</i>								x				Starfish beds, Auld Thorns. Ardmillan Brae.
97	<i>STROPHOMENA</i> <i>Walmstedti</i> , <i>Linds</i>			x									x Cuddystone Glen. Penkill beds, Penwhapple Glen.
98	— <i>rhomboidalis</i> , <i>Wilck</i>				x								Newlands, Woodland Point. Mullock Hill. Thraive, Drummuck (Starfish beds), Auld Thorns. Shallock Mill.
99	— <i>applanata</i> , <i>Salter</i>								x				Craighead.
100	— <i>pecten</i> , <i>Linn</i>			x									Penkill, Cuddystone Glen, Bargany Pond Burn. Newlands, Woodland Point.
101	— <i>antiquata</i> , <i>Sow</i>			x									Mullock Hill. Bargany-Pond Burn, Penkill. Woodland Point.
102	— <i>imbrex</i> , var. <i>semi-globosina</i> , <i>Dav</i>				x								Mullock Hill. x Craighead.

GENERA AND SPECIES.	Ludlow.	Wenlock.	Termonon.	Upper Llandovery.	Middle Llandovery.	Lower Llandovery.	Upper Caradoc.	Middle Caradoc.	Lower Caradoc.	Llandocho.	STRATIGRAPHICAL DIVISIONS by PROF. C. LAFWORTH.	LOCALITIES FURNISHED by MRS. R. GRAY.					
	103 STROPHOMENA, Llandeiloensis, Dav.											×	Ardmillan Brae, Minunton.				
104 — deltoidea, Conrad }											×	Drumuck.					
105 — retroflexa, Salter.....											×	Ardmillan Brae, Craighead, Balclethie.					
											×	Ardmillan Brae, Dow Hill, Balclethie.					
												Woodland Point.					
106 — corrugatella, Dav.												Benan Crag.					
												Drumuck.					
												Shallock Mill.					
												×	Balclethie, Dow Hill.				
107 — expansa, Sow.												×	Woodland Point.				
												×	Mullock Hill, Head of Thraive Glen, Auld Thorns.				
												×	Shallock Mill.				
108 — grandis, Sow. ?												×	Minunton, Benan Burn, Doularg, Craighead.				
109 — arenacea, Salter ...													Thraive Glen.				
110 — Waltoni, Dav.													Camregan Wood.				
111 — Shallockensis, Dav.													Woodland Point.				
112 LEPTENA, sericea, Sow.													Cuddystone Glen.				
													×	Shallock Mill, Balclethie.			
													×	Thraive, Drumuck.			
													×	Shallock Mill.			
													×	Ardmillan Brae, Doularg, Balclethie Cong., Dow Hill, Minunton.			
var. rhombica, M'Coy													×	Balclethie Cong., Craighead.			
113 — transversalis, Dal.														Penkill, Camregan Wood, Bargany-Pond Burn.			
														Penkill beds, Penwhapple Burn.			
														Woodland Point.			
114 — quinquecostata, M'Coy }														Whitehouse Bay, Shallock Mill.			
														×	Ardmillan Brae, Balclethie.		
115 — tenuicincta, M'Coy.....														×	Shallock Mill.		
														×	Ardmillan Brae, Craighead, Balclethie.		
116 — segmentum, Angelin ...															Cuddystone Glen.		
117 — Youngiana, Dav.															Woodland Point.		
118 — Etheridgei, Dav.															×	Craighead.	
119 — Llandeiloensis, Dav.															×	Craighead, Balclethie Cong.	
120 — Grayii, Dav.															×	Craighead, Armillan Brae, Doularg.	
121 — scissa, M'Coy															×	Craighead.	
																×	Woodland Point.

NAMES OF SCOTTISH SILURIAN SPECIES OF BRACHIOPODA THAT HAVE NOT BEEN HITHERTO DISCOVERED IN AYRSHIRE, AND WHICH WILL BE FOUND RECORDED IN TABLE II.

<i>Lingula Lewisii</i> , Sow.	<i>Rhynchonella?</i> <i>Pentlandica</i> , Haswell.
— <i>lata</i> , Sow.	— <i>Jackii</i> , Dav.
— <i>minima</i> , Sow.	— <i>Maccoyana</i> , Dav.
<i>Discina Portlocki</i> , Geinitz.	<i>Skenidium Lewisii</i> , Dav.
<i>Obolella sagittalis</i> , Salter.	<i>Orthis Kilbucoensis</i> , Dav.
<i>Spirifera crispa</i> , Wahl.	<i>Stroph. Hendersoni</i> , Dav.
<i>Meristella?</i> <i>Maclareni</i> , Haswell.	<i>Chonetes striatella</i> , Dalm.
<i>Glossia compressa</i> , Sow.	

LIST OF LOCALITIES IN AYRSHIRE FROM WHERE MRS. R. GRAY OBTAINED THE SPECIES MENTIONED IN TABLE I, AND THEIR DISTANCES FROM GIRVAN.¹

Geological horizon.

Ardmillan Brae	4 miles S. of Girvan	Llandeilo.
Aldons	6 miles S. of Girvan	Llandeilo.
Benan Burn	6 miles S.E. of Girvan	Llandeilo.
Baleletchie	6 miles E. of Girvan	Llandeilo.
Baleletchie Conglomerate	6 miles E. of Girvan	Llandeilo.
Craighead	3½ miles N.E. of Girvan	Llandeilo.
Camregan Wood	2 miles E. of Girvan	Upper Llandoverly.
Cuddystone Glen	1 mile E. of Girvan	Upper Llandoverly.
Drummuck beds	6 miles N.E. of Girvan	Upper Caradoc.
Doularg	8 miles E. of Girvan	Llandeilo.
Dow Hill	1 mile E. of Girvan	Llandeilo.
Mullock Hill beds	7 miles N.E. of Girvan	Lower Llandoverly.
Minuntion	6 miles S.E. of Girvan	Llandeilo.
Newlands	7 miles N.E. of Girvan	Middle Llandoverly.
Penkill beds	3 miles E. of Girvan	Upper Llandoverly.
Shallock Forge	1½ miles S. of Girvan	Middle Llandoverly.
Shallock Mill	2 miles S. of Girvan	Middle Caradoc.
Thraive Dyke (Starfish beds) and Auld Thorns	7 miles N.E. of Girvan	Upper Caradoc.
Thraive	7 miles N.E. of Girvan	Upper Caradoc.
Formitchell	6 miles E. of Girvan	Llandeilo.
Woodland Point	2½ miles S. of Girvan	Middle Llandoverly.
White-House Bay	3½ miles S. of Girvan	Middle Caradoc.

¹ This list of localities, &c., was prepared by Mrs. R. Gray and revised by Prof. C. Lapworth.

TABLE II.—*Scottish Silurian Brachiopoda from Midlothian, Lanarkshire, Peebleshire, Dumfriesshire, Kircudbrightshire, Berwickshire, Sutherlandshire.*

GENERA AND SPECIES.	Lanlow.	Wenlock.	Llandovery.	Caradoc.	Llandelo.	LOCALITIES.
1 LINGULA Lewisii, <i>Sow.</i>	x					On the North Esk, Bed D; also in the Gutterford Burn in beds between A and B, about 2000 feet below Bed D; Pentland Hills, <i>Midlothian</i> .
2 — Symondsii, <i>Salter</i>	x					Same bed, in Gutterford Burn, <i>Midlothian</i> .
3 — lata, <i>Sow.</i>	x	x				North Esk Burn, above the pond, Pentland Hills, <i>Midlothian</i> .
4 — minima, <i>Sow.</i>	x	x				Lesmahago, <i>Lanarkshire</i> .
5 — attenuata, <i>Sow.</i>			x			Wrae Limestone, three miles south of Broughton, <i>Peebleshire</i> .
6 — brevis, <i>Portlock</i>			x			Cairn Burn, <i>Dumfriesshire</i> .
7 DISCINA Portlocki, <i>Geinitz</i>			x			Cairn Burn, <i>Dumfriesshire</i> .
8 — perrugata, <i>M' Coy</i>			x			Wrae Limestone, <i>Peebleshire</i> .
9 — oblongata, <i>Portl.</i>			x			Dobbs Linn, near Moffat, <i>Dumfriesshire</i> .
10 — crassa, <i>Hall</i>			x			Dobbs Linn, near Moffat, <i>Dumfriesshire</i> .
11 ORBICULOIDA Forbesi, <i>Dav.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
12 PHOLIDIPS (crania) implicata, <i>Sow.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
13 OBOLLELLA sagittalis, <i>Salter</i>			x			Cairn Burn, <i>Dumfriesshire</i> .
14 SIPHONOTHETA nicula, <i>M' Coy</i>			x			Glenkill, <i>Dumfriesshire</i> .
15 ACROTETA Nicholsoni, <i>Dav.</i>			x			Dobbs Linn, near Moffat, <i>Dumfriesshire</i> .
16 CYRTIA exportecta, <i>Wahl.</i>	x	x				Bed D, and in a brown mudstone about 100 feet higher in the Series F, Pentland Hills, <i>Midlothian</i> .
17 SPIRIFERA crispata, <i>Hes</i>	x					North Esk, Bed H, Pentland Hills, <i>Midlothian</i> .
18 WHITEFELDIA (Meristella) tumida, <i>Dal.</i>	x					North Esk, Bed D, Pentland Hills, <i>Midlothian</i> .
19 MERISTELLA? Maclearni, <i>Haswell</i>	x					North Esk, Bed D, Pentland Hills, <i>Midlothian</i> .
20 NUCLEOSPIRA pisum, <i>Sow.</i>	x					North Esk, Bed D, Pentland Hills, <i>Midlothian</i> .
21 GLASSIA (Athyris) compressa, <i>Sow.</i>	x					Beveland and Gutterford Burn, Pentland Hills, <i>Midlothian</i> .
22 ATHEYA reticularis, <i>Linn.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
23 RHYNCHONELLA? Pentlandica, <i>Haswell</i>	x	x				Beds D and H, North Esk, Pentland Hills, <i>Midlothian</i> .
24 — Wilsoni, <i>Sow.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
25 — nucula, <i>Sow.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
26 — sp. ?.....	x					Parishholm, near Lesmahago, <i>Lanarkshire</i> .
27 — Jacki, <i>Dav.</i>			x			Duntercleugh Burn, Leadhills, <i>Dumfriesshire</i> .
28 — Maccovana, <i>Dav.</i>			x			Glencotho Quarry, near Broughton, <i>Peebleshire</i> .
29 OETHIS calligramma, <i>Dal.</i>			x			Duntercleugh Burn and Black Burn, <i>Dumfriesshire</i> ; Snar Water, <i>Lanarkshire</i> ; Kilbucho, <i>Peebleshire</i> .
30 — biloba, <i>Linn.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
31 — elegantula, <i>Dal.</i>	x					Bed D, North Esk, and common in a thin limestone Gutterford Burn between Beds A and B, Pentland Hills, <i>Midlothian</i> .
32 — polygramma, <i>Sow.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
var. Pentlandica.....			x			Black Burn, Leadhill District, <i>Dumfriesshire</i> .
33 — protensa, <i>Sow.</i>			x			Kilbucho, <i>Peebleshire</i> ; Snar Water, <i>Lanarkshire</i> .
34 — biforata, <i>Schl.</i>			x			Duntercleugh Burn, <i>Dumfriesshire</i> .
35 — crispa, <i>M' Coy</i>			x			Kilbucho, <i>Peebleshire</i> ; Snar Water, <i>Lanarkshire</i> .
36 — testudinaria, <i>Dal.</i>			x			Snar Water, <i>Lanarkshire</i> ; Durness, <i>Sutherlandshire</i> .
37 — Sowerbyana, <i>Dav.</i>			x			Glencotho, <i>Peebleshire</i> .
38 — Kilbuchoensis, <i>Dav.</i>			x			Kilbucho, <i>Peebleshire</i> .
39 SKENIDIUM (Orthis) Lewisii, <i>Dav.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
40 STROPHOMENA rhomboidalis, <i>Wilckens</i>	x					Bed D, North Esk and Gutterford Burn, Pentland Hills, <i>Midlothian</i> . Nearly all the fossils found in Bed D, North Esk, are got in the same bed at Dear Hope Rig half a mile S.S.W.
41 — antiquata, <i>Sow.</i>	x					Kilbucho, <i>Peebleshire</i> .
42 — Wainstedti, <i>Lindst.</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
43 — pecten, <i>Linné</i>	x					Bed D, North Esk and Gutterford Burn, Pentland Hills, <i>Midlothian</i> .
44 — applanata, <i>Salter</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
45 — Hendersoni, <i>Dav.</i>	x					Bed D, in Dearhope Burn, Pentland Hills, <i>Midlothian</i> .
46 — grandis, <i>Sow.</i>	x					Duntercleugh, Leadhill District, <i>Dumfriesshire</i> .
47 — arenacea? <i>Salter</i>	x					Duntercleugh Burn, <i>Dumfriesshire</i> , and Snar Water, <i>Peebleshire</i> .

GENERA AND SPECIES.	Ludlow.	Wenlock.	Llandovery.	Caradoc.	Llandeilo.	LOCALITIES.
48 STROPHOMENA expansa, <i>Sow</i>				x		Black Burn, Leadhill District, <i>Dumfriesshire</i> ; Snar Water, <i>Lanarkshire</i> .
49 — corrugatella, <i>Dav</i>				x		Black Burn, Wanlock Water, <i>Dumfriesshire</i> .
50 LEPTENA transversalis, <i>Wahl</i>	x					Bed D, North Esk, Pentland Hills, <i>Midlothian</i> .
51 — sericea, <i>Sow</i>				x		Kilbucho, <i>Peebleshire</i> ; Snar Water, <i>Lanarkshire</i> ; East Bay, Gipsy Point, <i>Kircudbrightshire</i> ; East Burn, Lauder, <i>Berwickshire</i> ; Dauterleugh Burn, <i>Dumfriesshire</i> .
52 — sericea, var. rhombica, <i>M'Coy</i>				x		Dauterleugh Burn, Wanlock Water, <i>Dumfriesshire</i> .
53 — tenuicincta, <i>M'Coy</i>				x		Dauterleugh Burn, <i>Dumfriesshire</i> ; Kilbucho, <i>Peebleshire</i> ; Snar Water and Glatrip Burn, <i>Lanarkshire</i> .
54 CHONETES striatella, <i>Dal</i>	x					Bed D, North Esk, and in thin limestone Gutterford Burn, Pentland Hills, <i>Midlothian</i> .

If we briefly consider the general results shown by our Tables of Scottish Silurian Brachiopoda, it will be seen that about 134 so-termed species have been discovered and distributed into 25 genera; that about—

64 species are recorded from the *Llandeilo* formation (including much of the *Lower Caradoc* of Murchison, Ramsay, and Gekie).

44 from the *Lower, Middle, and Upper Caradoc* (including beds from a little below the *Caradoc Limestone* of North Wales to the base of the *Lower Llandovery*).

47 from the *Lower, Middle, and Upper Llandovery*.

8 from the *Wenlock*.

28 from the *Ludlow*.

It is also evident that in Scotland the largest number of species have been got from the *Llandeilo*; of these about—

22 are common to the *Llandeilo* and the *Caradoc*.

7 pass from the latter formation into the *Llandovery*, 3 into the *Wenlock*, and 1 into the *Ludlow*.

Of the *Caradoc* species, 11 pass into the *Llandovery* (chiefly the *Lower Llandovery*), 17 from the *Llandovery* (chiefly the *Upper Llandovery*) into the *Wenlock* and *Ludlow*.

It is also evident even from these approximate and provisional estimates, that in Scotland the large number of species are restricted to their formations. The *Llandeilo* is extremely rich; and, although only about a third of its species are found in the *Caradoc* of Scotland, some more of them occur likewise in the *Caradoc* of England; but the exact line of separation between the *Lower Caradoc* and *Upper Llandeilo* has still to be correctly defined, as also the different horizons of the *Llandeilo* itself. Prof. Lapworth tells me that the beds which contain the fossils of the Lower Girvan series, namely at Craighead, Balclatchie, and Ardmillan Brae, are mapped in South Wales as *Upper Llandeilo*, in North Wales as *Bala*, and in Shropshire as *Caradoc*; and that there is much to be done before we can sort out the different strata properly. The *Upper Llandeilo* and *Lower Caradoc*

being so nearly related, it is not to be wondered at that we should find so many of the species to be common to both.

The Upper and Middle *Caradoc* in Scotland are also very rich; but, as far as our present knowledge will carry us, are not quite as rich as the Llandeilo seems to be. The Lower *Caradoc* is badly represented.

In Scotland the *Llandovery* has afforded us some 46 or 47 species. These are distributed as follows:

18 in Lower *Llandovery*.

27 in Middle *Llandovery*.

34 in Upper *Llandovery*.

Of these 12 seem common to the *Lower* and *Middle* *Llandovery*, 16 are common to the *Middle* and *Upper* *Llandovery*, and about 9 to the three divisions.

The *Wenlock* in Scotland seems poorly represented, while the *Ludlow* is well developed and has afforded some 28 species, a large proportion of which are likewise found in the *Wenlock* of England.

These estimates and numbers, as I have already said, must be taken as *essentially provisional*, or as near as could be arrived at with the incomplete material in our possession. Further collecting and more extended study of several of the species enumerated in our Tables will also *certainly* tend to modify the numbers we have given, which are only the result of my own investigations.

I have now come to the end of my long series of Supplements, and in reality of the Monograph, as far as I am able to make it with the material at my command. Every now and then as our rocks continue to be searched, new forms will turn up which will require to be described and illustrated. Specimens also will be found more complete of a number of those imperfectly described, and these will form the subject of future Supplements.

I began visiting localities and collecting British Brachiopoda as far back as 1835. The first plate relating to this Monograph was drawn on stone and submitted to the Council of the Palæontographical Society in 1849; and the first part of the work was printed in 1850, and issued in June, 1851. Since that period I have never relaxed in my efforts to grapple with the large and very difficult subject that has been entrusted to my care. Sorry indeed am I to be compelled to admit that, although very much progress has been effected in our general knowledge of the Brachiopoda, and of British species in particular, very much must, for the present, be left in an incomplete and unsatisfactory condition—and this from want of the necessary material which has still to be discovered, and which time and fortunate circumstances alone can reveal.

Many unavoidable mistakes and shortcomings occur in the old Monograph, some of

these I have been able to put right in the Supplement, but many will still require to be corrected by future palaeontologists as science progresses and our knowledge becomes extended.

A large proportion of our species have certainly been thoroughly worked out, all their external characters and internal details having been completely elaborated; but many so-termed species cannot yet claim that advantage, and their generic and specific characters have still to be precisely determined. Many of them, when better understood, will, no doubt, have to be considered as synonyms of some of those that have been fully described; but many years must necessarily elapse before it will be possible to offer a definite list of our species. Every form that can be thoroughly made out, described, and illustrated is positive gain to science. It is wrong to burden science with specific names that are not absolutely necessary; and it is equally wrong to combine under a single name forms that are in reality specifically distinct.

I shall add one part more to this volume, in order to sum up general results, and to give a catalogue of the species described in this and the previous four volumes, as well as a Brachiopodal bibliography.

It now remains for me once again to express my grateful thanks to the many British and Foreign scientific friends who have afforded me valuable and valued help during the progress of my lengthened investigations.

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 - — *virgata*. Dav. Sil. Mon., p. 243, pl. xxxv, figs. 23, 24.
 - *canaliculata*, *Lindstrom.* Dav. Sil. Mon., p. 218, pl. xxvii, figs. 12, 13.
 - *Carausii*, *Salter.* Dav. Sil. Mon., p. 229, pl. xxxiii, figs. 1—7; Sil. Sup., p. 181, pl. xiv, figs. 21—26.
 - *confinis*, *Salter.* Dav. Sil. Mon., p. 266, pl. xxxvi, figs. 1—4; and Sil. Sup., p. 180.
 - *crassa*, *Lindstrom.* Dav. Sil. Mon., p. 213, pl. xxvii, fig. 17—19.
 - *crispa*, *M'Coy.* Dav. Sil. Mon., p. 256, pl. xxxviii, figs. 5—10; Sil. Sup., p. 176, pl. xiii, figs. 7—8.
 - ? *Crofti*, *Dav.* Dav. Sil. Sup., p. 179, pl. xiii, figs. 18, 19.
 - *Edgelliana*, *Salter.* Dav. Sil. Mon., p. 228, pl. xxxii, figs. 1—4.
 - *elegantula*, *Dalman.* Dav. Sil. Mon., p. 211, pl. xxvii, figs. 1—9; Sil. Sup., p. 178.
 - *elegantulina*, *Dav.* Dav. Sil. Sup., p. 219, pl. xiii, fig. 17.
 - *fallax*, *Salter.* Dav. Sil. Mon., p. 223, pl. xxxi, figs. 9—11.
 - *flabellum*, *Sow.* Dav. Sil. Mon., p. 248, pl. xxxiv, figs. 1—12; Sil. Sup., p. 179, pl. xiii, figs. 3—6, and 20—28.
 - *Girvaniensis*, *Dav.* Dav. Sil. Mon., p. 216, pl. xxviii, fig. 10.
 - *Hicksii*, *Salter.* Dav. Sil. Mon., p. 230, pl. xxxiii, figs. 13—16; Sil. Sup., p. 184.
 - *Hirmantensis*, *M'Coy.* Dav. Sil. Mon., pl. xxxii, figs. 5—9; Sil. Sup., p. 189, pl. xi, figs. 8—11.
 - *hybrida*, *Sow.* Dav. Sil. Mon., p. 214, pl. xxvii, figs. 15, 16.
 - *intercostata*, *Portlock.* Dav. Sil. Mon., p. 236, pl. xxxviii, figs. 1—4.
 - *Jonesi*, *Dav.* Dav. Sil. Sup., p. 190, pl. xi, figs. 15, 16.

- ORTHIDS?** *Kilbuckoensis*, *Dav.* Dav. Sil. Sup., p. 188; pl. xiii, figs. 1, 2.
 — *Lapworthi*, *Dav.* Dav. Sil. Sup., p. 176, pl. xiii, figs. 9, 10.
 — *lenticularis*, *Wahl.?* Dav. Sil. Mon., p. 230, pl. xxxiii, figs. 22—28.
 — *lunata*, *Sow.* Dav. Sil. Mon., p. 215, pl. xxviii, figs. 1—5.
 — *Menapise*, *Hicks.* Dav. Sil. Mon., p. 228, pl. xxxiii, figs. 8—12.
 — *Mullockiensis*, *Dav.* Dav. Sil. Mon., p. 221, pl. xxix, figs. 14—18; and Sil. Sup., p. 180, pl. xvi, figs. 14, 15.
 — *nina*, *Dav.* Dav. Sil. Sup., p. 177, pl. xiii, fig. 11.
 — *patera*, *Salter.* Dav. Sil. Mon., p. 267, pl. xxx, figs. 1—8.
 — *Philipi*, *Dav.* Dav. Sil. Sup., p. 188, pl. xi, figs. 13, 14.
 — *plicata*, *Sow.* Dav. Sil. Mon., p. 245, pl. xxxv, figs. 25, 26; pl. xxxvii, fig. 1; Sil. Sup., p. 182, pl. xiii, fig. 27.
 — *polygramma*, *Sow.*, var. *Pentlandica.* Dav. Sil. Mon., p. 219, pl. xxix, figs. 1—10; Sil. Sup., p. 179, pl. xiii, figs. 15, 16.
 — *porcata*, *M'Coy.* Dav. Sil. Mon., p. 250, pl. xxxi, figs. 12—20; pl. xlvi, fig. 4.
 — *protensa*, *Sow.* Dav. Sil. Mon., p. 257, pl. xxxvi, figs. 24—30.
 — *Rankini*, *Dav.* Dav. Sil. Sup., p. 190, pl. xi, figs. 17—19.
 — *retrorstriata*, *M'Coy.* Dav. Sil. Mon., p. 265, pl. xxxvi, figs. 39—42; Sil. Sup., p. 185, pl. xiv, figs. 7—16.
 — *reversa*, *Salter.* Dav. Sil. Mon., p. 220, pl. xxix, figs. 11—13; Sil. Sup., p. 180, pl. xvi, fig. 13.
 — *rustica*, *Sow.* Dav. Sil. Mon., p. 238, pl. xxxiv, figs. 13—17; Sil. Sup., p. 178, pl. xiii, fig. 22.
 — — var. *rigida*, *Dav.* Dav. Sil. Mon., pl. xxxiv, figs. 18, 19.
 — — var. *Walsalliensis*, *Dav.* Dav. Sil. Mon., pl. xxxiv, figs. 20—22.
 — *sagittifera*, *M'Coy.* Dav. Sil. Mon., p. 260, pl. xxxvi, figs. 18—23; Sil. Sup., p. 181, pl. xiii, fig. 29.
 — *sarmentosa*, *M'Coy.* Dav. Sil. Mon., p. 262, pl. xxxvi, figs. 35—38; Sil. Sup., p. 189.
 — *Salteri*, *Dav.* Dav. Sil. Mon., p. 255, pl. xxxvi, figs. 31—84.
 — *simplex*, *M'Coy.* Dav. Sil. Mon., p. 255, pl. xxxii, figs. 10, 11.
 — *Sowerbyana*, *Dav.* Dav. Sil. Mon., p. 247, pl. xxxv, figs. 27—31; Sil. Sup., p. 178.
 — *testudinaria*, *Dalman.* Dav. Sil. Mon., p. 226, pl. xxvii, figs. 16, 22 to 24 (not figs. 13, 14, 15, 17 to 21), vol. iv, pl. xlii, fig. 26; Sil. Sup., p. 178, pl. xiii, figs. 30, 31.
 — *tricinaria*, *Conrad.* Dav. Sil. Mon., p. 276, pl. xxxviii, fig. 28.
 — *turgida*, *M'Coy.* Dav. Sil. Mon., p. 258, pl. xxxii, figs. 12—20; Sil. Sup., p. 187, pl. xiv, figs. 17—20.
 — *unguis*, *Sow.* Dav. Sil. Mon., p. 257, pl. xxxvii, figs. 16—22; Sil. Sup., p. 177, pl. xiii, fig. 28?
 — *Valpyana*, *Dav.* Dav. Sil. Mon., p. 235, pl. xxxii, figs. 29—33.
 — *vespertilio*, *Sow.* Dav. Sil. Mon., p. 236, pl. xxx, figs. 11—21.
ORTHISINÆ, *d'Orbigny.* Dav. Sil. Mon., p. 278.
 — *adscendens*, *Pander.* Dav. Sil. Mon., p. 278, pl. xlix, figs. 27—29; Sil. Sup., p. 175, pl. xvi, figs. 16—18.
PENTAMERUS, *Sow.* Dav. Sil. Mon., p. 142; Sil. Sup., p. 161.
 — *galeatus*, *Dalman.* Dav. Sil. Mon., p. 145, pl. xv, figs. 13—23; Sil. Sup., p. 164, pl. ix, figs. 25.
 — *globatus*, *Sow.* Dav. Sil. Mon., p. 156, pl. xix, figs. 10—12; Sil. Sup., p. 163, pl. ix, figs. 21—24.
 — *Knightsii*, *Sow.* Dav. Sil. Mon., p. 142, pl. xvi, figs. 1—3; pl. xvii, figs. 1—10; pl. xix, fig. 3.
 — *linguifer*, *Sow.* Dav. Sil. Mon., p. 149, pl. xvii, figs. 11—14.
 — *oblongus*, *Sow.* Dav. Sil. Mon., p. 151, pl. xviii, figs. 1, 2, pl. xix, figs. 1, 2; Sil. Sup., p. 161.

- PENTAMERUS, *rotundus*, *Sow.* Dav. Sil. Mon., p. 150, pl. xv, figs. 9—11; Sil. Sup., p. 163, pl. ix, figs. 6—9.
- *Schallockiensis*, *Dav.* Dav. Sil. Sup., p. 164, pl. ix, fig. 26.
- *undatus*, *Sow.* Dav. Sil. Mon., p. 155, pl. xix, figs. 4—9; Sil. Sup., p. 162, pl. ix, figs. 10—20.
- PHOLIDOPS, *Hall.* Dav. Sil. Sup., p. 216.
- (*Crania*) *implicata*, *Sow.* Dav. Sil. Mon., p. 80, pl. viii, figs. 13—18; Sil. Sup. p. 216, pl. xvii, fig. 48.
- PORAMBONITES, *Pander.* Dav. Sil. Mon., p. 195.
- *intercedens*, *Pander.* Dav. Sil. Mon., p. 195 (in part), pl. xxv, fig. 16 (not figs. 17, 18, 19), pl. xxvi, figs. 1, 2, 3.
- RETZIA, *King.* Dav. Sil. Mon., p. 124; Sil. Sup., p. 92.
- *Baylei*, *Dav.* Sil. Mon., p. 127, pl. xii, figs. 23—25, 27.
- *Bouchardi*, *Dav.* Dav. Sil. Mon., p. 127, pl. xii, figs. 26—28, 30.
- (*Rhynch.*) *æmula*, *Salter.* Dav. Sil. Mon., p. 188, pl. xxiv, fig. 21; Sup., p. 160, pl. x, fig. 17 ?
- *Salteri*, *Dav.* Dav. Sil. Mon., p. 125, pl. xii, figs. 21, 22; Sil. Sup., p. 92, pl. iv, figs. 12—14.
- RHYNCHONELLA, *Fischer.* Dav. Sil. Mon., p. 163; Sil. Sup., p. 147.
- *Balcletchiensis*, *Dav.* Dav. Sil. Sup., p. 160, pl. x, figs. 15, 16; and p. 200, pl. xi, fig. 23.
- *Beltiana*, *Dav.* Dav. Sil. Mon., p. 189, pl. xxiv, fig. 22.
- *bidentata*, *His.* Dav. Sil. Mon., pl. xxi, fig. 22; Sil. Sup., p. 150, pl. x, fig. 3.
- *borealis*, *Schl.* Dav. Sil. Mon., p. 174, pl. xxi, figs. 14—27 (excluding fig. 23, which belongs to *Rh. diodontata*, also *R. bidentata* from Synonyms); Sup., p. 148, pl. x, fig. 25.
- *Callayana*, *Dav.* Dav. Sil. Sup., p. 159, pl. x, fig. 18.
- *cuneata*, *Dalman.* Dav. Sil. Mon., p. 164, pl. xxi, figs. 7—11; Sil. Sup., p. 152, pl. x, figs. 9—10.
- *cuneatella*, *Dav.* Dav. Sil. Sup., p. 200, pl. x, fig. 11.
- *Dayi*, *Dav.* Dav. Sil. Sup., p. 152, pl. x, fig. 2.
- *decemplicata*, *Sow.* Dav. Sil. Mon., p. 177, pl. xxiii, figs. 20—24; Sil. Sup., p. 202, pl. xi, fig. 27.
- *deflexa*, *Sow.* Dav. Sil. Mon., p. 178, pl. xxii, figs. 24—27; Sup., p. 156, pl. x, fig. 23.
- *diodonta*, *Dalman.* Dav. Sil. Sup., p. 151, pl. x, fig. 4.
- *Edgelliana*, *Dav.* Dav. Sil. Mon., p. 190, pl. xxiv, figs. 27, 28.
- *Glassiana*, *Dav.* (*Atrypa depressa*, *Sow.*, *Athyris* ? *Dav.*). Dav. Sil. Mon., p. 123, pl. xii, figs. 11—15; pl. xiii, fig. 6; Sup. pp. 155, 219, pl. x, fig. 22. (The name *Glassiana* having already been applied to a Carboniferous form, we have given the name *Glassiana* to the Silurian one.)
- *Girvaniensis*, *Dav.* Dav. Sil. Sup., p. 155, pl. x, fig. 26.
- *Jackii*, *Dav.* Dav. Sil. Sup., p. 158, pl. ix, fig. 30.
- *Lapworthi*, *Dav.* Dav. Sil. Mon., p. 154, pl. x, fig. 7.
- *Lewisii*, *Dav.* Dav. Sil. Mon., p. 180, pl. xxiii, figs. 25—28.
- *Llandoveriana*, *Dav.* Dav. Sil. Mon., p. 184, pl. xxiv, figs. 8—13; Sil. Sup., p. 157, pl. x, figs. 32—37.
- *Maccoyana*, *Dav.* Dav. Sil. Mon., pl. xxv, fig. 17—19 (not 16, or pl. xxvi, figs. 1—3); Sil. Sup., p. 161, pl. viii, fig. 33.
- *nana*, *Salter.* Dav. Sil. Mon., p. 192, pl. xxiv, fig. 26.
- *nasuta*, *M^cCoy.* Dav. Sil. Mon., p. 173, pl. xxiii, fig. 10; Sil. Sup., p. 160, pl. x, figs. 20, 21 ?

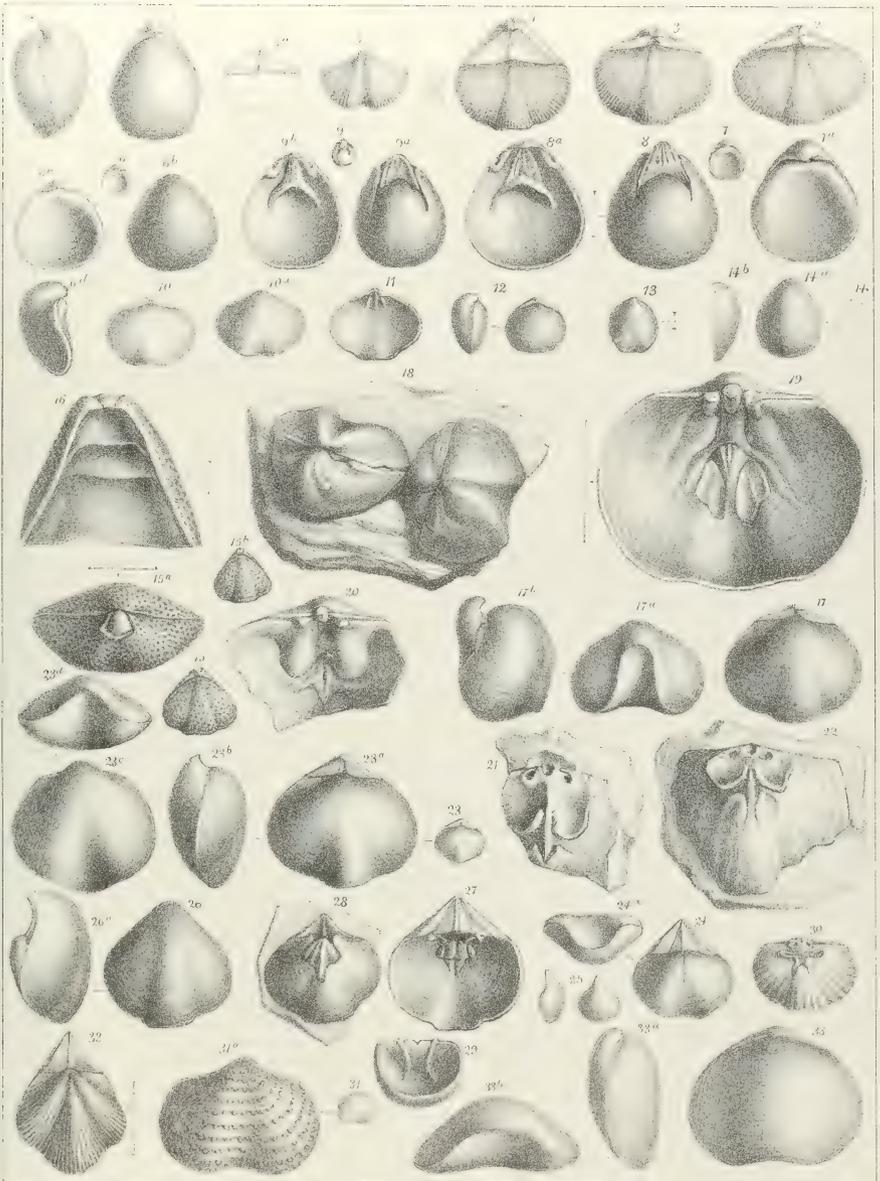
- RHYNCHONELLA**, *nucula*, *Sow.* Dav. Sil. Mon., p. 181, pl. xxiv, figs. 1—7; Sil. Sup., p. 157, pl. x, figs. 27—29, pl. xi, fig. 24 ?
- *Peachi*, *Dav.* Dav. Sil. Sup., p. 201, pl. xi, fig. 25.
- *Pentlandica*, *Haswell.* Dav. Sil. Mon., p. 187, pl. xxii, figs. 9—19; Sil. Sup., p. 134.
- *Portlockiana*, *Dav.* Dav. Sil. Mon., p. 189, pl. xxiv, figs. 23—25; Sil. Sup., p. 159, pl. x, figs. 12, 13, 14.
- *Salteri*, *Dav.* Dav. Sil. Mon., p. 188, pl. xxiv, figs. 19—20.
- *Scotica*, *Dav.* Dav. Sil. Sup., p. 201, pl. xi, fig. 26.
- *Shallockiensis*, *Dav.* Dav. Sil. Sup., p. 154, pl. x, fig. 19.
- *Stricklandii*, *Sow.* Dav. Sil. Mon., p. 166, pl. xxi, figs. 1—6 and 28.
- *sub-borealis*, *Dav.* Dav. Sil. Sup., p. 149, pl. x, fig. 5, 6.
- *Thomsoni*, *Dav.* Dav. Sil. Mon., p. 186, pl. xxiv, fig. 18.
- *tripartita*, *Sow.* Dav. Sil. Mon., p. 185, pl. xxiv, figs. 15—16.
- *Weaveri*, *Salter.* Dav. Sil. Mon., p. 185, pl. xxiv, fig. 14; Sil. Sup., p. 158, pl. x, fig. 24.
- *Wilsoni*, *Sow.* Dav. Sil. Mon., p. 167, pl. xxiii, figs. 1—9; Sil. Sup., p. 156.
- var. *Davidsoni*, *M'Coy.* Dav. Sil. Mon., p. 172, pl. xxiii, figs. 11—14.
- var. *sphaeroidalis*, *M'Coy.* Dav. Sil. Mon., p. 173, pl. xxiii, fig. 10.
- SIPHONOTRETA**, *de Verneuil.* Dav. Sil. Mon., p. 75; Sil. Sup., p. 218.
- *Anglica*, *Morris.* Dav. Sil. Mon., p. 75, pl. viii, fig. 1.
- *micula*, *M'Coy.* Dav. Sil. Mon., p. 76, pl. viii, figs. 2—6.
- *Scotica*, *Dav.* Dav. Sil. Sup., p. 217, pl. xvi, figs. 31—33.
- SKENIDIUM**, *Hall.* Dav. Sil. Sup., p. 173.
- *Grayiæ*, *Dav.* Dav. Sil. Sup., p. 175, pl. xi, figs. 3—5.
- ? var. *Hughesii* (Orthis), *Dav.* Sil. Mon., p. 254, pl. xxxviii, fig. 26; Sil. Sup., p. 174.
- *Lewisii*, *Dav.* (Orthis?). Dav. Sil. Mon., p. 208, pl. xxvi, figs. 4—9; Sil. Sup., p. 173.
- var. *Woodlandiense*, *Dav.* Dav. Sil. Sup., p. 174, pl. xi, figs. 1, 2.
- ? *Shallockiense*, *Dav.* Dav. Sil. Sup., p. 175, pl. xi, figs. 1, 2.
- SPIRIFERA**, *Sow.* Dav. Sil. Mon., p. 84; Sil. Sup., p. 80.
- *bijugosa*, *M'Coy.* Dav. Sil. Mon., p. 89, pl. x, figs. 1—3.
- *crispa*, *Hisinger.* Dav. Sil. Mon., p. 97, pl. x, fig. 13—15; Sil. Sup., pl. iv, figs. 9, 10.
- *elevata*, *Dalman.* Dav. Sil. Mon., p. 95, pl. x, figs. 7—11.
- *plicatella*, var. *radiata*, *Sow.* Dav. Sil. Mon., pp. 84 and 87, pl. ix, figs. 1—6; Sil. Sup., p. 137, pl. vi, figs. 11, 12; and pl. viii, figs. 2, 3.
- var. *globosa*, *Salter.* Dav. Sil. Mon., p. 89, pl. ix, figs. 7, 8.
- var. *interlineata*, *Sow.* Dav. Sil. Mon. (Linné's type of *Anomia plicatella*), p. 84, pl. ix, fig. 9—12.
- *sulcata*, *Hisinger.* Dav. Sil. Mon., p. 91, pl. x, figs. 4—6.
- STREPTIS**, *Dav.* Dav. Sil. Sup., p. 139.
- *Grayii*, *Dav.* (Atrypa?). Dav. Sil. Mon., p. 141, pl. xiii, figs. 14—22; Sil. Sup., p. 139.
- STREPTORHYNCHUS**, *King.* Dav. Sil. Sup., p. 172.
- *nasutus*, *Lindstrom* (under *Cyrtia*?). Dav. Sil. Mon., p. 201, pl. xxv, figs. 1, 2; Sil. Sup., p. 172.
- STRICKLANDINIA**, *Billings.* Dav. Sil. Mon., p. 157; Sil. Sup., p. 164.
- *Balcletchiensis*, *Dav.* Dav. Sil. Sup., p. 166, pl. ix, figs. 27—29.
- *lens*, *Sow.* Dav. Sil. Mon., p. 161, pl. xix, figs. 13—23; Sil. Sup., p. 165, pl. ix, figs. 2—5.
- *lirata*, *Sow.* Dav. Sil. Mon., p. 159, pl. xx, figs. 1—13; Sil. Sup., p. 165, pl. ix, fig. 1.

- STROPHOMENA, *Rafinesque*. Dav. Sil. Mon., p. 280.
- antiquata, *Sow.* Dav. Sil. Mon., p. 299, pl. xlv, figs. 2—13 and 21, 22; Sil. Sup., p. 193, pl. xv, figs. 12—14.
 - arenacea, *Salter*. Dav. Sil. Mon., p. 296, pl. xlii, figs. 6—8; Sil. Sup., p. 197, pl. xvi, figs. 2—5.
 - applanata, *Salter*. Dav. Sil. Mon., p. 308, pl. xliii, figs. 12—14.
 - bipartita, *Salter*. Dav. Sil. Sup., p. 193, pl. xvi, figs. 9—12.
 - Callawayiana, *Dav.* Dav. Sil. Sup., p. 193, pl. xvi, figs. 6, 7.
 - compressa, *Sow.* Dav. Sil. Mon., p. 315, pl. xlvi, figs. 7—10.
 - corrugatella, *Dav.* Dav. Sil. Mon., p. 301, pl. xli, figs. 8—14; Sil. Sup., p. 192, pl. xv, figs. 23—26.
 - Dayi, *Dav.* Dav. Sil. Mon., p. 292, pl. xli, fig. 7.
 - deltoidea, *Covrad.* Dav. Sil. Mon., p. 292, pl. xlii, figs. 1—5, pl. xxxix, fig. 22; Sil. Sup., p. 197, pl. xv, figs. 16—22.
 - — var. undata, *M'Coy*. Dav. Sil. Mon., p. 295, pl. xxxix, figs. 23, 24.
 - euglypha, *Hisinger*. Dav. Sil. Mon., p. 288, pl. xl, figs. 1—5.
 - expansa, *Sow.* Dav. Sil. Mon., p. 312, pl. xlv, figs. 1—10; Sil. Sup., p. 194, pl. xv, figs. 1—5.
 - filosa, *Sow.* Dav. Sil. Mon., p. 307, pl. xlv, figs. 14—20.
 - Fletcheri, *Dav.* Dav. Sil. Mon., p. 317, pl. xlvii, fig. 5.
 - funiculata, *M'Coy*. Dav. Sil. Mon., p. 290, pl. xl, fig. 9—13.
 - grandis, *Sow.* Dav. Sil. Mon., p. 311, pl. xlvi, figs. 1—3 and 5, 6; Sil. Sup., p. 195, pl. xv, fig. 6; and Dav. Sil. Sup., vol. iv, p. 329, pl. xlvii, figs. 1—6.
 - Hendersoni, *Dav.* Dav. Sil. Mon., p. 311, pl. xliii, fig. 15.
 - Hollii, *Dav.* Dav. Sil. Mon., p. 303, pl. xlii, figs. 18, 19.
 - imbrex, var. semiglobosa, *Dav.* Dav. Sil. Mon., p. 286, pl. lxi, figs. 1—4.
 - — var. semiglobosina, *Dav.* Dav. Sil. Mon., p. 286, pl. xli, figs. 5, 6; and Sil. Sup., p. 195, pl. xv, figs. 9—11.
 - Jukesii, *Dav.* Dav. Sil. Mon., p. 296, pl. xxxvi, figs. 23—26.
 - Llandeiloensis, *Dav.* Dav. Sil. Mon., p. 316, pl. xlvi, figs. 11—14.
 - Orbignyi, *Dav.* Dav. Sil. Mon., p. 306, pl. xlii, figs. 12—14.
 - ornatella, *Salter*. Dav. Sil. Mon., p. 309, pl. xliii, figs. 16—20.
 - pecten, *Linné*. Dav. Sil. Mon., p. 304, pl. xlii, figs. 1—11; Sil. Sup., p. 194, pl. xv, fig. 15.
 - retroflexa, *Salter*. Dav. Sil. Mon., p. 298, pl. xlii, figs. 15—17; Sil. Sup., p. 195; pl. xv, figs. 7—8.
 - rhomboidalis, *Wilckens*. Dav. Sil. Mon., p. 281, pl. xxxix, figs. 1, 2, pl. xlv, fig. 1; Sil. Sup., p. 192.
 - Shallockiensis, *Dav.* Dav. Sil. Sup., p. 192, pl. xi, figs. 20, 21, pl. xii, fig. 30; pl. xvi, fig. 8.
 - Siluriana, *Dav.* Dav. Sil. Mon., p. 303, pl. xlvii, figs. 1—4.
 - simulans, *M'Coy*. Dav. Sil. Mon., p. 297, pl. xlii, figs. 9—10.
 - ungula, *M'Coy*. Dav. Sil. Mon., p. 285, pl. 20, 21.
 - Walmstedti, *Lindstrom*. Dav. Sil. Mon., p. 290, pl. xl, figs. 6—8.
 - Waltoni, *Dav.* Dav. Sil. Mon., p. 310, pl. xlii, fig. 11, and Sil. Mon., p. 195, pl. xvi, fig. 1.
- TRIPLESIA, *Dav.* Dav. Sil. Mon., p. 197; Sup., p. 141.
- ? apiculata, *Salter*. Dav. Sil. Mon., p. 202, pl. xxv, fig. 6; Sil. Sup., p. 145.
 - ? Grayæ, *Dav.* Dav. Sil. Mon., p. 198, pl. xxiv, figs. 31, 32; and pl. xxv, figs. 9—11; Sil. Sup., p. 144, pl. viii, fig. 32.

- TRIPLESLIA ? *incerta* (*Atrypa* ?) *Dav.* *Dav. Sil. Mon.*, p. 203, pl. xxiv, fig. 30, pl. xxv, figs. 7, 8; *Sil. Sup.*, p. 145, pl. viii, figs. 24—29.
- *insularis*, *d' Eichwald* (*Orthis*). *Dav. Sil. Mon.*, p. 273, pl. xxxvii, figs. 8—15; *Sil. Sup.*, p. 143, pl. viii, figs. 17—22.
- ? *Maccoyana*, *Dav.* *Dav. Sil. Mon.*, p. 199, pl. xxiv, fig. 29.
- ? *monolifera*, *M'Coy*. *Dav. Sil. Mon.*, p. 200, pl. xxv, fig. 3—5; *Sil. Sup.*, p. 147, pl. viii, fig. 31.
- ? *spiriferoides*, *M'Coy* (*Orthis*?). *Dav. Sil. Mon.*, p. 275, pl. xxxvii, figs. 3—7; *Sil. Sup.*, p. 146, pl. viii, fig. 30.
- *Wenlockiensis*, *Dav.* *Dav. Sil. Sup.*, p. 144, pl. viii, fig. 23.
- WALDHEIMIA, *King*. *Dav. Sil. Sup.*, p. 76.
- ? *Glassii*, *Dav.* *Dav. Sil. Sup.*, p. 77, pl. iv, fig. 4.
- *Mawii*, *Dav.* *Dav. Sil. Sup.*, p. 76, pl. iv, figs. 1—3.
- WHITFIELDIA, *Dav.* *Dav. Sil. Sup.*, p. 107.
- *tumida*, *Dalman* (*Meristella*). *Dav. Sil. Mon.*, p. 109, pl. xi, figs. 1—13; *Sil. Sup.*, p. 107, pl. v, figs. 5, 6; pl. vi, figs. 1—9.
- ZIGOSPIRA, *Hall*. *Dav. Sil. Sup.*, p. 122.
- *anticostiensis*, *Billings* (*Atrypa* *Headii*, var. *anglica*). *Dav. Sil. Mon.*, pl. xxii, figs. 1—8; *Sil. Sup.*, p. 127.
- *erratica*, *Hall*. *Dav. Sil. Sup.*, p. 126 (not British).
- *Headii*, *Billings*. *Dav. Sil. Sup.*, p. 125 (not British).

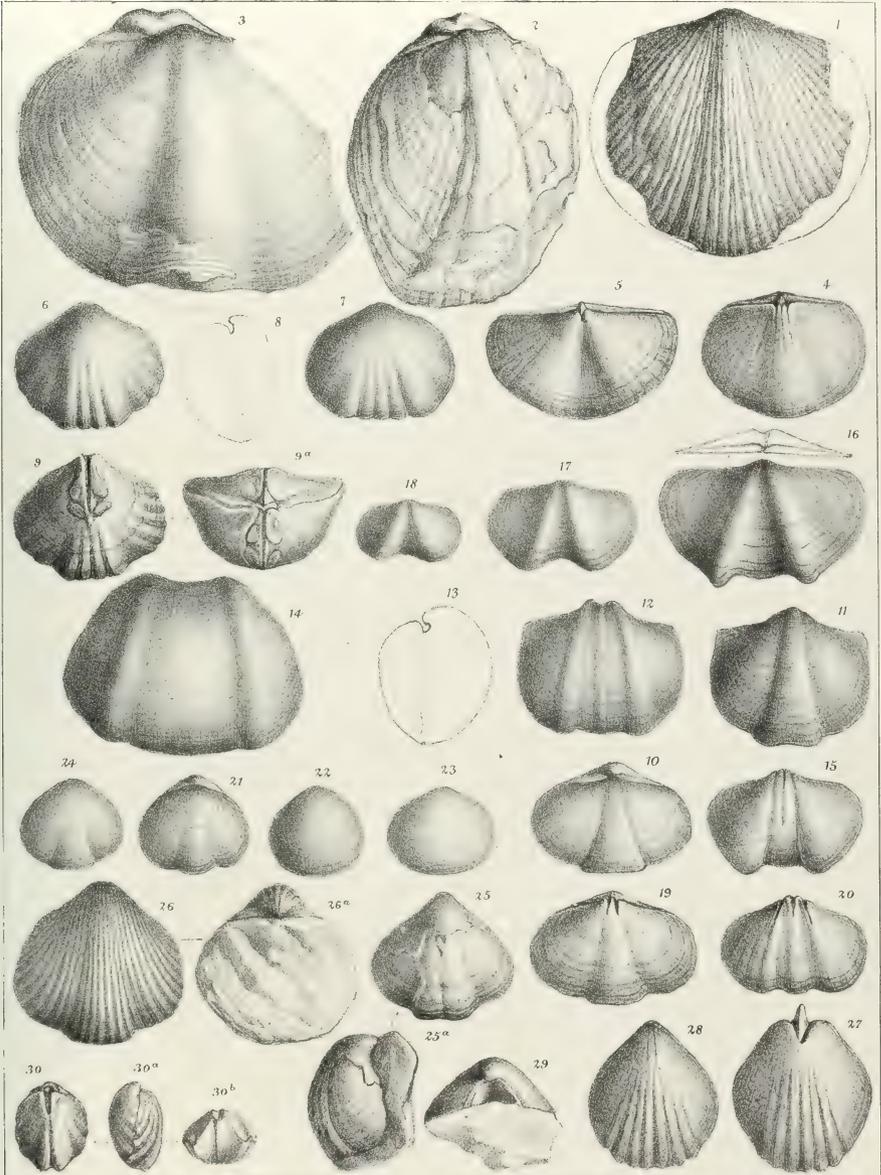
SUPPLEMENT, PLATE VIII.

- FIG.
1. *Meristella? angustifrons*, M'Coy. A large example. Lower Llandovery. Mullock Hill, Girvan. Coll. of Mrs. R. Gray. (Sil. Mon., P. 111.)
 - 2, 3. *Spirifera plicatella*, var. *radiata*, Sow. 2. Upper Llandovery, Bargany Pond Burn. 3. Same formation. Penkill Beds, Penwhapple Glen, Girvan. Coll. of Mrs. R. Gray. (P. 137.)
 - 4, 5. *Cyrtia exporrecta*, Wahl. 4. Upper Llandovery, Penkill, Girvan. Coll. of Mrs. R. Gray. 5. From Caradoc or Horderley Sandstone, Chatwall, Salop. Coll. of Dr. C. Callaway. (P. 137.)
 - 6—9. *Merista? cymbula*, Dav. 6, 7. Exterior of both valves. 8. Internal cast of ventral valve. 8 a. Interior of valve taken in gutta percha from the cast. 9. Internal cast of same valve. 9 a. Interior of valve. Upper Caradoc, Drummuck, Girvan. 6. Hunterian Museum, Glasgow. 7, 8. Same loc. 9. Thraive, Girvan District, Ayrshire. 7, 8, 9. Coll. of Mrs. R. Gray. (P. 138.)
 - 10, 11. *Athyris? subundata*, M'Coy. Upper portion of Upper Llandovery, Minsterley, Shropshire.
 12. *Glossia obovata*, Sow. sp. Upper Llandovery, Penkill, Girvan. Coll. of Mrs. R. Gray. (P. 116.)
 13. *Athyris? sp.* Llandeilo, Balclethie. Coll. of Mrs. R. Gray.
 14. „ ? „ Middle Caradoc, Whitehouse Bay, Girvan. Coll. of Mrs. R. Gray.
 - 15, 16. *Eichwaldia Capewelli*, Dav. 15. From Lower Wenlock shales, Buildwas. 15 a. From Upper Wenlock shales under Benthall Edge, Shropshire. 15 b. Specimen enlarged, seen from the beaks, to illustrate the bare portion of the beak of the ventral valve. 16. Portion of the interior of a Swedish specimen, enlarged, after Lindstrom. (P. 140.)
 - 17—22. *Triplesia insularis*, Eichwald. 17. Complete specimen from the Caradoc. Ty-isaaf. Coll. of Dr. C. Callaway. 18. From the Upper Llandovery, Minsterley, Shropshire. Collected by Mr. R. Philip. 19. Interior of a dorsal valve, enlarged. Caradoc. Ty-isaaf. Coll. of Dr. C. Callaway. 20. Fragment of the interior of a dorsal valve. 21, 22. Internal casts (fragments) of the dorsal valves, Caradoc shales of Cerrig Caedog, south-east of Moel Ferna, Corwen, Merionethshire. (P. 143.)
 23. „ *Wenlockiensis*, Dav. Collected by Dr. C. Callaway from Wenlock shale? Wenlock, Shropshire. My collection. (P. 144.)
 - 24—29. „ ? *incerta*, Dav. 24, 25, 26. Exterior. Upper Llandovery, Penkill, Ayrshire. 27. Interior of dorsal valve. 28. Internal cast of same valve. 29. Interior of ventral valve, from a specimen excavated by Mr. J. Young, and in Hunterian Museum, Glasgow. The other specimens from the coll. of Mrs. R. Gray. (P. 145.)
 30. „ ? *spiriferoides*, M'Coy. Internal cast. Llandeilo, Girvan. Coll. of Mrs. R. Gray. (P. 146.)
 31. „ ? *monilifera*, M'Coy. Middle Llandovery, Woodland Point, Girvan. Coll. of Mrs. R. Gray. (P. 147.)
 32. „ ? *Grayæ*, Dav. Llandeilo, Craighead, Ayrshire. Coll. of Mrs. R. Gray. (P. 144.)
 33. *Rhynchonella Maccoyana*, Dav. Caradoc, Glencotho Quarry, near Broughton, Peebleshire. Coll. of the Geol. Survey of Scotland. (P. 161.)



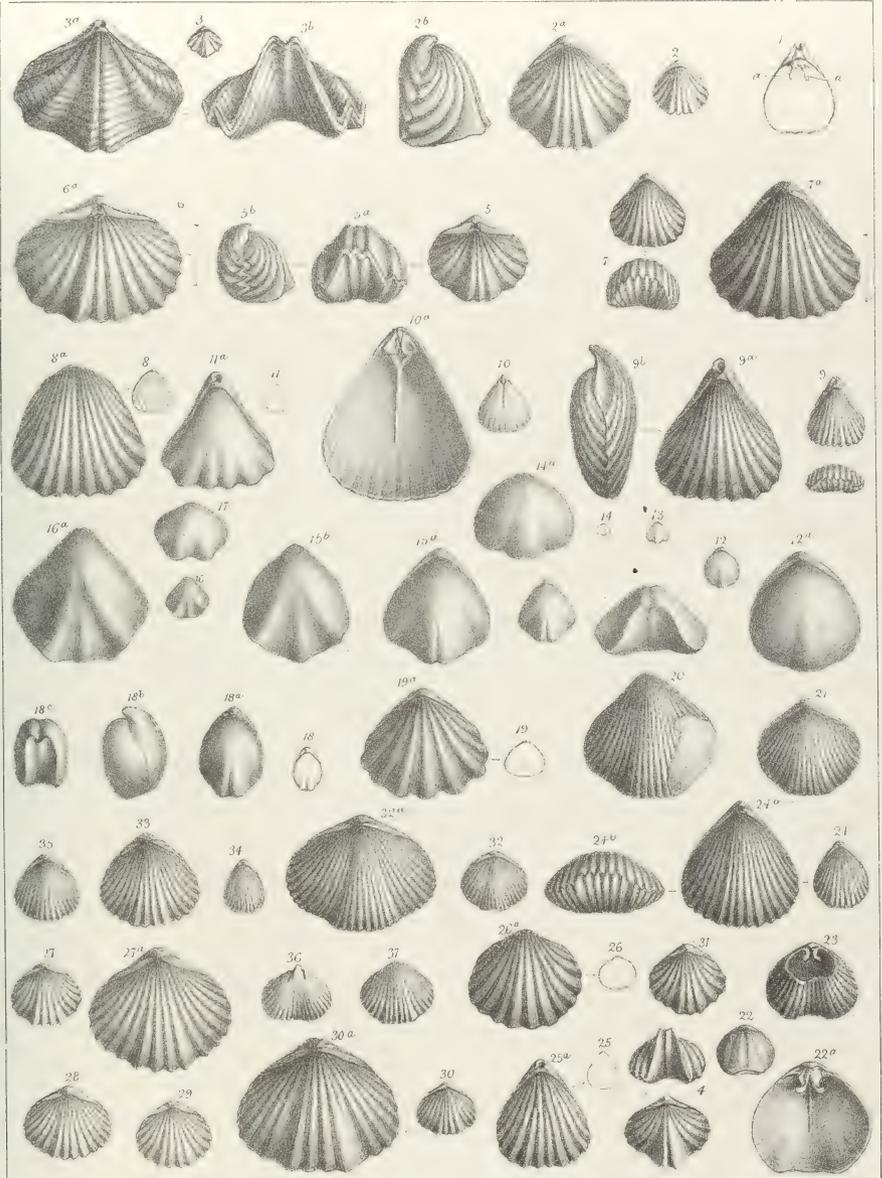
SUPPLEMENT, PLATE IX.

- FIG.
 1. *Stricklandinia virata*, Sow. Middle Llandoverly, Woodland Point, Girvan District, Ayrshire. Collection of Mrs. R. Gray (P. 165.)
- 2—5. „ *lens*, Sow. Different specimens from Middle Llandoverly, Woodlands Point, Girvan. 2, 3, 4. Collections of Mrs. R. Gray. (P. 165.)
- 6—9. *Pentamerus rotundus*, Sow. Upper Llandoverly, Penkill, Girvan. 6, 7, 8. From the collection of Mrs. R. Gray. 9 and 9 a. Internal cast, showing muscular and other impressions. (P. 163.)
- 10—20. „ *undatus*, Sow. Middle Llandoverly. 10—18. Woodland Point. 19, 20. Internal casts. Middle Llandoverly, Newland bed, Girvan. All the specimens, except 15, from the collection of Mrs. R. Gray. (P. 162.)
- 21—24. „ *globosus*, Sow. Upper Llandoverly, Penkill, Girvan. Collection of Mrs. R. Gray. (P. 163.)
- 25, 25 a. „ ? *galeatus*, Dal. Upper Llandoverly, Penkill, Girvan. (P. 164.)
- 26, 26 a. „ ? *Shallockiensis*, Dav. Middle Caradoc, Shallock Mill, Girvan. Collection of Mrs. R. Gray. Genus uncertain. (P. 164.)
- 27—29. *Stricklandinia?* *Baleletchensis*, Dav. Llandeilo, Baleletchie Conglomerate, Baleletchie, Girvan. Collection of Mrs. R. Gray. Genus uncertain. (P. 166.)
- 30, 30 a, 30 b. *Rhynchonella Jackii*, Dav. Caradoc, Duntercleugh Burn, Wanlock Water, Leadhills, Dumfriesshire. Collection of the Geological Survey of Scotland. (P. 158.)



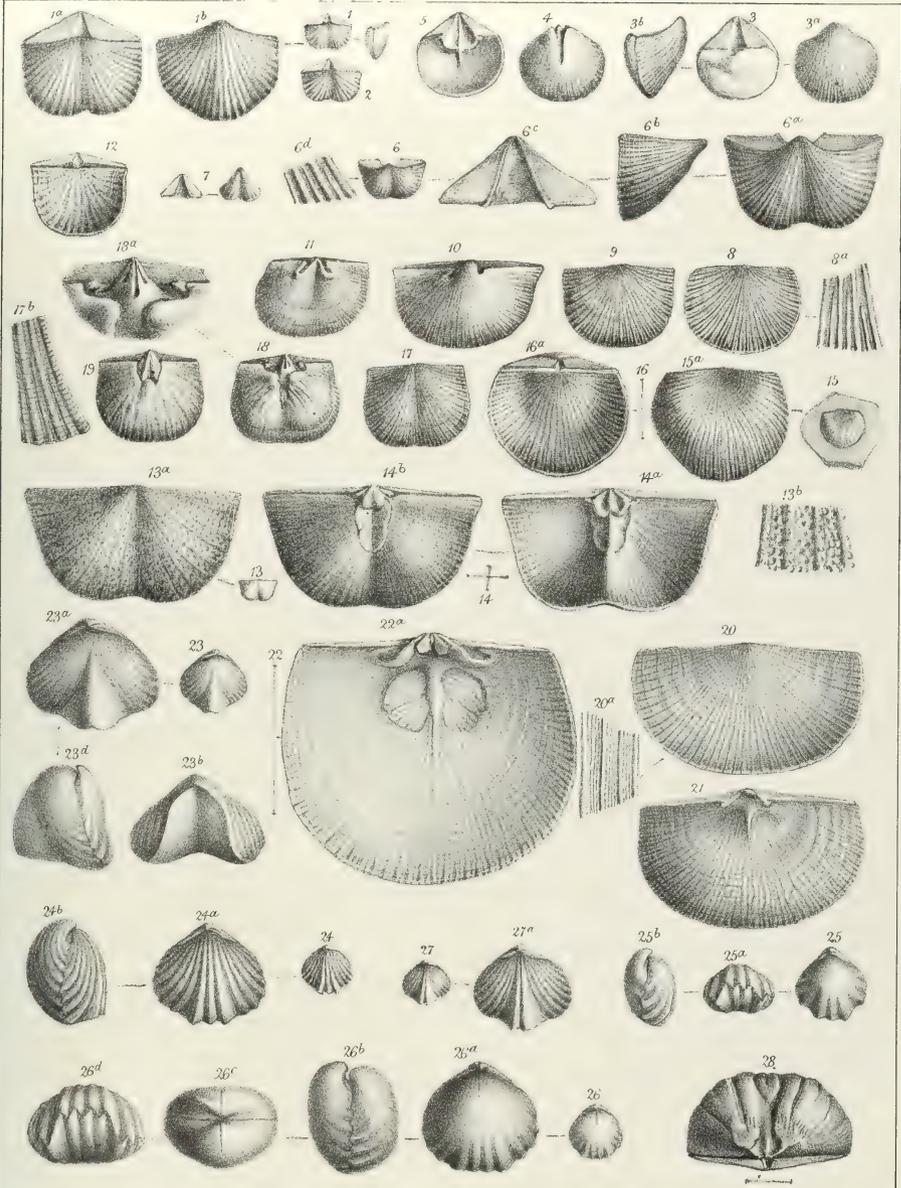
SUPPLEMENT, PLATE X.

- FIG.
1. *Rhynchonella cuneata*, Dal. Wenlock, Dudley. Developed by the Rev. N. Glass to show short curved crura for the support of labial appendages. 2 *a*, *b*. Enlarged. (P. 152.)
 - 2, 2 *a*, *b*. „ *Dayi*, Dav. Wenlock limestone and shales, Benthall Edge. 2 *a*, *b*. Enlarged. (P. 152.)
 - 3, 3 *a*, *b*. „ *bidentata*, Hisinger. Wenlock limestone and shales, Benthall Edge and Buildwas, Shropshire. 3 *a*, *b*. Enlarged. (P. 150.)
 4. „ *diodonta*, Dal. Wenlock shale, near Dudley. (P. 151.)
 - 5, 6. „ *sub-borealis*, Dav. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. 6 *a*. Enlarged. (P. 149.)
 - 7, 7 *a*. „ *Lapworthi*, Dav. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. 7 *a*. Enlarged. (P. 154.)
 - 8, 8 *a*. „ „ sp.? Llandeilo, Balcletchie Conglomerate, Balcletchie, Girvan. Coll. of Mrs. R. Gray. 8 *a*. Enlarged. (P. 154.)
 - 9 to 10, „ *cuneata*, Dal.? 9. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. 9 *a*, *b*. Enlarged. 10. Internal cast. 10 *a*. Interior of dorsal valve. Taken from cast. Upper Llandovery, Speakes Rough, near Minsterley, Salop. Coll. of Mr. R. Philip. (P. 152.)
 11. „ *cuneatella*, Dav. 11, 11 *a*. Llandeilo, Balcletchie Conglomerate, Girvan. Coll. of Mrs. R. Gray. 11 *a*. Enlarged. (P. 200.)
 - 12, 13, 14. „ *Portlockiana*, Dav. Llandeilo, Balcletchie Conglomerate, Balcletchie, Girvan. Coll. of Mrs. R. Gray. 12 *a* and 14 *a*. Enlarged. (P. 159.)
 - 15, 16. „ *Balcletchiensis*, Dav. Llandeilo, Craighead, and Balcletchie Conglomerate, Girvan. Coll. of Mrs. R. Gray. 15, 16. Nat. size. (See also Pl. XI, fig. 23.) (Pp. 160, 200.)
 17. „ *amula*, Salter sp.? Upper Llandovery, Penkill, Girvan. Coll. of Mrs. R. Gray. Much enlarged. (P. 160.)
 - 18, 18 *a*—*c*. „ *Callawayana*, Dav. Wenlock shales, Walsall. Coll. of Dr. C. Callaway. 18 *a*, *b*, *c*. Enlarged. (P. 159.)
 - 19, 19 *a* „ *Shallockiensis*, Dav. Llandeilo, Shallock Hill, Girvan. Coll. of Mrs. R. Gray. 19 *a*. Enlarged. (P. 154.)
 - 20, 21. „ *nasuta*, M'Coy. Llandeilo, Craighead, Girvan. 21. Coll. of Mrs. R. Gray. (P. 160.)
 - 22—22 *a*. „ *Glassiana*, Dav. (*Atrypa depressa*, Sow.). 22. Exterior. 22 *a*. Interior of dorsal valve developed by the Rev. N. Glass to show the two curved processes of *Rhynchonella*. Woolhope limestone, road between Alfric and Crew Station, Malvern. 22 *a*. Enlarged. (Pp. 155, 219.)
 23. „ *defteza*, Sow., sp. Specimen developed by the Rev. N. Glass to show the two short curved crura. Wenlock limestone, Benthall Edge. (P. 156.)
 - 24, 24 *a*. „ *Weaveri*, Salter.? Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. 24 *a*. Enlarged. (P. 158.)
 - 25, 25 *a*. „ *borealis*, Sch. Young specimen. 25 *a*. Enlarged. Wenlock limestone, Benthall Edge. (P. 148.)
 - 26, 26 *a*. „ *Girvaniensis*, Dav. Llandeilo, Balcletchie Conglomerate, Girvan. Coll. of Mrs. R. Gray. 26 *a*. Enlarged. (P. 155.)
 - 27, 28, 29. „ *nucula*, Sow. 27. Upper Ludlow, Ludlow. 28. Upper Llandovery, Hope, Shropshire. Coll. of Rev. H. Day. 29. Middle Caradoc, Shallock Mill, Girvan. Coll. of Mrs. R. Gray. 27 *a*. Enlarged. (P. 157.)
 - 30, 30 *a*. „ „ var.? Llandeilo, Balcletchie Conglomerate, Balcletchie, Girvan. Coll. of Mrs. R. Gray. This identification is uncertain.
 31. „ „ var. Upper Llandovery, Minsterley, Shropshire.
 - 32—37. „ *Llandoveryana*, Dav. 32 to 35. Typical specimens. Upper Llandovery, Minsterley, Shropshire. Coll. of Mr. R. Philip. 32 *a*. Enlarged. 36, 37. Upper Llandovery, Camregan Wood, Girvan District, Ayrshire. (P. 157.)



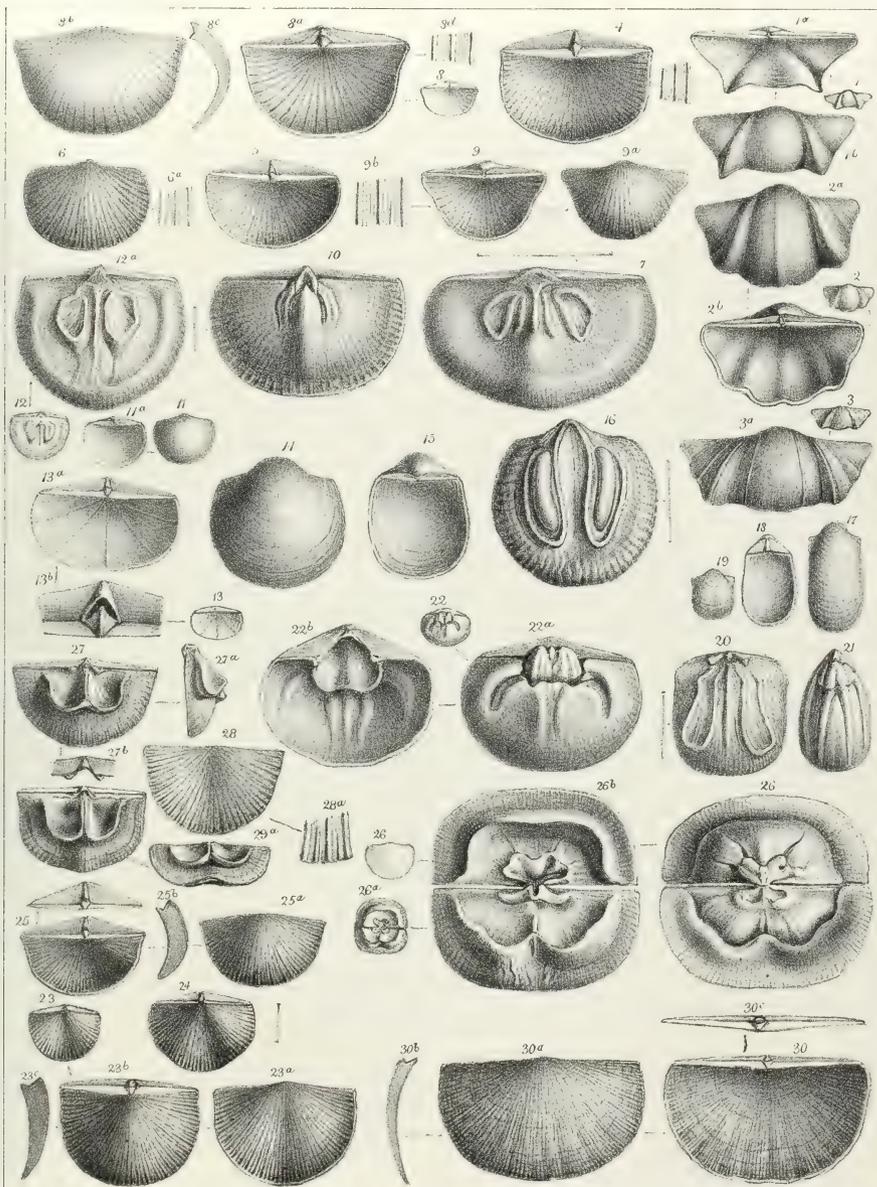
SUPPLEMENT, PLATE XI.

- FIG.
1, 2 *Skeneidium Lewisii*, var. *Woodlandiense*, Dav. Middle Llandovery, Woodland Point, Girvan District. Coll. of Mrs. R. Gray. 1 *a, b*. Enlarged. (P. 174.)
- 3—5. " *Grayia*, Dav. 3. Middle Caradoc, Thraive, Ayrshire. 4. Internal cast of ventral valve. 5. Interior of valve taken in gutta percha from the cast. (P. 175.)
- 6, 7. " ? *Shallockiense*, Dav. Middle Caradoc, Shallock Mill, Ayrshire. 6. A ventral valve, nat. size. 6 *a, b, c*. Enlarged. 7. Another smaller ventral valve. Coll. of Mrs. R. Gray. (P. 174.)
- 8—11. *Orthis Hirmantensis*, M'Coy. Caradoc shales above Hermant limestone, Aber Hermant, near Bala. 10, 11. Internal cast of ventral valve. (P. 189.)
12. " *Actonia*, Sow. Caradoc, Gelli Goin, near Bala. Coll. of Mr. J. Parrott. (P. 190.)
- 13, 14. " *Philipi*, Dav. Caradoc, Ty-isaaf, Llansantffraid, Wales. 13. Exterior. 13 *a*. Enlarged. 13 *b*. Fragment of shell enlarged. 14. Internal cast of dorsal valve. 14 *a*. Interior of same valve taken from the cast by means of gutta percha, enlarged. Coll. of Mr. C. Croft, of Manchester. (P. 188.)
- 15, 16. " *Jonesi*, Dav. 15. Impression or cast of the exterior of dorsal valve. 15 *a*. The same enlarged. 16. Dorsal valve and beak and area of ventral valve, enlarged. (P. 190.)
- 17—19. " *Rankini*, Dav. Llandeilo, Ardmillan Brae, Ayrshire. Coll. of Mrs. R. Gray. 17, 17 *a*. Exterior of dorsal valve. 18. Internal cast of dorsal valve. 18 *a*. Portion of same enlarged. 19. Internal cast of ventral valve. (P. 190.)
- 20, 21. *Strophomena Shallockiensis*, Dav. 20. Exterior. 21. Interior of ventral valve. Upper Caradoc or Bala Schists, Trystion Valley, near Cynwyd, North Wales, at the foot of Moel Ferna, Berwyn mountains. Coll. of Mr. J. Parrott. (P. 192.)
22. " *grandis*, Sow. Interior of dorsal valve, enlarged, taken from an internal cast found by Dr. C. Callaway in the Caradoc at Marsh Brook, Shropshire. (P. 195.)
23. *Rhynchonella Balclutchiensis*, Dav. Llandeilo, Minunton, Ayrshire. Coll. of Mrs. R. Gray. 23 *a, b, c*. Enlarged. (P. 200.)
24. " *nucula*, var. ? Llandeilo, Minunton, Ayrshire. Coll. of Mrs. R. Gray. 24 *a*. Enlarged. (P. 201.)
25. " *Peachi*, Dav. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. (P. 201.)
26. " *Scotica*, Dav. Llandeilo, Craighead, Ayrshire. Coll. of Mrs. R. Gray. 26 *a, b, c, d*. Enlarged. 26. Seen from the beaks to show septum (s) on both valves. (P. 201.)
27. " *decemplicata*, Sow. Lower Llandovery, Mullock Hill beds of Thraive Glen. 27 *a*. Enlarged. Coll. of Mrs. R. Gray. (Pp. 151, 202.)
28. *Leptana tenuicincta*, M'Coy. External cast of ventral valve seen from the beak, enlarged. Llandeilo, Ayrshire. (P. 168.)



SUPPLEMENT, PLATE XII.

- FIG.
 1, 2, 3. *Leptana segmentum*, var. *cornuta*, Dav. Middle Wenlock shale, Coal Brook Dale Railway Station, half mile from Buildwas Abbey, Shropshire. Figs. 1, 2, 3. Nat. size. (P. 166.)
- 4, 5, 6, 7. „ *sericea*, var. *rhombica*, M'Coy. 4. Caradoc, Duntercleugh Burn, Leadhill District, Dumfriesshire. Coll. Geol. Survey of Scotland. 5. Llandeilo, Balcletchie. 6. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. 7. Interior of dorsal valve, enlarged. (P. 169.)
- 8, 9, 10. „ *sericea*, Sow. Llandeilo, Craighead, Girvan. 9. Middle Caradoc, Shallock Mill, Girvan. 10. Llandeilo, Balcletchie, Girvan. All in the coll. of Mrs. R. Gray. (P. 169.)
- 11, 12. „ *Etheridgei*, Dav. Llandeilo, Craighead, Ayrshire. Coll. of Mrs. R. Gray. 12 *a*. Interior of dorsal valve, enlarged. (P. 170.)
13. „ *quinquecostata*, M'Coy. Llandeilo, Ardmillan Brae, Girvan. 13 *a*, 13 *b*. Enlarged. Coll. of Mrs. R. Gray. (P. 169.)
- 14, 15, 16. „ *Youngiana*, Dav. 16. Interior of dorsal valve, enlarged. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. (P. 168.)
- 17—21. „ *tenuicincta*, M'Coy. Llandeilo. 17, 18, 19. Varieties in form. Llandeilo, on Balcletchie Conglomerate, Balcletchie, Girvan. Coll. of Mrs. R. Gray. 20. Interior of dorsal valve. Balcletchie. 21. Internal cast. Caradoc, Kilbucho, Peebleshire. Coll. of the Geol. Survey of Scotland (see also Pl. XI, fig. 28). (P. 168.)
22. „ *scissa*, Salter. Upper Llandovery, Minsterley, Salop. Coll. of Mr. R. Philip. 22 *a*, *b*. Interior of ventral valve, enlarged. (P. 170.)
- 23—25. „ *Grayæ*, Dav. Llandeilo, Craighead, Girvan. Coll. of Mrs. R. Gray. (P. 171.)
- 26—29. „ *Llandeiloensis*, Dav. Llandeilo. 26. Ardmillan Brae. 27—29. Craighead, Girvan. 26—28. Coll. of Mrs. R. Gray. 29. Hunterian Museum, Glasgow. (P. 171.)
30. *Strophomena Shallockiensis*, Dav. Upper Caradoc, Cynyd beds, near Corwen, Merionethshire. Collected by Mr. J. Parrott. (P. 192.)

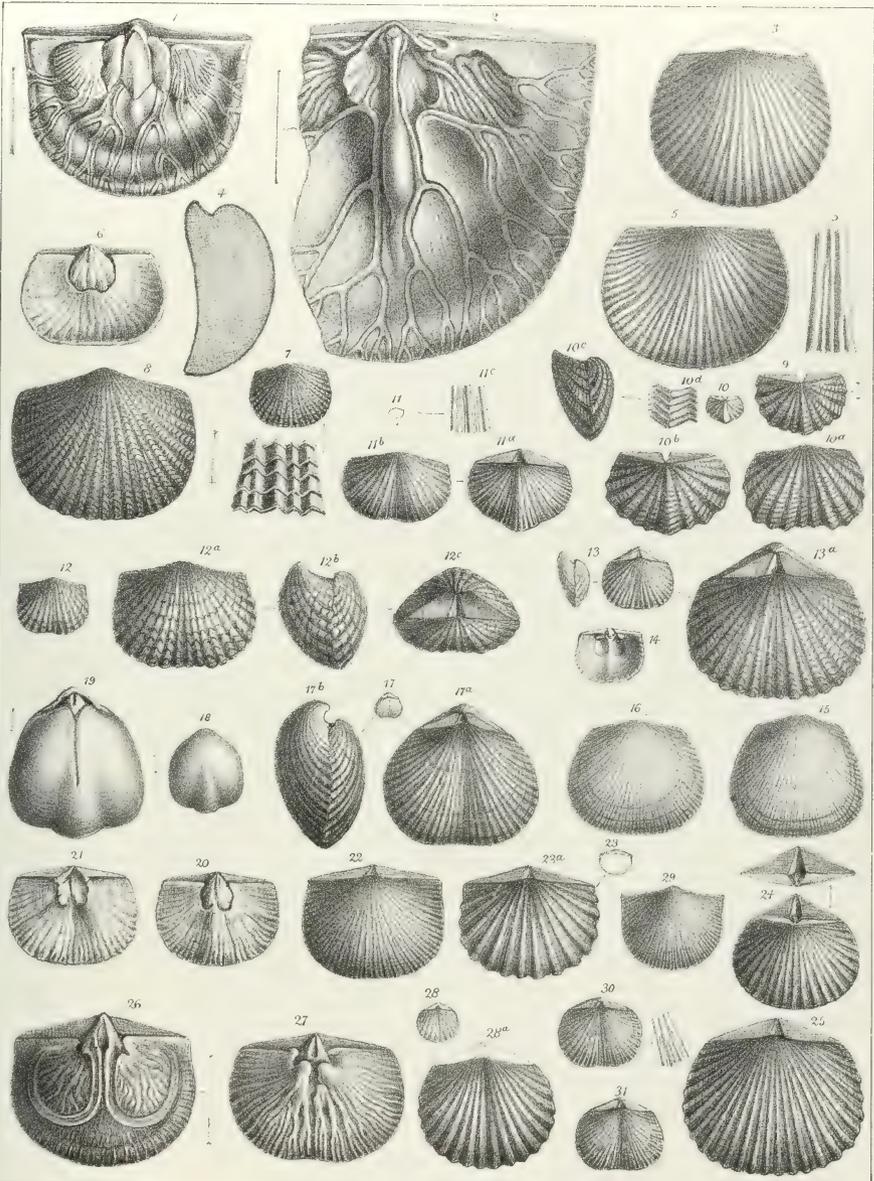


SUPPLEMENT, PLATE XIII.

- FIG.
 1, 2. *Orthis* or *Strophomena*? *Kilbuckoensis*, Dav. 1. Internal cast, showing muscular, ovarian, and vascular impressions, enlarged. 2. Interior of the dorsal valve, taken in gutta percha from a finely preserved internal cast, enlarged, showing cardinal process, septum, muscular and ovarian, and vascular impressions in a wonderfully beautiful state of preservation. Caradoc, Kilbucko, near the church, two and a quarter miles west of Culter, Peebleshire. Coll. of the Geol. Survey of Scotland. (P. 188.)
- 3—6. „ *flabellulum*, Sow. 3, 4, 5. Llandeilo, Craighead, Girvan. 6. Cast of interior of ventral valve, Upper Caradoc, Thraive. All in coll. of Mrs. R. Gray. (P. 179.)
- 7, 8. „ *crispa*, M'Coy. 7. Middle Caradoc, Thraive, Girvan. 8. Llandeilo, Ardmillan Brae, Girvan. Both in the coll. of Mrs. R. Gray. (P. 176.)
- 9, 10. „ *Lapworthi*, Dav. 9. Middle Caradoc, Shallock Mill, Girvan. 10. Llandeilo or Balcletchie Conglomerate, Girvan. Both in the coll. of Mrs. R. Gray. (P. 176.)
11. „ *nina*, Dav. Middle Caradoc, Whitehouse Bay, Girvan. Coll. of Mrs. R. Gray. 11 *a, b*. Enlarged. (P. 177.)
- 12—14. „ *Balcletchiensis*, Dav. 12 and 14. Llandeilo, Craighead, Girvan. 13. Balcletchie Conglomerate, Girvan. Coll. of Mrs. R. Gray. (P. 176.)
- 15, 16. „ *polygramma*, Sow., var. *Pentlandica*, Dav. Upper Llandoverly Penkill, Girvan. Coll. of Mrs. Gray. (P. 179.)
17. „ *elegantulina*, Dav. Lower Wenlock shales, Buildwas, Shropshire. (P. 219.)
- 18, 19. „ ? *Crofti*, Dav. Caradoc, Ty-isaaf, Llansantffraid. Coll. of Mr. Croft. (P. 179.)
- 20, 21. „ *flabellulum*, Sow. Llandeilo, Ardmillan Brae. Coll. of Mrs. R. Gray. (P. 179.)
22. „ *rustica*, Sow. Upper Llandoverly, Penwhapple Glen, Girvan. Coll. of Mrs. R. Gray. (P. 178.)
- 23—26. „ *calligramma*, Dal. 23. Llandeilo, Ardmillan Brae. 24. Craighead. 25. Upper Llandoverly, Penkill beds, Penwhapple Glen. 26. Internal cast, Llandeilo, Ardmillan Brae. All in Girvan district, and coll. of Mrs. R. Gray. (P. 181.)
27. „ *plicata*, Sow. Upper Llandoverly, Minsterley, Shropshire. Coll. of Mr. R. Philip. (P. 182.)
28. „ *unguis*?, Sow. Llandeilo, Craighead, Girvan. Coll. of Mr. J. Thomson. (P. 177.)
29. „ *sagittifera*, M'Coy. Lower Llandoverly, Mullock Hill, Girvan. Coll. of Mrs. R. Gray. (P. 181.)
- 30, 31. „ *testudinaria*, Dal. 30. Llandeilo, Craighead. 31. Middle Caradoc, Girvan. Coll. of Mrs. R. Gray. (P. 178.)

SILURIAN

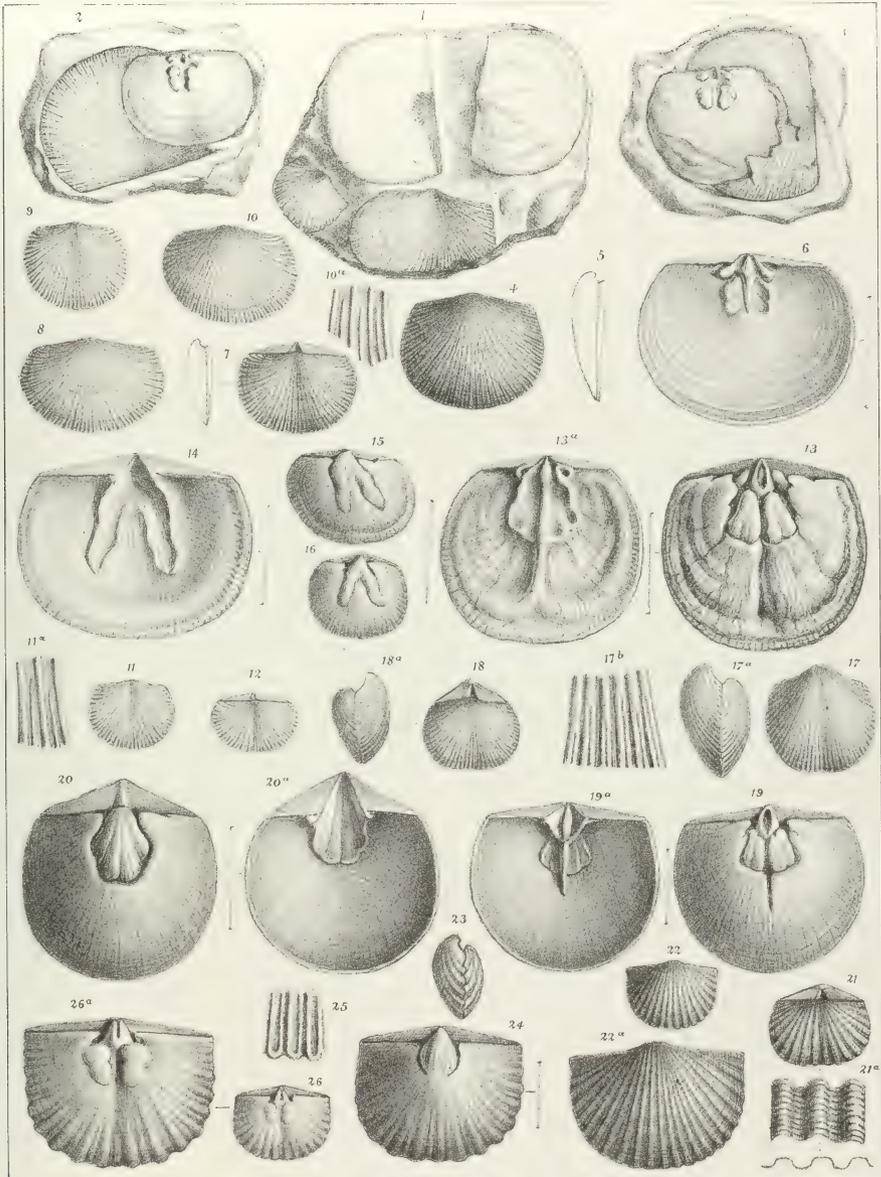
PLATE 11



SUPPLEMENT, PLATE XIV.

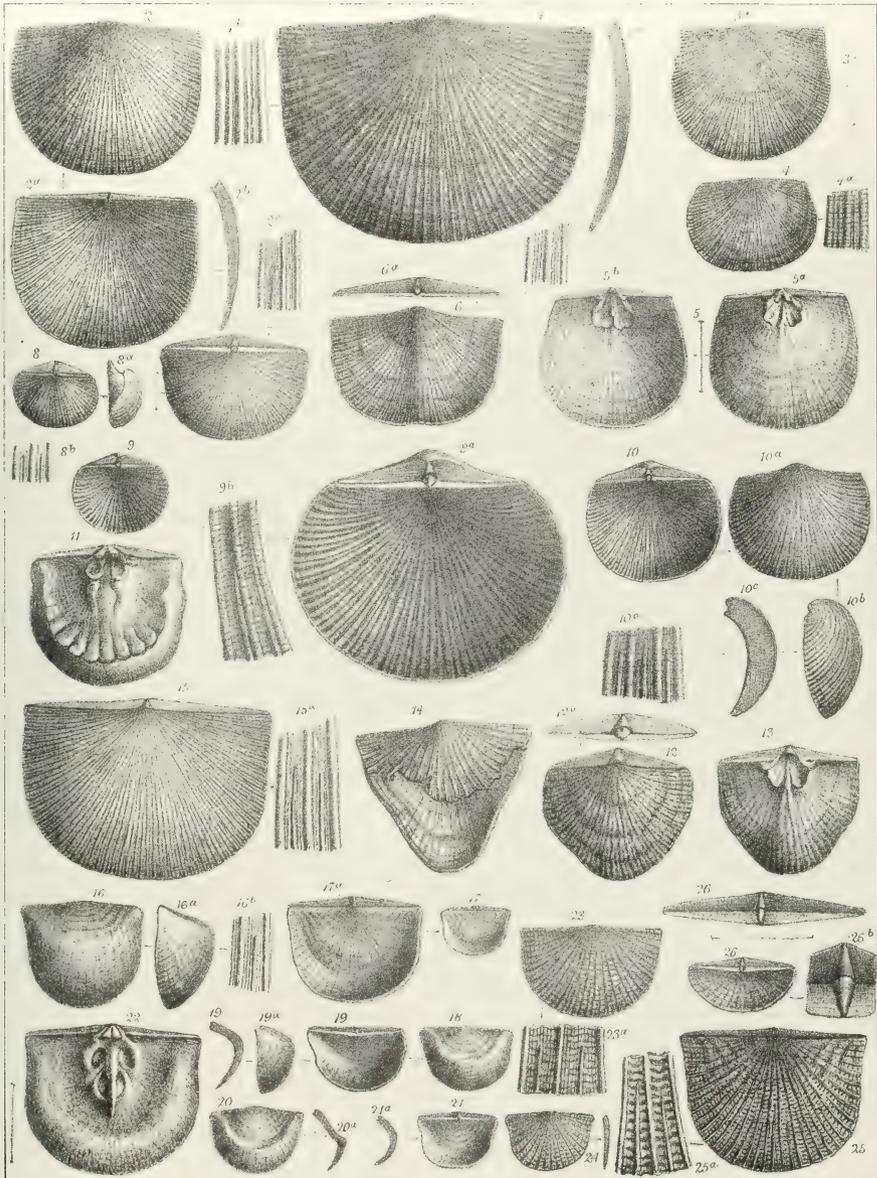
FIG.

- 1—6. *Orthis alternata*, Sow. 1. After original figure, in Sil. System, pl. xix, fig. 6. Caradoc, Cheney Longville, Shropshire. 2—6. Middle Caradoc, Horderley, Woodwardian Museum, Cambridge. (P. 187.)
- 7—16. „ *retrorsistria*, M'Coy. A series of exteriors and interiors from the Middle Caradoc. 7. Cerrig-y-Druidion. 8. Pentre Cwmdu. 9. Hafod Evans. 10. Peny Gaer. 11. Cerrig-y-Druidion. 12. Pentre Cwmdu. 13. Interior and cast of interior of dorsal valve, Cerrig-y-Druidion. 14. Interior of ventral valve, same locality. 15, 16. Internal casts. All in the Woodwardian Museum, Cambridge. (P. 185.)
- 17—20. „ *turgida*, M'Coy. 17. Lower Caradoc, Llandeilo. 18. Llandeilo, Craighead, Girvan. 19, 19a. Interior and internal cast of dorsal valve, Middle Caradoc, Hills N. of Conway Palls. 20 and 20a. Internal cast and interior of ventral valve, Lower Caradoc, Goldengrove, Llandeilo. 17, 19, and 20. M'Coy's types in the Woodwardian Museum, Cambridge. 18. In the collection of Mrs. R. Gray. (P. 187.)
- 21—26. „ *Carausii*, Salter. From Lower Tremadoc, of Bone, Tyhen, Treiorwerth Anglesea. Collected and given to me by Prof. Mc. K. Hughes. (P. 182.)



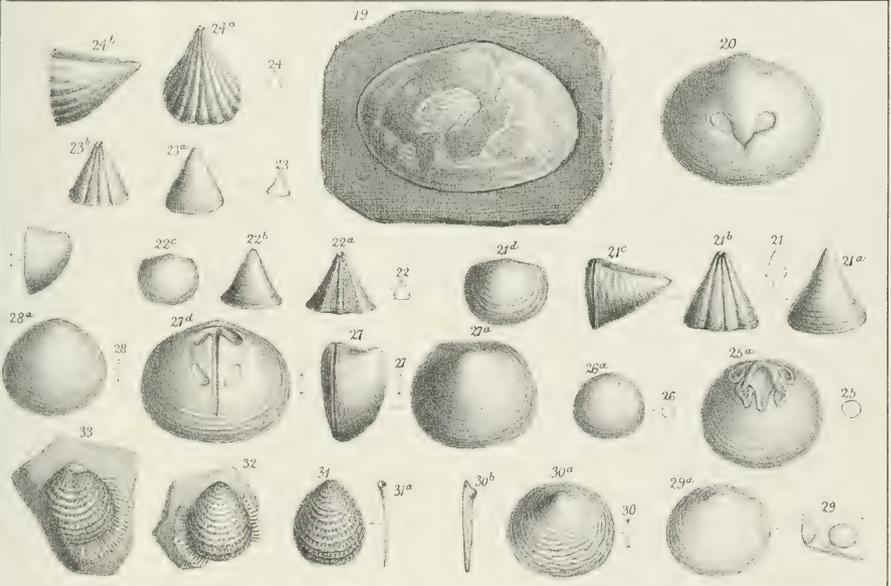
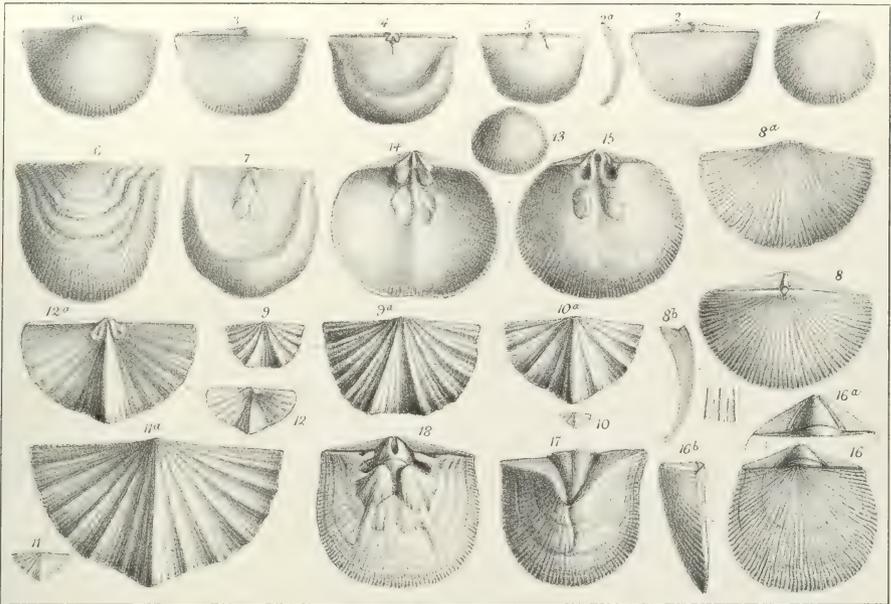
SUPPLEMENT, PLATE XV.

- FIG.
- 1—5. *Strophomena expansa*, Sow. 1. A large example. Lower Llandoverly, Mullock Hill. 2. Llandeilo Minunton. 3—5. Lower Llandoverly, Mullock Hill, Ayrshire. Collection of Mrs. R. Gray. 5 *a*, 5 *b*. Interior of both valves. (P. 194.)
6. „ *grandis*, Sow? Upper Caradoc, Thraive, Ayrshire. Collection of Mrs. R. Gray. (P. 195.)
- 7—8. „ *retroflexa*, Salter. Llandeilo, Craighead. 8. Collection of Mrs. R. Gray. (The reference to the plate and figure was inadvertently omitted at page 195.)
- 9—11. „ *imbrea*, var. *semiglobosina*, Dav. 9. A specimen with coarse ribs from the Llandeilo, Balcletchie, Ayrshire. 9 *a*. Enlarged. 10 *a*. Specimen from same locality with finer ribs. 11. Interior of dorsal valve, Craighead, Ayrshire. All in the collection of Mrs. R. Gray. (P. 195.)
- 12—14. „ *antiquata*, Sow. Middle Llandoverly, Woodland Point, Ayrshire. Collection of Mrs. R. Gray. (P. 193.)
15. „ *pecten*, Linné. Middle Llandoverly, Woodland Point, Girvan. Collection of Mrs. R. Gray. (P. 194.)
- 16—22. „ *delloidea*, Conrad. 16, 18, 19, 20. Llandeilo, Craighead. 17, 18. Balcletchie. 22. Interior of dorsal valve, enlarged Balcletchie conglomerate in Ayrshire and collection of Mrs. R. Gray. (P. 197.)
- 23—26. „ *corrugatella*, Dav. 23, 24, and 26. Llandeilo, Balcletchie Cong., Ayrshire. 25. Middle Llandoverly, Woodland Point, same county and collection of Mrs. R. Gray. (P. 192.)



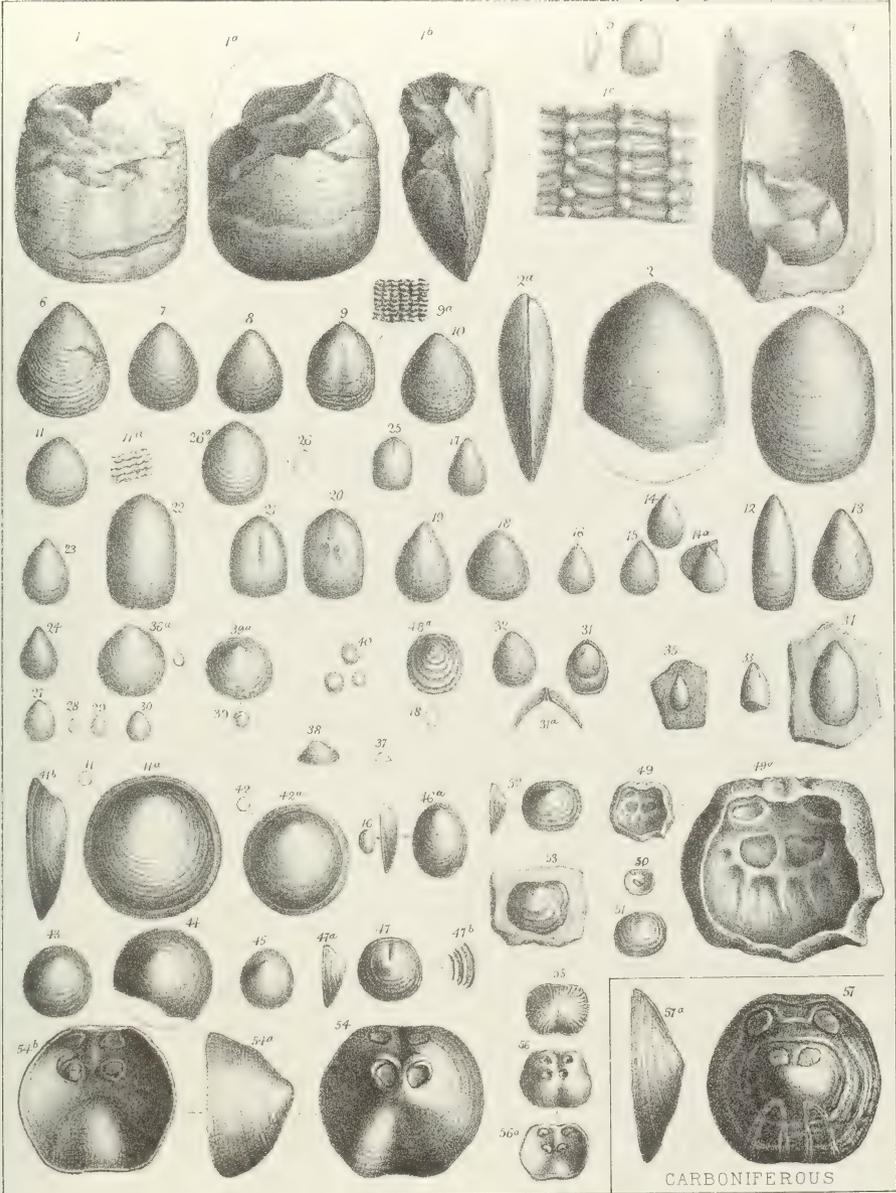
SUPPLEMENT, PLATE XVI.

- FIG.
1. *Strophomena Waltoni*, Dav. Upper Llandoverly, Cuddyston Glen. Coll. of Mrs. R. Gray. (P. 195.)
 - 2—5. „ *arenacea*, Salter. 2. Middle Llandoverly, Woodland Point, Girvan. 3, 3 a, 4, 5. Upper Llandoverly, Camregan Wood, Girvan. Coll. of Mrs. R. Gray. (P. 197.)
 - 6, 7. „ *Callawayiana*, Dav. Caradoc, Marsh Brook, Gretton. Coll. of Dr. C. Callaway. (P. 193.)
 - 8, 8 a, b. „ *Shallockiensis*, Dav. Middle Caradoc, Shallock Mill, Girvan. Coll. of Mrs. R. Gray. (P. 192.)
 - 9—12. „ ? *bipartita*, Salter. Middle Caradoc or Chatwall sandstone, south end of Ragleigh Hill, Vetnich Station, and Caradoc, Ty-isaaf, Llansantffraid. Collections of Messrs. C. Callaway and Croft. (P. 193.)
 13. *Orthis reversa*, Salter. Upper Llandoverly or Penkill beds, Penwhapple Glen, Girvan. Coll. of Mrs. R. Gray. (P. 180.)
 - 14, 15. „ *Mullockiensis*, Dav. External cast and interior of the dorsal valve. Lower Llandoverly, Mullock Hill, Girvan. Coll. of Mrs. R. Gray. (P. 180.)
 - 16—18. *Orthisina adscendens*, Pander. 16, 16 a, b. Complete specimens showing the dorsal valve. 17. Ventral valve. 18. Interior of dorsal valve. Upper Caradoc, Bwlch-y-Gossi beds near Cynwyd. (P. 175.)
 19. *Dinobolus? Hicksii*, Dav. Upper Arenig, St. David's. (P. 212.)
 20. „ *Davidsoni*, Salter. Lower Wenlock or Upper Llandoverly, Uggool, near Ballaghadereen, County Mayo, Ireland. Museum of Geol. Survey of Ireland. (P. 212.)
 - 21—23. *Acrotreta Nicholsoni*, Dav. 21. Llandeilo, Craighead. 22. Same formation, Balcletchie. 23. Ardmillan Brae. All in the Girvan district and coll. of Mrs. R. Gray. (P. 213.)
 24. „ ? *costata*, Dav. Llandeilo, Balcletchie. Coll. of Mrs. R. Gray. (P. 213.)
 - 25, 26. *Obolella sagittalis*, Salter. Llandeilo, Cairn Burn, Druidhill Burn, Dumfriesshire. Coll. Geol. Survey Scotland. (P. 211.)
 - 27, 28. „ *Sabrinæ*, Callaway. Tremadoc (Shinerton shales, Shinerton, Salop). (P. 211.)
 - 29, 30. *Acrothele granulata*, Linnarsson. Llandeilo, Coalpit Bay, County Down, Ireland. Figures much enlarged. (P. 214.)
 - 31—33. *Siphonotreta scotica*, Dav. Llandeilo, Craighead, Girvan, and coll. of Mrs. R. Gray. (P. 217.)



SUPPLEMENT, PLATE XVII.

- FIG.
 1 *a, b, c. Lingula Canadensis*, Bill. Llandeilo, Balcletchie Conglomerate. Coll. of Mrs. R. Gray. 1 *e*. Portion of exterior sculpture greatly magnified. (P. 202.)
 2, 3. „ *quadrata*, Eichw. Llandeilo, Craighead. Coll. of Mrs. R. Gray. (P. 203.)
 4. „ *Brodiei*, Dav. Lower Wenlock, Little Hope quarries, Woolhope. Coll. of Rev. P. B. Brodie. (P. 204.)
 5. „ *Philipi*, Dav. Upper Llandovery, Minsterley, Salop. Coll. of Mr. R. Philip. (P. 206.)
 6—11. „ *Ramsayi*, Salter. Llandeilo, Craighead and Balcletchie, Ayrshire. Principally from the coll. of Mrs. R. Gray. (P. 206.)
 12. „ *Leseuri*, Rouault. From the drift of Moseley, Birmingham. (Lowest Llandeilo). (P. 204.)
 13—19. „ *attenuata*, Sow. 13. Llandeilo, Ardmillan Brae. 14, 15. Ditto, Balcletchie. Coll. of Mrs. R. Gray. 16. Llandeilo, Wrae Quarry, three miles south of Broughton, Peebleshire. Coll. of Geol. Survey of Scotland. 17. Lower Caradoc, Horderley, Shropshire. Coll. of Rev. P. B. Brodie. 18, 19. Llandeilo, Meadow Town, near Minsterley, Shropshire. Coll. of Mr. R. Philip. (P. 206.)
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A MONOGRAPH

OF THE

BRITISH FOSSIL TRIGONIÆ.

BY THE LATE

JOHN LYCETT, L.R.C.P.E., &c.

SUPPLEMENT No. 2.

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APPENDIX.¹

DURING the latter period of the publication of my Monograph on the British Fossil Trigonæ and subsequently, the fossils of the Inferior Oolite of Oxfordshire were brought very fully under my notice; these were found to contain three new species of *Trigonæ*, *T. Guisei*, *Walfordi*, and *Windoesi*, four varieties of *T. signata*, Ag., which I have here named at pages 5—10, *Zietenii*, *rugulosa*, *Stutterdi*, and *decurtata*. Three of the varieties, viz. *rugulosa*, *Stutterdi*, and *decurtata*, appear to be unknown at other British localities. These discoveries have resulted from the labours of several local investigators. The fine collection of Oxfordian fossils made by Mr. Stutterd, of Banbury, and now placed in the Oxford University Museum, has stimulated, as might be expected, the exertions of other observers; of these may be mentioned Mr. E. A. Walford, F.G.S., of Banbury, and Mr. J. Windoes, of Chipping Norton, who, for several years past, have been ardent searchers of Oxfordshire Inferior-Oolite fossils. Owing to their kind consideration I have had the advantage of comparing their cabinets with those of my old friend Mr. Witchell, of Stroud, who has so long worked in the same formations in the Cotteswolds, more especially in the higher beds in the vicinity of Stroud. The results are novel and interesting, and are embodied in the descriptions of the figures in Plates I—IV of this Supplement. In addition I am enabled to illustrate a previously undescribed, but well-marked Inferior-Oolite variety of a recognised Great-Oolite species, as well as a variety of a foreign Lower-Oolite species hitherto unknown in Britain (if not a new species itself). Also further illustrations of three Inferior-Oolite species, and one from the Lias.

TRIGONIA SIGNATA, Ag., var. ZIETENII. Trigon. Supplement, Plate I, figs. 3, 4, 5, 16, 17, and Plate IV, fig. 7.

Trigonía signata is illustrated in the previous portion of this Monograph (page 29, Plate II, figs. 1, 2, 3) by three specimens, two of which are from the Cotteswold Hills, the other from the north-eastern coast of Yorkshire; they all exemplify a single variety, for which I propose the name *Zietenii*. In Yorkshire this *Trigonía* is the sole variety

¹ The manuscript of the Appendix did not come into the possession of the Palæontographical Society until some time after the lamented author's death. The explanations of the plates, and the localities have been revised by Mr. E. A. Walford, F.G.S.

known; it is rare, and is unlike the usual forms attributed to *T. signata*. In Yorkshire *T. signata*, var. *Zietenii*, is remarkable for a general regularity and uniformity of aspect, both as regards the figure of the shell and the surface ornaments; the costæ and the tubercles are slightly developed, so that usually the tubercles are distinct only near the middle of the valve, and the costæ become small or string-like, and disappear or are attenuated as they approach the pallial border. This variety occurs rarely, near Scarborough, at Cloughton, in the zone with *Ammonites Blagdeni*, *A. Braikeiridgii*, and *A. Humphriesianus*.

In the South of England, in the Cotteswolds, *T. signata*, var. *Zietenii*, is known only in a higher position, or zone of *Ammonites Parkinsoni*, where it is also a rare species, but has a greater diversity of aspect in the figure of the shell, in its costæ, in its tubercles, and in the ornamentation of its area; the costæ are sometimes malformed or broken and irregular; the tubercles vary much in size and prominence; the carinæ may be either prominent, or faintly defined; and the transverse plications upon the area are either fine and delicate, or coarse and irregularly disposed. In the Cotteswolds the tubercles upon the costæ are comparatively large, and continue rounded even to the pallial border; the area has its ornamentation almost evanescent both in its carinæ and in its transverse plications, becoming almost steep and narrow, and the shell acquires greater convexity. The Oxfordshire variety *Zietenii* is generally and constantly smaller than that of the Cotteswolds and somewhat more lengthened posteally; the costæ are equally numerous, but have the tubercles smaller and numerous, which imparts a neater aspect to the shell; the individual peculiarities are also less conspicuous and rarely exceed those exhibited in the forms on Suppl., Pl. I, figs. 4 and 5, which have been selected to exhibit malformations of the rows of costæ upon the middle of the valves; but the differences of ornamentation upon the area are comparatively trifling.

The bed of white limestone (Upper Trigonia-grit) is the only stratum which has produced *T. signata* in the Cotteswolds. My experience of twenty-two years' residence in that district, together with frequent subsequent comparisons of its fossils, induce me to regard the Upper Trigonia-grit as affording specimens greatly inferior to those of the sandy limestones of Oxfordshire. The condition of preservation of the more minute and delicate features is usually less satisfactory. These remarks will more especially apply to the present variety, a typical shell of the Inferior Oolite, everywhere rare, but especially so in the Cotteswolds, where not more than one or two really fine specimens can be expected to fall to the lot of any collector, however extended in time may be his search for them. Even in Oxfordshire, where the species has occurred in greater numbers in the sands and sandy limestones of Hook Norton and Rollright Heath, it has of late years become somewhat rare. Mr. Stutterd, of Banbury, was fortunate enough to collect numerous fine specimens which now adorn the University Museum, Oxford, a success which has not subsequently been rivalled by any other person, and the species is no longer common.

In Oxfordshire, at Hook Norton¹ and Rollright Heath, which have produced this species less rarely, these varietal features are more strongly developed, and specimens have greater differences of aspect. For a better knowledge of these, and for the comparison of instructive illustrative specimens, I am much indebted to Mr. E. A. Walford, of Banbury, who forwarded to me his collection from the Inferior Oolite of Oxfordshire, together with that of another industrious collector, Mr. J. Windoes, of Chipping Norton, in the same County. The notes which Mr. Walford has supplied to me describing the strata of Hook Norton and their fossil contents evince discriminative ability and minute observation; they entitle him to my sincere thanks.

The description of *Trigonia signata*, Ag., var. *Zietenii*, given at page 29, is sufficient to render further remarks unnecessary; they may, however, be supplemented by the note upon *Trigonia ingens*, page 207, comparing the latter with the Inferior-Oolite shell. So considerable is the zoological affinity between these two forms that I have seen experienced observers take up the Neocomian form in the full belief that they were handling the shell of the Inferior Oolite. No doubt the distinctive differences indicated at page 207 are constant and reliable; but these are of such small importance in a zoological point of view, that it is difficult to escape the conviction that in the Inferior-Oolite shell *Trigonia signata*, var. *Zietenii*, we see the precursor or progenitor of the Neocomian *T. ingens*, however great may be the stratigraphical hiatus separating the two forms. I have therefore deemed it desirable to figure two of the Oxfordshire forms which exhibit variations in the surface ornaments, and also one additional Yorkshire example which has none of these individual peculiarities. Trigon. Suppl., Plate I, figs. 16, 17, represent two little immature forms which appear to be examples of the same variety in a very young state; one of these (fig. 17) is from the Upper Trigonia-grit of Rodborough Hill, supplied by my friend Mr. Witchell; the other (fig. 16), of nearly similar dimensions, was collected by Mr. Windoes in one of the lower beds of the formation in Oxfordshire; these two specimens have a distinct plain marginal carina and tuberculated inner carina even as far as the apex, the costæ then become slightly tuberculated at the third row, and the general ornamentation of the valve is thence established.

The Oxfordshire collections forwarded to me by Mr. Stutterd, by Mr. Walford, and Mr. Windoes, are also especially interesting, as they exhibit three other well-marked

¹ The following general section of the strata at Hook Norton has been supplied to me by Mr. E. A. Walford:

	Feet.	Inches.
Upper Lias <i>Leda ovum</i> beds (at bottom)	—	—
A. Sand and blue hearted limestone	2	3
B. Flaggy limestone, very sandy	1	6
C. Limestone courses, divided by sand	4	8
D. Sands, clays, and thin courses of limestone, with plant remains	17	0
E. Sand with oysters, pectens, bored limestone, and sandy whitish limestone (Rollright Grits)	6	0

varieties of *Trigonia signata*, which are herewith figured, and named as varieties, and described. These, it will be observed, occur only at a lower position in the Inferior Oolite, apparently in the zone of *Ammonites Murchisoni*; they seem not to be known beyond the limits of Oxfordshire, unless possibly the variety *rugulosa* may be identical with the figure of *T. clavellata*, Quenstedt, 'Jura,' tab. 60, fig. 13, from the Brown Jura of Swabia.

At page 221 are remarks upon the abundance and variety of the CLAVELLATE in the Middle and Upper Jurassic Rocks, and of their sudden disappearance thereafter. We might naturally expect to find the progenitors of these forms, so numerous and varied, in some of the older beds containing Trigoniæ; it is my present belief and impression that in the Inferior Oolite of Oxfordshire we have the precursors of at least two of the more abundant of the later forms, and that the variety under notice should be placed zoologically as an analogue of *T. ingens* of the Neocomian Rocks.

TRIGONIA SIGNATA, *Ag.*, var. RUGULOSA, *Lycell.* Trigon. Supplement, Plate II, figs. 1, 2, 3; Plate IV, figs. 2, 4.

Dimensions equal to the more common variety *T. signata*, var. *Zietenii*, but the test is thicker and more ponderous; the convexity is more considerable, the area narrow, steep, and slightly expanded, the hinge-border is comparatively short and depressed, the siphonal border oblique, forming only a small angle with the hinge-border; the lower termination of the siphonal border is produced and pointed; the area altogether is extremely rugose, especially its bounding carinæ; its transverse costellæ, where they are distinct, form a double curvature when well defined, and are depressed in the middle by the median furrow; the lower third of the area has the plications large, oblique, rugose, and irregular. The rows of costæ (about 15) are large with much upward curvature posteriorly, the tubercles in the rows are for the most part closely placed and are larger than in var. *Zietenii*; they become partially cord-like, but are large and very unequal even to the pallial border; the first-formed two or three rows of costæ are quite plain, as in the other varieties. The rugose aspect of the whole shell is very striking and remarkable.

An unusually fine specimen with the valves open, now in the Geological Survey Museum, London, exhibits the peculiarities of this variety in a very conspicuous manner; it was worked out by myself about thirty years ago, and was known to have been obtained in the vicinity of Chipping Norton. It is alluded to in the Monograph, page 30, and would have been figured had not its geological position at that time remained doubtful; it is, indeed, only very recently that the exact position of this variety has become known, the three specimens herewith figured, Plate II, figs. 1, 2, 3, collected by Mr. Walford and Mr. Windoes, and the two by Mr. Stutterd, Plate IV, figs. 2, 4, amply illustrate

this remarkable variety. It is rare. The matrix of these fossils is tough and hard, and required a considerable expenditure of time, labour, and steel implements to bring these specimens to their present condition. The two larger and more perfect specimens (Pl. II, figs 1, 3) were obtained at the cross-roads near Over Norton, the others (Pl. IV, figs. 2, 4) in the lower beds of the Inferior Oolite at Rollright.

Possibly the remarkable shell figured by Quenstedt, 'Der Jura,' a Swabian species, tab. 60, fig. 13, under the name *clavellata*, should really be arranged with this variety of *T. signata*, of which it has the usual rugose aspect, more especially in the characters of the costæ, fewer in number, broken and irregular, with their cord-like tubercles extending even to the pallial border; the stratigraphical position appears also to agree with that of this variety. The hard, unyielding matrix is altogether unlike the more sandy stratum in the upper beds of the formation which have yielded the *Zietenii* variety; it may be compared rather with the Clypeus-grit of the Cotteswolds.

TRIGONIA SIGNATA, *Ay.*, var. STUTTERDI, *Lycett.* Trigon. Supplement, Plate II, figs. 9, 10, 11; Plate IV, figs. 1, 5, 6.

The shell, less depressed than in the former two varieties, is more sub-ovate and less lengthened; the umbones are prominent, and are more recurved and less forward; the anterior side is more produced; the hinge-border is shorter, and more distinctly concave; the area is wide and flattened, much expanded posteaally; on each side it is bounded by a prominent row of large, rounded, regular carinal tubercles; the median carina is represented by an obscure row of small tubercles; the transverse plications are inconspicuous; near the apex they become linear, and are very closely arranged. The sides of the valves have more convexity than in the former varieties; the rows of costæ are much less numerous, and more widely separated; they are very regular in their arrangement, and are all curved obliquely; the few latter-formed costæ are curved upwards nearly perpendicularly, as is usual in the shells of *T. signata*; the tubercles are larger than in the other varieties, and less numerous, more especially in the latter-formed rows; they are moderately rounded, excepting near to the pallial border, where they become cord-like, but are continued even to the border. The lines of growth are remarkably large and conspicuous over the whole of the valves; the first-formed two or three rows of costæ are plain, as in the other varieties. The number of tubercles in the rows are comparatively few; the largest are about the middle of each row; they become attenuated as they curve upwards in their approach to the marginal carina.

The present variety presents an approach to the well-known *T. clavellata*; a comparison of specimens show that the Inferior-Oolite Shell has the umbones more recurved, the hinge-border shorter, and the rows of costæ with a greater curvature. The pecu-

liarity of their postæal attenuation and upward curvature, forming varices towards the carina, would of itself be always sufficient to separate the two forms; nevertheless, the approximation is such that I think we may fairly regard this variety as the precursor of the well-known species of the Middle Oolites.

The remarkably fine example of this variety contributed by Mr. Stutterd, of Banbury, and two others from my cabinet, constitute the three specimens on Plate IV. A comparison of these, and of a fourth specimen sent by Mr. Stutterd, but not figured, as well as a fifth in my cabinet, and of the three specimens from the collections of Mr. Walford and Mr. Windoes figured on Plate II, figs. 1, 2, 3,—a comparison of these with the figure of *Trigonia trigona* (Waagen, 'Beiträge, über der Zone des Am. Sowerbyi,' plate xxix, fig. 3, *a*, *b*) induces me to regard the species from Southern Germany as constituting another variety of *Trigonia signata* allied to the present Oxfordshire variety, but distinct from all known British forms.

The terminal postæal varix in each row of costæ in our variety has a considerable resemblance to Dr. Waagen's fine *Trigonia*, of which it constitutes a prominent feature in the ornamentation; the figure of the shell, however, and of surface ornaments constitutes a distinction.

Position and localities.—The specimens contributed by Mr. Stutterd (Pl. IV, figs. 1, 5, 6) are from the Inferior Oolite of Rollright Heath; those on Plate II, figs. 1, 2, 3, are from the Inferior Oolite of the Cross roads, near Over Norton. It is rare and appears to be one of the most variable of the Oxfordshire forms in its general aspect and ornaments.

TRIGONIA SIGNATA, var. DECURTATA, *Lycett*. Trigon. Supplement, Plate I, figs. 1, 2; Plate IV, fig. 3.

Shell with the general figure of *T. signata*, but less depressed and somewhat shorter postæally; umbones large and moderately recurved; hinge-border somewhat concave, sloping obliquely; area of moderate breadth, somewhat raised and flattened; transversely, closely, and minutely striated throughout its entire length; median carina very minutely papillated; the two bounding carina nearly similar in character, and not very distinctly separable from the transverse striations. The other portion of the shell has curved rows of costæ, which are less numerous than in the first two varieties, and are more irregular in their general direction and aspect.

Our description is founded upon two specimens which vary moderately from each other in the characters of their pallial costæ. In both specimens the first few rows are sub-concentric or transverse, and minutely tuberculated, and become attenuated as they approach the anterior border. The succeeding rows are for the most part obliquely curved, but with less regularity; the tubercles are small, unequal, and sometimes

imperfectly developed; the few last costæ enlarge much postœally, their tubercles become more prominent; they approach the marginal carina at a considerable angle, the last three or four rows terminating in varices, which are attenuated and not distinctly tuberculated; the larger specimen has about fifteen, the smaller one thirteen costæ; the lines of growth are moderately distinct upon both specimens.

Length of the larger specimen 29 lines; height 14 lines. The smaller specimen, which is more imperfect, has the length about 17 lines.

The smallness, inequality, and irregularity of the tubercles, together with the tendency to effacement about the middle of the valve, together with the enlargement of the costæ postœally, are the most prominent distinguishing features of this small variety, which appears to be rare, as Mr. Walford can only refer to three specimens.

Position and locality.—Hook Norton in the lower beds, limestone with courses of sand, B and C of Mr. Walford's section (page 7).

TRIGONIA PULCHELLA, *Ag.* Trigon. Monog., Plate XXXVIII, figs. 10—12; and Trigon. Supplement, Plate III, figs. 7—12.

The figures of this pretty little Liassic species (given Plate XXXVIII, figs. 10—12, page 185) are of small dimensions, and do not illustrate the shell in its more advanced condition of growth; I therefore gladly take the present opportunity to figure other and more suitable specimens; The two larger shells (Pl. III, figs. 10—12) exemplify the ultimate stage of growth and exhibit a considerable change in the ornamentation of the large area; it will be observed that the acute transverse costæ, which in immature forms are widely separated, become ultimately closely arranged and even crowded near to the siphonal border.

Specimens in my collection, showing the interiors of the valves, have three alternating prominences and pits near to the postœal extremity of the pallial border. It would appear that the specimens at the disposal of Agassiz did not exhibit the interiors of the valves, or no doubt he would gladly have figured and described these internal features; his specimens are only of median size; the larger single specimen figured by Quenstedt ('Der Jura,' plate xliv, fig. 1) was probably imperfect postœally, and so obtained the short truncated aspect which the species does not possess.

Position and Locality.—*Trigonia pulchella* has been collected at Lincoln, in the Upper Lias in the Zone of *Ammonites communis*, both by Mr. Keeping, of Cambridge, myself, and Mr. W. D. Carr; to the last I am indebted for the unusually fine specimens herewith depicted. I am not aware that the species has been obtained at any other British locality.

TRIGONIA MORETONI, var. OXONIENSIS, *Lycett*. Trigon. Supplement, Plate I, figs. 13—15.

The typical or Great-Oolite variety of *Trigonia Moretoni* has been sufficiently depicted in the Monograph on Plate II, figs. 4, 5, 7, 8, also Plate IV, fig. 6, and has been described pp. 47, 59, 63, 70, 78; it is there shown to be a very variable species even in the Great Oolite, and I have now to describe a distinct variety which has been obtained rather sparingly by Mr. Walford and by Mr. Windoes in the lower beds of the Inferior Oolite at Hook Norton, Oxon.

All the specimens of *Trigonia Moretoni*, var. *Oxoniensis*, obtained are smaller than the typical form, and differ from it in the following features: the entire ornamentation of shell is larger and bolder or more strongly defined; the concentric costæ are fringed with papillæ, from the pallial margin to the apex; they are remarkably prominent, regular, and concentric; their papillæ are also very large, rounded, and elevated; but even these costæ are not without variability, for, notwithstanding this regularity, some specimens have the costæ rather transverse than concentric, with little curvature. The area has its costellæ unusually elevated, and scarcely any two specimens have them alike; but the inner carina is always distinct, prominent, and spinose. The largest shells of this little variety are not more than six lines across the valve.

It may be a matter of doubt whether I am justified in placing this little species as a variety of *T. Moretoni*, it differs so considerably from the Great-Oolite forms; the limits of variability assumed by this species are in truth so considerable that I feel much diffidence in deciding upon differences with strata having a wide stratigraphical separation. Apparently the present specimens are not of adult growth, and the decision of this question may be relegated to a period when the number of known specimens shall have become more considerable, and the results of comparison more certain.

TRIGONIA FORMOSA, *Lycett*. Trigon. Monogr., Plate V, figs. 4, 5, 6; Plate XI, fig. 2; Plate XXXVII, fig. 10; var. *lata*, Plate XXIX, figs. 11, 12; var. *lata*, Pl. XXXV, fig. 7; Trigon. Supplement, Plate I, figs. 11, 12.

I am induced to figure the two forms on Plate II, figs. 11 and 12, on account of the great concavity of the area and hinge-border: of these the Rev. Mr. Wiltshire has also sent me other fine specimens. The contrast afforded by these forms when compared with the *Trigonia striata* of Dorsetshire and Somersetshire is very striking, and fully justifies the separation I have made between that species and the *T. formosa* of the Cotteswolds. I do not, however, altogether perceive the necessity of erecting the present into a distinct

variety of *T. formosa*, as I think that some forms tending to connect them may be found in the specimens obtained by Mr. Witchell, which would reduce the distinction to individual peculiarities; they are, however, fully worthy of being figured and compared. I would also more especially direct the attention of foreign palæontologists to the figures of *T. formosa*, when no reliable British specimens can be obtained, as I have repeatedly been requested to show them the two species placed side by side for comparison. I am, however, quite satisfied with the figures of *T. striata* (Plate V, figs. 6', 7, and 8), and would request them to compare the siphonal and hinge-borders of these three figures with the corresponding parts of *T. formosa*. I fear that fig. 6 (*T. formosa*) of Plate V has sometimes been mistaken for *T. striata* in mistake for 6' of the same plate, which in its explanation is misprinted 3.

The figured specimens are from the Inferior Oolite near Stroud.

TRIGONIA GEMMATA, *Lycett*. Trigon. Monogr., Plate I, fig. 7; Trigon. Supplement, Plate II, fig. 6; var. *bifera*, Plate II, fig. 7.

The unusually well-preserved specimen of this rare little species herewith figured has been forwarded to me by Mr. Walford from the Hook Norton locality, where apparently it occupies a lower position in the Inferior Oolite (beds B and C) than in the Cotteswolds. The surface ornaments are minutely and delicately preserved.

Figure 7 on the same plate represents a specimen of the variety *bifera*, obtained by Mr. Witchell from the Inferior Oolite of Rodborough Hill, and described in a footnote, page 239. Mr. Witchell has also kindly forwarded to me other specimens of *T. gemmata* from the Clypeus-grit of the Stroud district; these, unfortunately, all imperfect, are chiefly remarkable for the minuteness of their ornamentation.

I have also discovered a specimen from the Dogger at Blue Wyke, North Yorkshire. In common with the fossils generally that crowd those beds in that locality, it is wanting in the delicacy of preservation which is often found in the fossils of Oxfordshire and of the Cotteswolds, and notably so in the Oxfordshire specimen here figured. I mention its occurrence on account of the geological position, which appears nearly to agree with that of the Oxfordshire form, and near the base of the Inferior Oolite; the Cotteswold examples, on the other hand, come from the highest beds of the formation.

TRIGONIA PRODUCTA, *Lycett*. Trigon. Monogr., Plate XIII, figs. 1, 2, 3, 4; and Plate XXXVII, figs. 1, 2; Trigon. Supplement, Plate II, figs. 4, 5.

The smallest of our figures (Suppl., Plate II, fig. 5), from the Clypeus-grit of the

Inferior Oolite of Rodborough Hill, is apparently a dwarfed specimen. Although only nine lines in length, it has formed seven transverse or oblique tuberculated costæ, and has commenced to develop the postæal ones. The specimen (fig. 4) from the Upper Trigonia-grit of the same locality is about half the adult size and has just commenced to develop the postæal costæ.

The present examples, together with those previously figured, will, I think, amply illustrate this large species, which is apparently more rare in the Cotteswolds than in Oxfordshire.

TRIGONIA ARDUENNA, var. *Rigaux* and *Sauvage* (not *Buvignier*). Trigon. Supplement, Plate I, fig. 6.

Descr. de quelques espèces nouvelles de l'Étage Bathonien du Bas-Boulonnais, par MM. E. Rigaux et W. Sauvage, Mém. de la Société Académique de Boulogne, pl. iv, fig. 4, Dec., 1867.

I have no doubt that the fragment herewith figured from the Inferior Oolite of Hook Norton (beds B and C) is identical with the shell figured by Messrs. Rigaux and Sauvage from the Clypeus-grit of the Bas-Boulonnais, which they regard as a variety of the small species figured by Buvignier from the Oxfordian beds of the Ardennes. I decidedly object, however, to the identification of this with the Oxfordian species, to which I think it is only remotely allied; the latter is evidently a much smaller and more convex species with very numerous small antæal costæ, and therefore altogether distinct from the much larger and more flattened shell of the Inferior Oolite. It may be hoped that other and more satisfactory specimens will be obtained in Oxfordshire; but at present I can only figure the present fragment, which, although so imperfect, is highly characteristic, and I believe should be separated as a species from Buvignier's little shell.

TRIGONIA GUISEI, *Lycett*, sp. nov. Trigon. Supplement, Plate III, figs. 1, 1 a, 2, 3, 3 a, 4, 5, 6.

Shell ovately oblong, lengthened, having considerable convexity anteally and mesially, depressed postæally; umbones large, recurved, antero-mesial, or placed within the anterior third of the valve; area much lengthened, narrow, flattened, bounded by two inconspicuous carinæ almost throughout its length; the marginal carina is entirely plain, the inner carina is minutely papillated; there is a small median furrow which on its outer side forms a narrow ridge. The escutcheon is much lengthened and excavated, forming

a lengthened and concave hinge-border; the siphonal border is comparatively short, placed almost at right angles with the hinge-border; the pallial border is lengthened and curved elliptically. The sides of the valves have very numerous small tuberculated costæ, at the umbonal extremity the first-formed three or four rows are subconcentric and plain, the succeeding rows become angulated with small irregular tubercles; the rows continue small near to the pallial border and are somewhat irregular in their direction; about the middle of the valve they are united to a much less numerous series of postæal costæ, which are also tuberculated. The posterior costæ are at first curved, but the succeeding ones become more perpendicular and are directed downwards from the marginal carina even to its postæal extremity. In adult forms the pallial costæ near to the border take nearly the direction of the lines of growth, and are small and crowded with minute fringing papillæ.

The general aspect of the ornamentation presents an approach to *Trigonia producta*, and is intermediate between that of *T. producta* and *T. angulata*; the curve of the uncompressed valve is, however, sufficiently distinct from either of those examples of the *Undulatæ* group and renders its separation as a species necessary. The distinctness of the species may, in fact, be recognised even in very young examples whenever they are well preserved, as well as in the apical portions of the more adult forms. I have therefore figured three of the smaller specimens collected by Mr. Walford and Mr. Windoes in Oxfordshire: the collection of Mr. Windoes contains two others of similar aspect, and also a much larger specimen apparently almost of adult growth. The surface ornaments are for the most part well preserved, but the postæal portion is too much truncated and imperfect to be submitted to the artist.

The largest of the Oxfordshire shells on our plate, figs. 3, 3 *a*, was obtained by Mr. Walford at Hook Norton in the lower beds of the formation. The surface ornaments are well preserved, but the specimen unfortunately is very imperfect postæally and is much flattened from vertical pressure. The acquisition of these specimens, together with the fine adult forms collected by Mr. Witchell in the Cotteswolds, has enabled me to discover and correct one of my own errors. The specimen attributed to *T. angulata* (Trigon. Monogr., Plate XIV, fig. 5) collected about twenty-five years ago in the Upper Trigonia-grit of Rodborough Hill, in its postæal portion is so defective and incomplete that I always entertained doubts of the correctness of that identification: the more recently obtained specimens in the Cotteswolds and in Oxfordshire enable me to separate this hitherto doubtful form from *T. angulata*, and to unite it to the present species, which is now well and sufficiently illustrated. The splendid and almost unique specimen from Mr. Witchell's collection (Trigon. Suppl., Plate III, figs. 1, 1 *a*) was obtained by him near the hamlet of Hyde in the parish of Minchinhampton in a whitish-grey limestone (Upper Trigonia-grit) and cleared by him after the employment of much skill and labour. The specimen obtained by Mr. Witchell (Plate III, fig. 2) from the Clypeus-grit of Rodborough Hill would also be considered a very fine specimen in the absence of the Hyde specimen, and proves

that the species occurs throughout the upper beds of the Inferior Oolite in the Cotteswolds.

Dimensions of the Hyde specimen. Length $3\frac{1}{2}$ inches; height $2\frac{1}{4}$ inches.

Dedicated respectfully to Sir W. V. Guise, Bart., F.L.S., F.G.S., of Elmore Court, now and for many years President of the Cotteswold Naturalists' Field Club, a position which he occupies with so much ability and benefit to its members.

TRIGONIA WALFORDI, *Lycett*. Sp. nov. Trig. Supplement, Plate II, fig. 8.

Shell somewhat thick in the adult condition, ovately trigonal, moderately convex, umbones prominent, recurved; antero-mesial hinge-border comparatively short, obliquely sloping; siphonal border nearly as long as the hinge-border, its postea extremity is somewhat produced and pointed; the pallial border is much lengthened, and curved elliptically throughout its length without angularity. The surface of the area is somewhat more raised than the other portion of the valve; it is comparatively narrow; its bounding carinæ are only slightly defined; it has the usual median furrow distinct throughout its length; its surface is inconspicuously striated transversely, excepting near to the apical extremity, where the bounding carinæ are distinct.

The surface has a few acute transverse costellæ, which are equal in size to the first-formed apical costæ, from which they are only separated by the minute carinal tubercles. The escutcheon is rather wide and flattened, having rugose, oblique plications of growth. The other and much the larger portion of the valve has the costæ numerous (about eighteen or nineteen), the few first-formed are narrow, closely arranged, and transverse or transversely concentric, those which succeed change in figure and acquire tubercles at their middle and postea portions, so that at about the ninth costa the postea portion of the row has short tubercular varices, which commence an upward flexure to the marginal carina; with each succeeding costa these tuberculated flexed varices rapidly enlarge, but with some irregularity, caused by the increasing prominence of the varices, so that the ornamentation then acquires an aspect confusedly and prominently nodulous over the middle and postea portions of the valve; the costæ at the antea portions continue narrow, rather acute, and attenuated even to their terminations at the pallial border, their number exceeding by two the postea large flexed varices.

It will thus be seen that the costæ undergo changes in their figure and ornamentation throughout the entire growth of the shell, and that the general aspect of the surface would scarcely be known or appreciated if illustrated by examples of less mature growth, or less well preserved. Apparently the figured specimen is of adult growth, judging from the plicated aspect of the siphonal border, and from the costæ having almost ceased to form

the short postæal varices. Compared with the general aspect of the *Undulatæ*, the narrow lengthened figure and prominence of the nodose varices upon the middle and postæal portions of the valve constitute features which will not readily be mistaken for other of the Lower-Jurassic species, whether British or foreign.

Dimensions.—Length measured upon the marginal carina 28 lines; measurement at right angles to the carina 20 lines; convexity of a single valve about $6\frac{1}{2}$ lines.

Position and Locality.—The specimen contributed by Mr. E. A. Walford was obtained from the Inferior Oolite of Oxfordshire, in the stratum above the *Clypeus-grit*, near Stow-on-the-Wold.

TRIGONIA WINDOESI, *Lycett*. Sp. nov. Trigon. Supplement, Plate I, figs. 7, 8, 9, 10

Shell in the very young condition much depressed, but acquiring a moderate convexity with advance of growth, ovately trigonal; umbones pointed, but little produced, antero-mesial, and slightly recurved; area large, flattened, divided by a median furrow and bounded by carinæ; of these the marginal carina is moderately elevated and plain, the inner carina is small, but is rendered serrated and rugose by the terminations of the transverse costellæ, which are plain, prominent, and become conspicuous as they approach the inner border of the area. The sides of the valves have a numerous series of plain, curved costæ (about thirteen), the first-formed five or six are simply curved and united posteriorly with the plain marginal carina; those which succeed enlarge and curve upwards at their postæal extremities, so that in the largest specimens the postæal portions of the costæ become oblique or nearly perpendicular varices, which are partially disunited from their antæal portions. There is much variability in the transverse costellæ upon the area, but usually they nearly disappear upon the area near to the siphonal border, which is oblique, but shorter than the hinge-border. The escutcheon is narrow, depressed, flattened, and inconspicuous. The entire plain marginal carina clearly separates the two portions of the valves, and is of itself sufficient to distinguish this little species from the *Trigonia cuspidata* of Sowerby, for which it has been mistaken; the latter is a minute, dwarfed, and very young form of a Great-Oolite species, probably *T. Moretoni*.

This small species has occurred rather sparingly in the lower beds of the Inferior Oolite at Hook Norton; the largest specimen has a length of 9 lines, the height being $7\frac{1}{2}$ lines, and the convexity of a single valve $2\frac{1}{2}$ lines.

This species belongs to the *Angulatæ* group, but with the general figure much shorter or subovate, and more depressed; the large area with its prominent costellæ is also very distinct; the smooth costæ are also quite destitute of tubercles. In the very young condition it might be taken for one of the *Costatæ*.

I take the name from Mr. J. Windoes, of Chipping Norton, who discovered and forwarded to me the present species, and is an ardent and energetic collector of the fossils of his locality; he has entrusted his collection to my care, and has supplied me with the following section of railway-cutting near Duckpool Farm, Hook Norton, giving the position of the present species, together with other testacea of the Inferior Oolite:

SECTION NEAR DUCKPOOL FARM, HOOK NORTON.

1. Flaggy limestone, with *Lima cardiiformis*, *Trigonia denticulata*, and *T. costata*.
2. Sand and rubbly limestone, with *Trigonia producta* and *T. costata*.
3. Pockets of sand and shells, yielding *Trigonia Windoesi*, Lyc., *T. Moretoni*, var. *Oxoniensis*, and *T. signata*, young specimen, *Pecten*, *Limæa*, *Limopsis*, *Cerithium*, *Chemnitzia*, all small shells. Soft sandy marl, four feet above Lias.
4. Upper-Lias Clay with *Leda ovum*, *Ammonites fibulatus*, &c. Floor of the cutting.
Thickness of Oolite 14 feet.

INDEX TO THE SUPPLEMENT OF THE BRITISH FOSSIL
TRIGONIÆ.

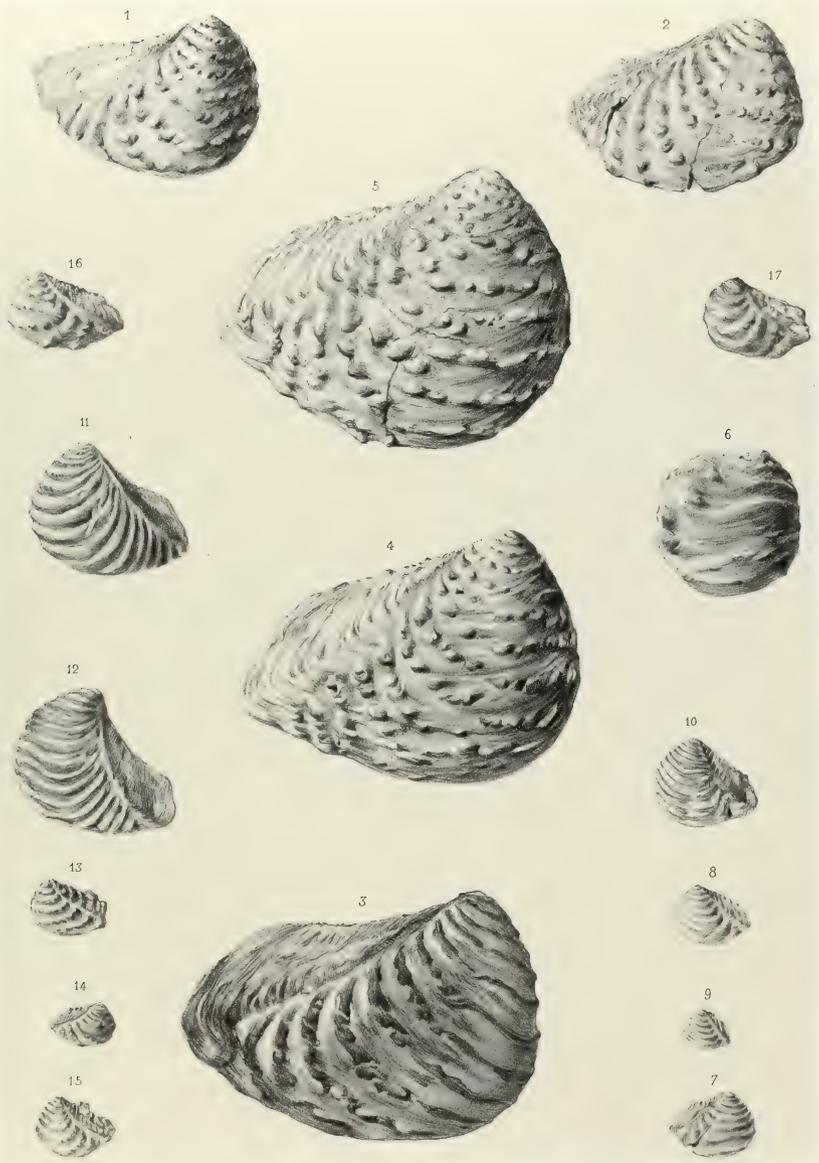
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TRIGONIA Arduenna, var., <i>Rigaux and Sauvage</i>	14
— <i>formosa, Lycett</i>	12
— <i>gemmata, Lycett</i>	13
— <i>Guisi, Lycett</i>	14
— <i>infra-costata, Lycett (foreign)</i>	3
— <i>Moretoni, var. Oxoniensis, Lycett</i>	12
— <i>Oviedensis, Lycett (foreign)</i>	2
— <i>producta, Lycett</i>	13
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— <i>signata, var. decurtata, Lycett</i>	10
— — „ <i>regulosa, Lycett</i>	8
— — „ <i>Stutterdi, Lycett</i>	9
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— <i>Windoosi, Lycett</i>	17

SUPPLEMENT PLATE I.

FIG.

- | | | |
|--------------|--|--|
| 1, 2. | <i>Trigonia signata</i> , var. <i>decurtata</i> , Lyc. | Hook Norton. (Page 10.) Coll. of Mr. E. A. Walford, F.G.S. |
| 3. | „ „ „ <i>Zietenii</i> , Lyc. | Cloughton, Yorkshire. (Page 5.) My cabinet. |
| 4, 5. | „ „ „ „ „ | Near Rollright, Oxfordshire. Coll. Walford. |
| 6. | „ <i>Arduenna</i> , var. Rig. and Sauv. | Hook Norton, Oxfordshire. (Page 14.) Coll. Walford. |
| 7, 8, 9, 10. | „ <i>Windoesi</i> , Lyc. | Hook Norton. (Page 17.) 7, Coll. Walford; 8, 9, 10, Coll. of Mr. J. Windoes. |
| 11, 12. | „ <i>formosa</i> , Lyc. | Near Stroud. (Page 12.) Coll. of Mr. Witchell. |
| 13, 14, 15. | „ <i>Moretoni</i> , Mor. and Lyc, var. <i>Oxoniensis</i> . | Hook Norton. (Page 12.) 13, Coll. Walford; 14, 15, Coll. Windoes. |
| 16. | „ <i>signata</i> , var. <i>Zietenii</i> , Lyc. | Hook Norton. (Page 5.) Coll. Windoes. |
| 17. | „ „ „ „ | Rodborough Hill, Oxfordshire. Coll. Witchell. |

All the specimens figured are from the Inferior Oolite.

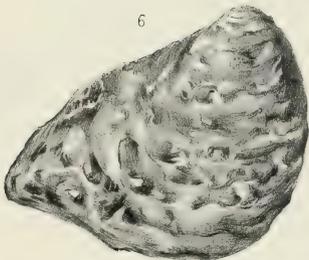
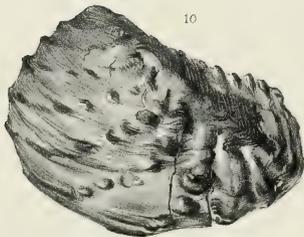
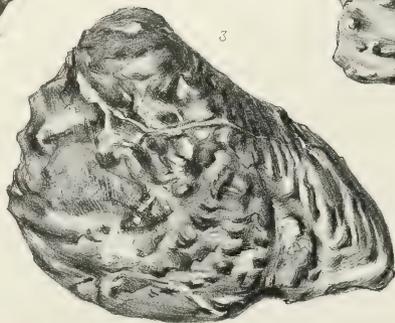


SUPPLEMENT PLATE II.

FIG.

- | | | |
|-----|--|---|
| 1. | <i>Trigonia signata</i> , var. <i>rugulosa</i> , Lycett. | Cross Roads, near Over Norton.
(Page 8.) Coll. Windoes. |
| 2. | " " " | Cross Roads, near Over Norton.
Coll. Walford. |
| 3. | " " " | Cross Roads, near Over Norton.
Coll. Walford. |
| 4. | " <i>producta</i> , Lycett. | Rodborough Hill. (Page 13.) Coll.
Witchell. |
| 5. | " " | Young form, Rodborough Hill. Coll.
Witchell. |
| 6. | " <i>gemmata</i> , Lycett. | Hook Norton. Coll. Walford. (Page 13.) |
| 7. | " " var. <i>bifera</i> , Lycett. | Rodborough. (Page 13.)
Coll. Witchell. |
| 8. | " <i>Walfordi</i> , Lycett. (Page 16.) | Above the Clypeus-grit near
Stow-on-the-Wold. Coll. Walford. |
| 9. | " <i>signata</i> var <i>Stutterdi</i> , Lycett. | Hook Norton, Oxfordshire.
(Page 9.) Coll. Walford. |
| 10. | " | Hook Norton, Oxfordshire.
Coll. Walford. |
| 11. | " | Prior Farm, near Chipping Norton.
Coll. Windoes. |

All the specimens figured are from the Inferior Oolite.



SUPPLEMENT PLATE III.

FIG.

1, 1a.	<i>Trigonia Guisei</i> , Lycett.	Inferior Oolite, near Minchinhampton. (Page 14.)	Coll. Witchell.
2	„ „	Inferior Oolite, Rodborough Hill.	Coll. Witchell.
3, 3 a.	„ „	Inferior Oolite, Hook Norton.	Coll. Walford.
4.	„ „	„ „	Coll. Windoes.
5.	„ „	„ „	Coll. Walford.
6.	„ „	„ „	„
7, 8, 9, 10, 11, 12.	„ <i>pulchella</i> , Ag.	Upper Lias, zone of <i>Ammonites communis</i> . Lincoln. (Page 11.)	My cabinet.



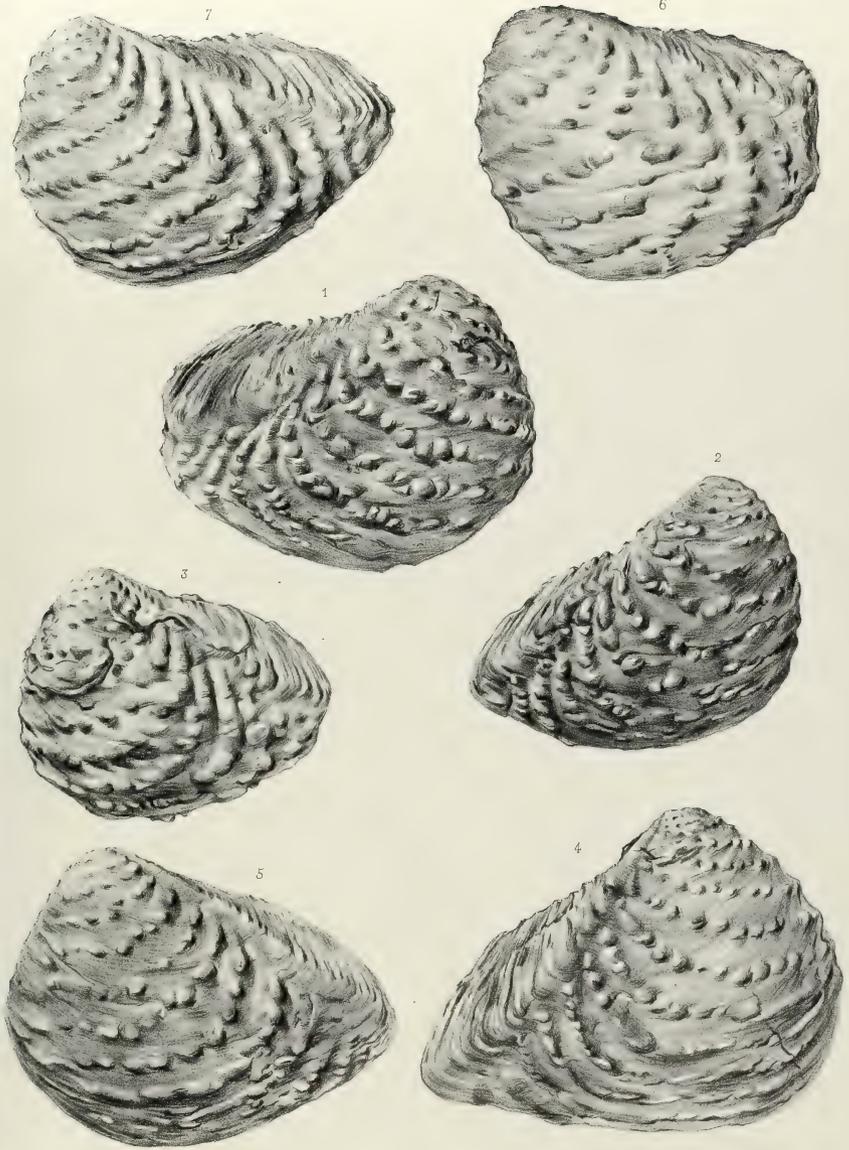
SUPPLEMENT PLATE IV.

Plate IV, is intended to illustrate the Oxfordshire varieties of *Trigonia signata*, Ag. The figures have been selected from specimens liberally placed at my disposal by Mr. Stutterd, of Banbury, taken from his cabinet, and obtained by him at Rollright, near Chipping Norton; these, together with the examples figured upon Plates I and II, will sufficiently illustrate the four Oxfordshire varieties of *T. signata*.

FIG.

- | | | |
|----------|---|---|
| 1. | <i>Trigonia signata</i> , Ag., var. <i>Stutterdi</i> , Lyc. | A double valved specimen in the collection of Mr. Stutterd. (Page 9.) |
| 5 and 6. | ,, ,, | Two other specimens of the same variety. My cabinet. |
| 2 and 4. | ,, var. <i>rugulosa</i> , Lyc. | (Page 8.) My cabinet. |
| 3. | ,, var. <i>decurtata</i> , Lyc. | (Page 10.) My cabinet. |
| 7. | ,, var. <i>Zietenii</i> , Lyc. | (Page 5.) My cabinet. |

All the specimens figured are from the Inferior Oolite.



THE

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MONOGRAPH

ON THE

LIAS AMMONITES

OF

THE BRITISH ISLANDS.

BY

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OF CHELTENHAM, CHARLTON KINGS, AND LECKHAMPTON.

PART SIXTH—DESCRIPTION OF SPECIES.

PAGES 401—440; PLATES LXX—LXXVII.

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this character, which, however, is fairly shown in portions of the fine specimen figured in Pl. LXX. The shell is extremely involute, and has a much smaller umbilicus than its associated species, *Amal. margaritatus*, with which in other respects *Amal. Engelhardti* stands in very close relationship. The siphonal area is very narrow forming a sharp keel, the margin of which is in general smoothly rounded and sometimes obscurely crenated; the spire is composed of very compressed whorls, which become thinly flattened away towards the siphonal area, and thickened near the umbilicus, around which they present an obliquely truncated wall; the aperture is high, oblongo-lanceolate, narrow, and compressed, its sides form an acute angle, rounded internally, where it embraces three fourths of the penultimate whorl. The suture-line is extremely complicated, forming a number of extremely minutely divided lobes, and in this respect differing from the suture-line of *Amal. margaritatus* (Pl. LIII). By taking an impression of one of these my artist has been enabled to give a very accurate delineation of the sutural outline, which he has placed *in situ* on the figure, and which is now drawn for the first time. Of this structure d'Orbigny said, "Je n'ai pu les apercevoir assez pour les dessiner et les décrire." The siphonal lobe is large and composed of several long lateral branches. The siphonal saddle is wide and terminates in small narrow folioles. The principal lobe is very large, it has a long, terminal, ramified stem in the centre, and three lateral ramified stems on each side, all of which are highly digitated. The lateral saddle is much smaller than the siphonal saddle, and terminates in six narrow folioles. The internal lateral lobe is much smaller than the principal lateral, and consists of a central stem terminating in a trifurcation, with two divided branches on each side of the central stem. The auxiliary lobes are small, with delicate pointed ramifications, and the auxiliary saddles terminate in minute rounded folioles; the sutural-lines are so closely approximated on the sides of the mould in consequence of the narrowness of the chambers that they present an inextricable labyrinth to the student, and require a most careful study in order to follow them out through all their windings.

I have not seen a young shell of this species, nor had d'Orbigny, but he felt assured that it presented the same characters throughout at all ages, and that it was not an adult variety of *Amal. margaritatus*. Young and Bird¹ described an Ammonite under the name *A. lenticularis*, which appears to be identical with *Amal. Engelhardti*. They say "the exterior of the whorl runs to a thin edge, plain, or very faintly crenated; the sides are smooth or marked with very faint undulating lines; the central part is an umbilicus, with upright sides, the inner whorls being scarcely visible and the aperture forms a triangle, of which the outer angle is extremely acute, owing to the thinness of the edge." Mr. Simpson² has described *A. reticularis*, which agrees so well with *Amal. Engelhardti* that, in the absence of figure, or specimen, his diagnosis may be considered identical. "Volutions five, inner ones more than three fourths concealed; outer whorl one half the diameter, most convex on the outer half. Transverse striæ numerous, fine, waving, crossing; numerous fine, longitudinal striæ; keel

¹ 'Geological Survey of the Yorkshire Coast,' 2nd ed., p. 269, 1828.

² 'Fossils of the Yorkshire Lias,' p. 78, 1855.

rounded and slightly crenated by striæ; aperture triangular or slightly ovate. Found in the ironstone bands of the Middle Lias along with *A. Hawskerensis*."

Affinities and Differences.—This species very much resembles *Amal. margaritatus*, of which it may be only a variety of that well-defined form. Those naturalists who insist upon the distinctness of the two species point to the longitudinal ribbing of the shell, the larger amount of the involution of the whorls, and smallness of the umbilicus in *Amal. Engelhardti*, the more complicated convolutions of the suture-line and the minute subdivisions of the lobes and saddles, and likewise the fact that the same characters are persistent throughout its life-history which approximate to, but are distinct from, some of the more lenticular varieties of *Amal. margaritatus*.

Locality and Stratigraphical Position.—This Ammonite has been collected from the upper portion of the Marlstone beds of the Middle Lias at Grettan Hill, near Winchcombe, and at Stinchcombe Hill by Dursley, localities which have yielded all the fine specimens I have obtained in Gloucestershire. It is found in the same bed at Yeovil, South Petherton, and Ilminster, Somersetshire, along with *Amal. spinatus*. In Yorkshire it is collected from the *Amal. spinatus-zone*, in the rich ironstone beds at Eston, Upleatham, Hawsker, &c., so that its true horizon is the uppermost strata of the Middle Lias.

AMALTHEUS SPINATUS, *Bruguière*. Pl. LV, figs. 1 and 2; Pl. LVI, figs. 1—5.

AMMONIS CORNU,	<i>Lachmund</i> . Oryctogr. Hildesheim, p. 49, 1669.
— —	<i>Lister</i> . Hist. Animal. Angliæ, p. 207, tab. vi, fig. 3, 1678.
— —	— Synops. Conchyl., Edit. alt., tab. 1041, fig. 21, 1770.
— —	<i>Baier</i> . Oryctographia norica, p. 64, tab. 3, figs. 4, 5, 1708.
— —	<i>Leibnitz</i> . Protogæa, p. 41, tab. 5, 1749.
— —	<i>Knorr and Walch</i> . Petrif., tom. ii, t. A II, fig. 1, 1755.
AMMONITES SPINATA,	<i>Bruguière</i> . Encycl. Méthod., t. i, p. 40, No. 14, 1792.
— —	<i>Bosc</i> . Buffon de Déterville, t. v, p. 176, 1801.
— —	<i>Roissy</i> . Hist. des Mollusques, t. v, p. 25, 1805.
NAUTILUS COSTATUS,	<i>Reinecke</i> . Naut. et Argon., p. 87, tab. ix, figs. 68, 69, 1818.
AMMONITES ANGULATUS,	<i>Schlotheim</i> . Die Petrefaktenkunde, p. 70, No. 16, 1820.
— COSTATUS,	— Ibid., p. 68, No. 12, 1820.
— SPINATUS,	<i>Haan</i> . Mon. Amm. et Goniatites, p. 102, No. 1, 1825.
— HAWSKERENSIS,	<i>Young and Bird</i> . Geol. Survey, p. 258, pl. xiv, fig. 6, 1828.
— —	<i>Phillips</i> . Geol. of Yorkshire, pl. xiii, fig. 8, 1829.
— COSTATUS,	<i>Zieten</i> . Versteiner. Würtemb., p. 5, pl. iv, fig. 7, 1830.
— —	<i>Roemer</i> . Norddeut. Oolithengebirg., p. 188, No. 16, 1836.
— —	<i>Bronn</i> . Leth. geognostica, Bd. i, p. 436, t. xxii, fig. 12, 1837

AMMONITES	HAWSKERENSIS,	Simpson.	Foss. York. Lias, p. 90, 1855.
—	SPINATUS,	d'Orbigny.	Pal. Française, Ter. Jurass., t. 52, p. 209, 1842.
—	COSTATUS,	Quenstedt.	Die Cephalopoden, pl. v, figs. 10 a, b, 1849.
—	SPINATUS,	Giebel.	Fauna der Vorwelt, Bd. iii, p. 537, 1852.
—	—	Chapuis et Dewalque.	Fossiles terr. secondaires, Mém. cour. l'Acad. Roy., tom. xxv, p. 49, pl. vi, fig. 4, 1854.
—	—	Morris.	Catal. British Fossils, p. 295, 1854.
—	—	Dumortier.	Dépôts Jurassiques, partie iii, p. 213, 1869.
—	—	Brauns.	Untere Jura, p. 240, 1871.
AMALTHEUS	—	Neumayr.	Zeitschr. Deutsch. geol. Gesellsch., Bd. xxvii, p. 886, 1875.
—	—	Tate and Blake.	Yorkshire Lias, p. 295, 1876.

Diagnosis.—Shell discoidal, compressed, slightly involute; umbilicus widely open; ribs prominent, sharp, bituberculated, separated by wide valleys, straight on the sides, and bent suddenly towards the aperture at an acute angle; siphonal area wide and concave; keel prominent, crenated, with small chevroned ribs, convex anteriorly; aperture quadrangular, outer border with two sinuses separated by the median carina, inner border slightly grooved by the turn of the spire.

Dimensions—large shell.—Pl. LV. Transverse diameter 180 millimètres; width of umbilicus 75 millimètres; height of aperture 60 millimètres, width 70 millimètres.

Smaller shell.—Pl. LVI, fig. 5. Diameter 100 millimètres; width of umbilicus 43 millimètres; height of aperture 34 millimètres, width 30 millimètres.

Smallest shell.—Pl. LVI, fig. 1. With test preserved showing the sharpness of the spines, ribs, and carina. Diameter 53 millimètres; width of umbilicus 22 millimètres; height of aperture 17 millimètres, width 18 millimètres.

The measurements of the French specimen, given by Professor A. d'Orbigny, were made on a shell, 135 millimètres in diameter, and the proportions in relation to the diameter were—width or height of the last whorl $\frac{31}{100}$, involution of the whorls $\frac{7}{100}$, thickness of the last whorl $\frac{31}{100}$, width of umbilicus $\frac{40}{100}$.

Description.—This is one of the most characteristic Ammonite-forms from the upper beds of the Middle Lias, always presenting its typical features and appearing as a leading fossil in the horizon to which it is limited. The shell is discoidal, compressed, with a wide siphonal area, having an elevated keel in the middle with concave depressions on each side; the keel is formed of short chevroned ribs, which produce a carinated structure with small arches, the convexities of which are directed forwards; the ribs, twenty-two to twenty-four in number, are sharp and straight on the sides, and bent forward towards the aperture at the angle; they each carry two tubercles, one blunt near the umbilical space, and another sharp, prominent, and thorn-like, near the siphonal angle; these spines are very distinct when the shell is preserved, as in Pl. LVI, fig. 1, but are not so démonstrable on the mould; the angle formed by the bending of the rib develops another considerable prominence of

shell, which has been mistaken for a third tubercle; the sides have wide concave valleys which separate the ribs from each other and clearly define their structure and character.

The whorls are slightly involute, and the umbilicus is therefore widely open, exposing the straight sides of all the ribs with their bituberculated eminences on each, and hence the umbilicus of this Ammonite has a highly ornate interior, which, together with the breadth of the siphonal area, and its bold, oblique ribbings and carinated keel, cause this species to be one of the handsomest shells in the Lias formation, as may be seen in this figure on Pl. LV. The aperture is nearly quadrangular, it presents two sinuses on its external border, which are separated by the median carina, and the inner border is slightly indented by the return of the spire (Pl. LV, figs. 1 and 2, and Pl. LVI, figs 3 and 5).

The sutural-line is rather complicated, and forms three lobes and as many saddles. The siphonal lobe is as long but not so wide as the principal lateral (Pl. LVI, fig. 4), it is ornamented on each side with four lateral branches and a terminal tuft of digitations. The siphonal saddle, wider than the principal lateral, is rounded above and divided into three accessory lobules, their size augmenting in length and width from without inwards. The principal lateral lobe is wide below, and ornamented with five branches, two lateral and one large terminal, each having several simple digitations. The lateral saddle is much smaller than the principal lateral lobe, and terminates in one round terminal and two lateral, unequal folioles on each side; of the two accessory lobes the external is the longest, and consists of a stem with several simple digitations, the internal is short and terminates in a point. The auxiliary saddles are very small, and terminate in two folioles.

The morphology of this species, when traced by a series of specimens, is very interesting. Up to a size of 2—3 millimètres the shell is entirely smooth with a round siphonal area, and its sides are covered with short, straight ribs; the siphonal area remains round until it attains 7 millimètres in diameter. The median line now becomes slightly prominent, and when a diameter of 12 millimètres is attained a keel makes its appearance. When the shell has grown to 34 millimètres in diameter, it has acquired all its ornamentation, and at 54 millimètres the row of external tubercles is very large and prominent. At about 180 millimètres (Pl. LV) it has attained its full measure of development; as old age draws on the ribs are not so numerous, and the tubercles are less prominent. There are some differences in the form of the shells which may probably depend upon sexual characters, such as a greater or lesser flattening of the shell in certain individuals, but as this is a problematical subject, I merely touch upon it here, as we have no facts on which to found any decided opinion.

Affinities and Differences.—In early life this species very much resembles *Amaltheus margaritatus*, but as growth proceeds its specific characters gradually evolve themselves, and finally new lines of development separate each form into its own special type, the narrow siphonal area of *Amal. margaritatus* with its deeply carinated keel, the longitudinal lines of punctations and lateral undulatory folds on the sides, produce a form widely different from the typical *Amaltheus spinatus* figured in Pl. LV.

Locality and Stratigraphical Position.—This Ammonite is found in the uppermost strata of the Marlstone Rock bed of the Midland Counties, where I have collected it in the Marlstone quarries at Grettan, Alderton, Churchdown, and Stinchcombe Hills. In Somersetshire it is found at South Petherton and Yeovil. In Dorsetshire the bed with *Amal. spinatus* forms the uppermost portion of the micaceous marls of De-la-Beche, consisting of brownish sands and sandstones with this species as the leading fossil. Associated with this Cephalopod are many Gastropods and other fossils with their shells intact, and in a fine state of preservation. From the extreme hardness of the rock they are extracted with extreme difficulty. I have collected here *Amaltheus spinatus*, Brug.; *Belemnites breviformis*, Voltz; *Pleurotomaria precaloria*, Deslong.; *P. bitorquata*, Deslong.; *P. rustica*, Deslong.; *P. mirabilis*, Deslong.; *P. procera*, d'Orbigny; *Cryptæna expansa*, Sow.; *Straparollus sinister*, d'Orb. Resting on this remarkable conglomeration of well-preserved shells are beds of Upper Lias Limestone with *Harpoceras serpentinum*, Reinecke. Professor Judd, 'Geology of Rutland,' found this species in the Marlstone Rock bed, along the sides of the Oakham and Melton-Mowbray Canal, and in a stone-pit north-west of the village, where it appears to be rare. In Yorkshire the *Amal. spinatus*-beds are well seen at Hawskers bottoms. Another section of these beds is found at Kettleless, where they form the base of the cliff, and have been long known as the "Kettleless beds" of Young and Bird. The Ironstone series of Old Nab, near Staithes, is chiefly formed of the *Amal. spinatus*-beds (see section of this coast, p. 105); and the reader is referred to an exhaustive account of the equivalent deposit in Tate and Blake's 'Yorkshire Lias,' p. 118. Professor Tate found the *Amal. spinatus*-bed at the south side of Portree Harbour, Isle of Skye. For a list of fossils in this bed, see p. 107.

Foreign Distribution.—In France the *Amal. spinatus*-beds are found at Fontaine-Étoupe-Four, Cury, Croisille, Évreux, Vieux-Pont, Calvados; Avesnes, Doubs; Haute-Saone; Salins, Jura; Saint-Amand, Cher; Saint-Fortunat, Rhône; Department of Aveyron. In Luxemburg at d'Aubange, near Athus. In Italy this zone is likewise found in Lombardy; and Province of Brescia (Reynès).

In Germany the *Amal. spinatus*-beds are found in Tönisberg, Hanover; Winzenburg, Westerberg; Helmstadt, Goslar, Huttenberg; Quedlinburg, Kley; Falkenhagen, Lauter, Bayreuth, and several other localities. In South Germany this zone is found in Swabia; one of the best exposures is in the vicinity of Altdorf in Bavaria, where it is found well displayed in relative position to the *Amal. margaritatus*-bed below, and the Posidonomyan or Upper-Lias schists above.

Family.—LYTOCERATIDÆ, *Neumayr*, 1875.

This family includes several genera which differ very much in external form, but closely resemble each other in internal structure. The shells are elongated cones rolled into cornute whorls, more or less involute, in the spire. They have a short body-chamber about two thirds the length of last turn; the mouth-aperture is circular and slightly produced on the columellar side. So far they have characters in common, but in the form of the shell, and in the morphological changes at different periods of life, the divergence from a common type is extreme. This becomes evident when we compare *Lytoceras* and *Phylloceras* with each other and these again with *Hamites*, *Turrilites*, and *Baculites*, all of which are grouped together in the natural family Lytoceratidæ.

Genus IV.—LYTOCERAS, *Suess*, 1865.

Shell discoidal, more or less flattened; umbilicus wide and open, exposing all the inner turns of the spire; the whorls round and loosely embracing each other. Body-chamber two thirds the length of the last whorl; mouth-border simple in the lateral and ventral sides, with a lappet-like production resting on the preceding whorl at the columellar side.



FIG 193.—*Lytoceras fimbriatum*, *Sow.*

The shell is highly ornate by the presence of transverse parallel lines of growth which encircle the whorl, crossed at right angles by longitudinal ridges, these together form a remarkable reticulate structure in *Lytoceras cornucopia*, *Young* (Pl. LXXIII). The shell of several species is ornamented with wing-like elevations forming prominent fringed ribs as in *Lyt. fimbriatum*, (Pls. LXXI and LXXII), or deep intermittent depressions formed from previous contractions of the aperture as in *Lyt. hircinum*, (Pl. LXXV, fig. 4), or rounded ribs as *Lyt. torulosum* (Pl. LXXVI, fig. 4).

The suture-line is very complicated and very well shown in *Lyt. cornucopia* (Pl. LXXIII, fig. 3). The lobes are few in number but much branched; the lateral lobes and saddles are much divided into small, uniform, symmetrical digitations; there are only two lateral, one very large principal, and a small lateral, with a large columellar lobe covered by the preceding whorl, see (Pl. LXXIII, fig. 3). The siphonal lobe is small and narrow, and almost concealed by the wide-spreading branches of the principal lateral.

The genus *Lytoceras* is found first in the Trias, where it is represented by *Lyt. Morloti*, *Hauer*; *Lyt. sphærophyllyum*, *Hauer*; *Lyt. patens*, *Mojs.*; and *Lyt. engyrum*, *Mojs.*

In the Lias it appears in the Marlstone (Middle Lias) as *Lyt. fimbriatum*, and *Lyt. lineatum*, in the Upper Lias in the zone of *Harpoceras bifrons* as *Lyt. cornucopia*, and in the zone of *Lyt. Jurense* as *Lyt. Jurense*, *Lyt. hircinum*, and *Lyt. torulosum*.

LYTOCERAS FIMBRIATUM, *Sowerby*. Pls. LXXI, fig. 1; LXXII, figs. 1—4.

- AMMONITES FIMBRIATUS, *Sowerby*. Min. Conchology, vol. ii, p. 145, pl. 164, 1817.
 — — *Hann.* Amm. et Goniât., p. 135, No. 79, 1825.
 — — *Keferstein*. Naturgesch., ii, 401, 1834.
 — — *von Buch*. Pétrif. remarq., tab. viii, fig. 2, 1831.
 — — *Roemer*. Norddeutschen Oolithgeb., p. 194, 1836.
 — — *Zieten*. Versteiner. Würtemb., p. 16, tab. xii, fig. 1, 1830.
 — — *d'Orbigny*. Pal. Fr., Terr. Jurass., t. i, p. 313, pl. 98, 1842.
 — LINEATUS var. FIMBRIATUS, *Quenstedt*. Flözgebirge Würtemb., p. 171, 1843.
 — — — Cephalopoden, p. 103, 1849.
 — LINEATUS, *Oppel*. Mittlere Lias Schwabens, p. 50, 1853.
 — FIMBRIATUS, *Morris*. Catal. British Fossils, p. 292, 1854.
 — — *Simpson*. Yorkshire Lias, p. 40, 1855.
 — — *von Hauer*. Cephalopod, N. E., Alp., p. 62, pl. xxii, figs. 1—4, 1856.
 — LINEATUS, *Quenstedt*. Der Jura, p. 134, tab. xvi, fig. 13, 1858.
 — FIMBRIATUS, *Dumortier*. Dépôts Jurassiques, partie iii, p. 92, 1869.
 — — *Brauns*. Untere Jura, p. 234, 1871.
 LYTOCERAS FIMBRIATUM, *Neumayr*. Zeitschr. Deutsch. geol. Gesellsch., Bd. xxvii, p. 893, 1875.
 — — *Tate and Blake*. Yorkshire Lias, p. 297, 1876.

Description.—This Ammonite was first figured and described by Mr. James Sowerby from a specimen collected at Lyme Regis by the late Dr. Buckland. The fragment that formed the subject of the Plate was very imperfect and has long been much misunderstood. Sowerby¹ says “that the mouth in a full-grown shell is furnished with an undulated reflected lip or ruffle, and the more or less perfect formation of this at various periods produces either undulating lines of growth, some of which are obtuse and others acute, or thin, annular fimbriæ surrounding the volutions at certain intervals. The obtuse lines of growth are indented at their backs, but straight towards the mouth and indicate that the undulation of the lip is strongest at the back of it. The whorls do not appear to have been very numerous; the shell is thin, and the margins of the septa have rounded lobes.”

The very beautiful specimens figured in Pls. LXXI and LXXII obtained from the Marlstone beds at Lyme Regis, exhibit in a satisfactory manner the anatomy of the shell of this splendid Ammonite. The shell is discoidal and formed of a round, elongated cone, a little compressed on the sides and rolled up into a disk, the volutions of which

¹ ‘Mineral Conchology,’ vol. ii, p. 145, tab. clxiv.

are only slightly involute. The shell is thin and ornamented transversely with from eighty to one hundred elevated striæ, the free margins of which in perfect specimens are fimbriated as shown in Pl. LXXI, and between these striæ, as they cross the siphonal area, a number of smaller intermediate striæ are introduced. Besides these regular fimbriated annular striæ the outer whorl exhibits from eight to twelve prominent plates, which stand boldly outwards and embrace the entire circumference of the volutions. These remarkable processes are finely preserved and carefully cleaned out in the splendid specimens figured in Pls. LXXI and LXXII.

The siphonal area is well rounded (Pl. LXXII, fig. 3), and partitioned off by the wing-like foliations; the body-aperture (Pl. LXXII, fig. 2) is oblong, only slightly grooved by the last turn of the spire; the sides are a little compressed, and the lip is thickened by an oral band shown to be a product of the mantle, which periodically put on increased formative activity and developed annular bands of shell-growth eight or ten times during the evolution of the last whorl.

The sutural line is very complicated, and the siphonal lobe (Pl. LXXII, fig. 4) is much smaller than the principal lateral. Each stem has four lateral branches, of which the two posterior are the longest and most digitate. The siphonal saddle is small and divided into two portions by the multidigitate character of the lobes.

The principal lateral lobe is very large and springs from a thick stem which divides into two large branches, each of which subdivides into a number of digitations producing an arborescent character in this well-developed lobe, as shown in Pl. LXXII, fig. 4.

The principal lateral saddle is much smaller than the lobe and formed of two unequal parts by a central secondary lobe, the external portion is the largest and most ramified.

The internal lateral lobe is about half the size of the principal, and like it has a central stem bifurcating into two branches which subdivide into several smaller branchlets.

The accessory lobe is formed of small oblique digitations, and the corresponding saddle is proportionately wider than the others, where it rests upon the involution of the spire.

The evolution of this species is only imperfectly known. D'Orbigny stated that when a young shell had attained a diameter of 12 millimètres and retained its test, he had noticed transverse striæ and indications of laminae. In older shells these characters became more developed; in one shell, 30 millimètres in diameter, the specific characters were well shown, and the lateral striæ were very small; the vertical laminae on the sides were inclined obliquely forward, and were vertical across the area.

The mould when entirely denuded of its shell is smooth; at those parts where laminae have existed, depressions instead of prominences, may be observed; these mark the former successive terminal apertures of the body-chamber.

Affinities and Differences.—This species has been often confused with *Lytoceras cornucopia*. In *Lyt. fimbriatum* the whorls are narrower and compressed on the sides,

whilst they are more convex and laterally inflated in *Lyt. cornucopia*. D'Orbigny has further observed that in *Lyt. fimbriatum* there are only two lateral lobes, whilst in *Lyt. cornucopia* there are three lateral lobes. To these differential characters it may be added that the shell is deeply ornate, and has a series of longitudinal striæ which intersect at right angles the transverse striæ, but produce a less regular square-celled structure than in the shell of *Lyt. cornucopia*. The wing-like elevations are more numerous and less elevated in *cornucopia* than they are in *fimbriatum*.

Locality and Stratigraphical Position.—*Lytoceras fimbriatum* had a considerable range of distribution in time during the deposition of the Middle Lias. I have collected this Ammonite in the *Aeg. Jamesoni*, *Aeg. Henleyi*, and *Amal. margaritatus* beds in the Counties of Gloucester, Somerset, and Dorset. The finest specimens were those collected near Charmouth, from a sandy stratum, associated with *Analthus margaritatus*.

LYTOCERAS LINEATUM, *Schlotheim*, Pl. LXIX, fig. 1.

AMMONITES LINEATUS,	<i>Schlotheim.</i>	<i>Petrefactenkunde</i> , p. 75, No. 24, 1820.
— TENUICOSTATUS,	<i>Young and Bird.</i>	Yorkshire Coast, p. 253, 1828.
— LINEATUS,	<i>Quenstedt.</i>	Flözgebirge Würtembergs, p. 171, 1843,
— —	—	Cephalopoden, p. 102, tab. vi, figs. 8 a, b, 1849.
— —	<i>Giebel.</i>	Fauna der Vorwelt, Bd. iii, p. 405, 1852.
— TENUICOSTATUS,	<i>Simpson.</i>	Yorkshire Lias, p. 40, 1855.
LYTOCERAS LINEATUM,	<i>Tate and Blake.</i>	Yorkshire Lias, p. 298, 1876.

Diagnosis.—Shell discoidal, volutions five, all exposed, rapidly diminishing in size; outer whorl two fifths the diameter of the shell; numerous fine, hair-like ribs, commencing at the suture, inclining gently towards the aperture, passing across the broad, round, siphonal area, and uniting with the ribs from the opposite side; the fine ribs are feebly fimbriated, and there are two wing-like elevations on the last whorl.

Dimensions.—Transverse diameter 168 millimètres; width of umbilicus 62 millimètres; height of aperture 70 millimètres.

Description.—This Ammonite possesses a leading feature, which is well expressed in the list of synonyms given above, but whether the numerous, slender, annular ribs with fimbriated margins encircling the whorls constitute a character of sufficient importance to differentiate a species distinct from *Lyt. fimbriatum*, with which it has so many points of structure in common, may well be doubted, I would prefer considering *Lyt. lineatum* as a small-ribbed variety of the typical *Lyt. fimbriatum* I have described in detail, and of which I have figured several very beautiful examples. If Sowerby's type figure ('*Mineral Conchology*,' vol. ii, pl. 164) be compared with Pl. LXIX, fig. 1, it becomes evident

that both represent a similar object. This affords an illustration of the confusion and misunderstanding arising from authors publishing imperfect specimens as types of species, and imparts a lesson to all palæontologists to exercise the greatest care in the selection of well-preserved examples for figures of new species. If this be not done endless trouble is entailed on those who in after years have to consult plates in original works; in fact it may be truthfully said that many of the figures of our predecessors are utterly useless and misleading when critically compared with better examples of the objects themselves that have been subsequently discovered.

This specimen from my collection has much of the thin shell well preserved; and the delicate fimbriæ on the free side of the numerous annular ribs are all directed obliquely forward, indicating the ornate character of this beautiful Cephalopod when it floated in the Jurassic sea. The whorls are extremely evolute, hence the fragmentary condition in which it is so often found. The penultimate whorl when perfect exhibits four wing-like projections at about equal recurrent intervals in the length of the whorl, the last whorl, which appears to have been the body-chamber of the Cephalopod, has only one of these processes, although they appear to have been developed in the inner whorls.

Affinities and Differences.—I consider this form to be only a fine-ribbed variety of *Lytoceras fimbriatum*, and I assume that the shells figured in Pl. LXXI and Pl. LXXII are the most perfect types of the species.

Locality and Stratigraphical Position.—I collected this specimen at Lyme Regis from a dark, shaly stratum of the Middle Lias, which readily wasted away when washed in water, but which has since dried up hard and has well preserved my formerly fragile specimen.

LYTOCERAS CORNUCOPIA, *Young and Bird*. Pl. LXXIII, figs. 1—3.

- AMMONITES CORNUCOPIA, *Young and Bird*. Geol. Surv. York., p. 252, pl. xii, fig. 6, 1822.
 — NITIDUS, — Ibid., p. 256, pl. xii, fig. 8, 1828.
 — BALTEATUS, *Phillips*. Geol. York., pl. xii, fig. 17, 1829.
 — FIMBRIATUS, *Simpson*. Monogr. Amm., p. 16, 1843.
 — — *Zieten*. Versteiner. Würtemb., p. 16, pl. xii, fig. 4, 1830.
 — — *Bronn*. Leth. geognostica, Bd. I, p. 441, Tf. xxiii, fig. 2, 1837.
 — CORNUCOPIA, *d'Orbigny*. Paléontol. Française, Ter. Jurass., tom. i, p. 316, pl. 99, 1842.
 — CORNUCOPIE, *Dumortier*. Dépôts Jurassiques du Rhône, partie iv, p. iii, pl. xxix, 1874.

- AMMONITES FIMBRIATUS, *Quenstedt*. Flözgebirge, p. 260, 1843.
 — CORNUCOPIÆ, *Giebel*. Fauna der Vorwelt, Bd. iii, p. 396, 1852.
 — — *Chapuis et Dewalque*. Terr. Second., Mém. Cour. Acad. Roy.,
 t. xxv, p. 60, pl. viii, fig. 2, 1854.
 — CORNUCOPIA, *Simpson*. Fossils of York. Lias, p. 40, 1855.
 — FASCIATUS, — *Ibid.*, p. 41, 1855.
 — FIMBRIATUS, *Brauns*. Der untere Jura, p. 235, 1871.
 LYTOCERAS CORNUCOPIÆ, *Neumayr*. Zeitschrift Deutsch. geol. Gesell., Bd. xxvii,
 p. 893, 1875.
 — CORNUCOPIA, *Tate and Blake*. Yorkshire Lias, p. 298, 1876.

Diagnosis.—Shell discoidal; whorls round and slightly depressed, encircled with from eighteen to twenty prominent, annular, undulating fimbriæ, with erect lamellæ; surface of the shell covered with transverse and longitudinal striæ, which cross each other and produce a successive series of small quadrate cellular depressions in the shell texture; whorls nearly evolute; siphonal area convex; aperture flattened at the sides.

Dimensions.—The figure is half the natural size. Transverse diameter 320 millimètres; width of umbilicus 126 millimètres; height of aperture 120 millimètres; transverse diameter of aperture 110 millimètres.

Description.—This is a very handsome Ammonite, which sometimes attains considerable dimensions. The finest specimen I have seen is in the Geneva Museum, for which it was purchased from a celebrated French collection of Upper-Lias fossils from Verpillière, Isère. By the kind permission and aid of my friend, Monsieur P. de Loriol, I had a very accurate delineation of this specimen, of the natural size, drawn by Monsieur Lunel, of Geneva, and have reduced his figure one half natural size to come into the plate. Having failed to discover in any of our museums an English specimen good enough for delineation in this work, I have had the French specimen drawn as a magnificent example of the typical characters which this species exhibits and especially in the ornamentation of its beautiful sculptured surface.

The shell is discoidal and slightly compressed on the sides. The whorls are round and nearly evolute, so that the whole of the inner whorls are fully exposed. The outer whorl is encircled by eighteen annular undulating fimbriæ, with erect, pointed lamellæ directed backward, the whole of the rest of the surface being covered with transverse and longitudinal striæ, which cross each other at right angles and evolve a consecutive series of small quadrate or polygonal cellular depressions, with raised walls, in the texture of the shell. The whorls are almost evolute, and the whole of the six volutions are exposed in the fine specimen herein figured. The siphonal area is round, and on it the elegant sculpturing of the shell is well displayed. The aperture is nearly round and only slightly flattened on the sides. In the opening lies embedded in the matrix a specimen of *Harpoceras bifrons*, one of the leading shells of the Upper Lias, and indicating the zone to which *Lyt. cornucopia* belongs.

The sutural line is extremely tortuous and followed with much difficulty; it forms three lobes and three saddles and some accessory parts. The siphonal saddle is smaller than the principal lateral lobe, and divides into two branches, each of which terminates in trifold folioles. The siphonal lobe is much smaller than the principal lateral, and formed of two nearly equal parts deeply divided in the middle. The principal lateral lobe forms two large, highly-ramified branches (Pl. LXXIII, fig. 3), which arise from a multibranching stem. The outer lateral saddle is much smaller than the superior lateral lobe, its central stem divides into two trifold folioles, with a central stem dividing them (fig. 3). The inner lateral lobe is not half the size of the principal lateral, and its stem, with lateral twigs, divides into two nearly equal-sized trifold terminal branches. The auxiliary saddle terminates in three folioles, and the auxiliary lobe is very short and divides into two long branches.

The late Professor A. d'Orbigny had an opportunity of studying some young forms of the shell, and his observation amounts to this that *Lyt. cornucopia* is very variable in form according to the different states of conservation in which it is found, and the precise age when it is examined; a shell of the diameter of 25 to 30 millimètres is ornamented with striæ united into fasciuli, and each is separated from the other by a furrow. Like *Lyt. fimbriatum* it has, according to the age of the individual, prominent undulating fimbriated ribs. When the external layer of the shell exists there are small ribs with very prominent festoons; when this layer is wanting the inner layer still retains feeble impressions, the mould, however, only shows a surface altogether smooth.

Affinities and Differences.—This species is closely related to *Lyt. fimbriatum*, it has the rounded whorls, prominent ribs, and fimbriated margin of that species, but the whorls are larger and more evolute, and the lobes and saddles are somewhat different.

Locality and Stratigraphical Position.—This Ammonite is collected from the Upper Lias with *Harpoceras serpentinum* at Whitby and Runswick, and with *Stephanoceras annulatum*, according to Prof. Blake, at Millington, Yorkshire. I have not met with it in the Midland Counties, nor in any collection of Upper-Lias fossils derived from this region, so conclude it is a rare form in the Midland district.

Foreign Distribution.—Professor d'Orbigny enumerates Ligny, near Lyon; Muhlhausen, Gundershofen, Bas-Rhin; Mende, Lozère; Fressac, Gard; Belvédère près de St. Amand, Cher; Clapier, Aveyron; Charolles, Saône-et-Loire.

Monsieur Dumortier¹ says *A. cornucopia* "is one of the most persistent and most important fossils of the zone; it is accompanied throughout by *A. bifrons*, and is recognised of all sizes. The mines of Verpillière have yielded a great number of very beautiful specimens (Pl. LXXIII an example), some of these were 400 millimetres in diameter. The test is well preserved, and does not appear to have suffered the least alteration in its form."

¹ 'Études Paléont. sur les Dépôts Jurassiques du Bassin du Rhône,' tom. iv, p. 113, 1874.

LYTOCERAS JURENSE, *Zieten*. Pl. LXXIV, figs. 3—5; Pl. LXXIX.

AMMONITES JURENSIS,	<i>Zieten</i> .	Versteiner. Würtemb., p. 90, tab. lxviii, fig. 1, 1830.
—	—	<i>d'Orbigny</i> . Pal. Française Ter. Jurass., p. 318, pl. 100, 1842.
—	—	<i>Quenstedt</i> . Flözgebirge Würtemb., p. 269, 1843.
—	—	—
—	—	Cephalopoden, p. 104, tab. vi, fig. 7, 1849.
—	GUBERNATOR, <i>Simpson</i> .	Mon. Amm., p. 17, 1843.
—	JURENSIS,	<i>Giebel</i> . Fauna der Vorwelt, Bd. iii, p. 406, 1852.
—	—	<i>Morris</i> . Catalogue of British Fossils, 2nd ed., p. 292, 1854.
—	GUBERNATOR, <i>Simpson</i> .	Foss. York. Lias, p. 40, 1855.
—	JURENSIS,	<i>Quenstedt</i> . Der Jura, p. 279, tab. 40, fig. 1, 1858.
—	—	<i>Brauns</i> . Der Mittlere Jura, p. 104, 1869.
—	—	<i>Dumortier</i> . Dépôts Jurassiques, partie iv, p. 109, 1874.
LYTOCERAS JURENSE,	<i>Neumayr</i> .	Zeitschr. Deut. geol. Gesellsch., Bd. xxvii, p. 893, 1875.
—	—	<i>Tate and Blake</i> . Yorkshire Lias, p. 298, 1876.

Diagnosis.—Shell discoidal, compressed; whorls half involute; sides flattened, and bevelled away towards the umbilical suture; siphonal area convex; shell ornamented with very fine lines of growth; mould smooth without a trace of shell-lineation; suture-line very complicated.

Dimensions.—Some German examples attain a diameter of two feet. One example in my collection from the Lias at Wasseralfingen, and only the inner portion of a large shell, is 155 millimètres in diameter; the inner whorls are convex and flat, and the outer whorl expands largely and abruptly with a deep concave slope towards the umbilicus. The small specimen, Pl. LXXIV, figs. 3—5, is 105 millimètres in diameter; the height of the aperture is 50 millimètres, and its width 32 millimètres.

Description.—Thirty years ago I collected this Ammonite from the Liassic sands of Frocester Hill, where a few individuals at that time were found. My original specimens were mislaid and lost soon after they were discovered, and the species was not again met with until 1880, when three or four rough examples were re-discovered in the same locality, and these have served to prove that the *Jurensis*-zone exists in the Cotteswold Hills.

The shell is discoidal and compressed; the whorls, which rapidly increase in height, are one half involute; they are flattened or slightly convex on the sides, and bevelled away towards the umbilical suture, a character which serves to distinguish this species from *Lytoceras oolithicum*, *d'Orb.*, an inferior oolite species with which it has many affinities. The siphonal area is extremely convex. The shell is extremely thin, and seldom preserved. When found it is seen to be ornamented with numerous very fine lines of growth that leave no mark on the mould, which is quite smooth. The sutural line (fig. 3) is very complicated. The siphonal lobe is one third shorter and as wide as the principal lateral,

it has four lateral branches on each side, which augment in size from without inwards, the terminal branch is the largest and bifurcated. The siphonal saddle is as large as the principal lateral lobe, and terminates in eight folioles, four on each side, which are nearly the copies of each other. The principal lateral lobe is almost symmetrical in structure, there are two short branches on each side of the stem near the base, and two large terminal branches, which bifurcate and trifurcate in their terminations, and are deeply divided by a small accessory saddle. The lateral saddle nearly resembles the siphonal in magnitude, structure, and symmetry. The inner lateral lobe is about half the size of the principal; the stem has two short lateral processes on each side, and the summit divides irregularly into three branches. The inner lateral saddle is much smaller than the outer lateral saddle, and terminates in three folioles. The auxiliary lobes, three in number, are small and unimportant.

Affinities and Differences.—This Ammonite appears to vary very little at different periods of growth, preserving nearly always the same form. Some specimens, however, are more convex and compressed than others; a few have the thickest portion of the shell near the umbilicus, from whence the shell is bevelled away towards the siphonal area, and the body-chamber then assumes a somewhat triangular form. I have large specimens of this from the Lias of Wasseraifingen, which strongly resemble the large forms obtained from Frocester Hill; in other varieties, as in the type fossil, a very fine mould, figured by Zieten, Verstein. Würtemb., tab. lxxviii, the whorls are more curved and inflated than is the case in the beautiful specimen I have figured in Pl. LXXIV, figs. 3—5, in which the bevelling away of the shell between the side wall and the umbilical suture is very well shown, as well as the suture-line on its sides.

Locality and Stratigraphical Position.—I have collected this Ammonite from the hard argillaceous shales at the base of the yellow sand above the Alum Shale at Blea Wyke, near Robin Hood's Bay, Yorkshire, associated with *Harpoceras variable*, *H. insigne*, and *H. striatulum*, and other fossils of the *Jurensis*-zone. In Gloucestershire I know it only from the Ammonite bed of the Liassic sands at Frocester Hill.

Foreign Distribution.—Prof. Quenstedt has shown the importance of this zone of the Upper Lias in Württemberg and Swabia; Prof. Leonhard in Baden; Profs. Strombeck, Ewald, and Credner in North Germany in many localities. Prof. R. Lepsius has described the *Jurensis*-Mergel in Lower Elsass; M. Terquem near Metz, Moselle; M. H. Harté near Bayeux. In addition Thouars, Deux-Sèvres; Verpillière and St. Quentin, Isère; Charolles, Saône-et-Loire; Mont d'Or, near Lyons, Saint-Romain, St. Fortunat, Poleymieux, Rhône; Semur, Côte d'Or; Saint-Julien, Charlieu; and Uhrweiler-Selzbrunnen, Bas-Rhin, may be cited as localities where this shell has been collected, and where the zone of *Lytoceras Jurensis* is developed. I have given the geographical distribution of this zone of life in Europe somewhat in detail as it has been much misunderstood by English geologists, and has not received the consideration to which it is entitled from students of Jurassic geology.

LYTOCERAS HIRCINUM, *Schlotheim*. Pl. LXXV, figs. 4—7; Pl. LXXVI, fig. 6.

AMMONITES		<i>Knorr</i> . Sammlung von Merkwürdigkeiten, pt. ii, pl. i, figs. 1, 2; pl. A, fig. 12, 1750.
AMMONITES HIRCINUS,		<i>Schlotheim</i> . Petrefaktenkunde, No. 19, p. 72, 1820.
— —		<i>De Haan</i> . Ammonit. et Goniatic., p. 130, 1825.
— —	INTERRUPTUS,	<i>Zieten</i> . Verstein. Würtemb., tab. xv, fig. 3, 1830.
— —	OBLIQUÈ INTERRUPTUS,	<i>Schübler</i> in <i>Zieten</i> . Ibid., tab. xv, fig. 4, 1830.
— —	GERMANI,	<i>d'Orbigny</i> . Pal. Franç., Ter. Jurass., p. 320, pl. 101, 1842.
— —	HIRCINUS,	<i>Quenstedt</i> . Flözgebirge Würtemb., p. 273, 1843.
— —	—	— Cephalopoden, p. 103, tab. vi, figs. 10 a, b, c, 1849.
— —	—	<i>Giebel</i> . Fauna der Vorwelt, Bd. iii, p. 402, 1852.
— —	—	<i>Oppel</i> . Jura Formation, p. 254, 1856.
— —	LECKENBYI,	<i>Lycett</i> . Cotteswold Hills Handbook, p. 123, pl. ii, fig. 7, 1857.
— —	HIRCINUS,	<i>Quenstedt</i> . Der Jura, p. 280, tab. 40, figs. 3—8, 1858.
— —	—	<i>Brauns</i> . Der Mittlere Jura, p. 103, 1869.
— —	—	<i>Dumortier</i> . Dépôts Jurassiques, tom. iv, p. 117, 1874.
LYTOCERAS HIRCINUM,		<i>Neumayr</i> . Zeitschr. Deutsch. geol. Gesellsch., Bd. xxvii, p. 893, 1875.
— —	GERMANI,	<i>Tate and Blake</i> . Yorkshire Lias, p. 298, 1876.

Diagnosis.—Shell discoidal, compressed, not carinated; whorls one-third involute, flattened on the sides, narrowing and rounded at the siphonal area; shell with small, annular, oblique ribs, interruptedly sulcated with twelve to fourteen marked constrictions, which are deepest on the siphonal area; umbilicus widely open; aperture oval.

Dimensions.—Transverse diameter 60 millimètres; width of umbilicus 18 millimètres; height of aperture 25 millimètres.

Description.—This Ammonite is nearly always found in England as a mould (Pl. LXXV, figs. 4—7) and seldom has any shell preserved. The mould is discoidal, compressed, the sides convex and flattened, the siphonal area narrow and extremely convex, but not carinated. When the shell, which is extremely thin, is preserved (Pl. LXXVI, fig. 6) it is ornamented with numerous delicate oblique striations or fine costæ; and on the last whorl there are about twelve to fourteen oblique sulcations, which were occupied by prominent ribs that extended beyond the intermediate costæ. The sulci are deeper and more marked on the siphonal area; and, as they approach the aperture, the constrictions are very deep in the two outer whorls; but are absent in the inner ones, and they likewise disappear in the old shells. The spire is formed of six very narrow cylindrical

whorls, which are about one-third involute. The aperture is oval or oblong, convex at the sides, tapering towards the area, and slightly grooved by the return of the spire. The sutural line is simple, and forms very symmetrical lobes and saddles. The siphonal lobe, almost as long and wide as the principal lateral, is furnished on each side with three points, and one branch with four. The siphonal saddle terminates in two unequal folioles, of which the external consists of three festoons and the internal of two. The principal lateral lobe divides into two terminal branches, of which the external is the larger. The lateral saddle terminates in one large external and two smaller internal festoons; the three other small auxiliary lobes decrease in size from without inwards.

Affinities and Differences.—The number of the large ribs which occupy the sulcations varies from twelve to fourteen, they resemble the annular fimbriæ seen on *Lyt. fimbriatum*. The intermediate oblique annular ribs in French specimens, according to d'Orbigny's figure, are in general extremely small, whilst in German forms, according to Zieten, they are larger (Pl. LXXVI fig. 6). When the shell was complete this Ammonite must have had a very elegant form. When the shell is absent, as is almost always the case in English specimens, the mould is smooth, with deep, wide, smooth constrictions on the outer and first inner whorls.

When the shell attains the diameter of seventy millimètres, according to d'Orbigny, it loses its ribs and sulci entirely, and becomes altogether smooth; the whorls then are very large and always much inflated, and very unlike the inner whorls of the shell.

This Ammonite, by its periodical interrupted constrictions in middle life, manifests affinities with *Lyt. fimbriatum* and *Lyt. cornucopia*; it differs from both, however, in having deep permanent sulcations on the mould, which are absent in these species; the suture-line likewise is much less complicated, and the whorls are compressed and never cylindrical. A perfect specimen of this fossil would display one of the most beautiful Ammonite structures with which I am acquainted, but the extreme thinness of its delicate shell, with the small amount of involubility in the whorls, renders it one of the Ammonite gems of the Lias formation. It resembles *Lyt. torulosum* (Pl. LXXVI, fig. 5) in general form, but differs from that species by its recurrent constrictions.

Locality and Stratigraphical Position.—I have collected several fragments from the *Jurensis*-bed at Frocester Hill; and Prof. Blake reports a single fragment from Blea Wyke, Yorkshire Coast, associated with *Harporoceras striatum*. The specimen figured Pl. LXXVI, fig. 6, is from Germany.

Foreign Distribution.—Schlotheim collected his numerous examples from the *Jurensis*-Schicht at Aschach, north-east of Amberg, in the Oberpfalz; Zieten's examples came from Gross-Eislingen and Wasseralfingen; it has been collected likewise from the same zone at Altdorf, Heiningen, Uhrweiler, and Muhlhausen. D'Orbigny states that this Ammonite was collected from the uppermost beds of the Upper Lias of the Charolles, Saône-et-Loire; in the environs of Salins, Jura; at Villenotte, near Semur, Côte-d'Or; and at Verpillière, Isère.

LYTOCERAS TORULOSUM, *Schübler*. Pl. LXXVI, figs. 4, 5.

AMMONITES TORULOSUS, <i>Schübler</i> , in <i>Zieten</i> .	Versteiner. Würtemb., p. 19, tab. xiv, fig. 1, 1830.
— TORULOSUS <i>Keferstein</i> .	Naturgesch., ii, 414, 1834.
— TORULOSUS, <i>d'Orbigny</i> .	Terr. Jurass., i, p. 322, pl. 102, figs. 1, 2, 6, 1842.
— — <i>Quenstedt</i> .	Flözgeb. Würtemb., p. 287, 1843.
— — <i>Quenstedt</i> .	Cephalopoden, i, p. 104, tab. vi, p. 99, 1849.
— — <i>Morris</i> .	Catalogue of Brit. Fossils, p. 295, 1854.
— — <i>Quenstedt</i> .	Der Jura, p. 306, tab. 42, fig. 7, 1858.
LYTOCERAS TORULOSUM, <i>Neumayr</i> .	Zeitschrift Deutsch. geol. Gesells., Bd. xxvii, p. 893, 1875.

Diagnosis.—Shell discoidal, one third involute; whorls round, and transversely ribbed; costæ nearly straight, broad, round, and separated by wide valleys; siphonal area round with very large ribs; shell thin, ornate, with numerous transverse striæ; umbilicus wide, ribs becoming attenuated near the spiral suture.

Dimensions.—Transverse diameter, 80 millimètres; height of aperture, 35 millimètres; width of whorl, 30 millimètres.

Description.—This fine Cephalopod has a discoidal shell slightly compressed and about one third involute. The sides and siphonal area are covered with nearly straight, round, prominent ribs, about from thirty to forty in number, according to age; on the last whorl they are separated by deep concave valleys, which impart a distinctive character to the ribbing of this shell. On the area the ribs attain their greatest thickness and the valleys their greatest depth, whilst near the umbilicus and around the spiral suture they are much attenuated and closely approximated. The shell is extremely thin and seldom preserved; when it exists, the outer lamina is found to possess a series of long, delicate striæ, which run along the ribs, and these are very well delineated on the area (Pl. LXXVI, fig. 5).

The siphonal area is wide, round, and very convex; the ribs are larger and the valleys deeper in this region than on the sides (figs. 4 and 5). The spire is composed of five or six roundish or ovate whorls, which are nearly one third involute. The aperture is oval and grooved below by the return of the spire.

The shell is extremely thin, about the thickness of drawing paper, and its outer lamina is covered with narrow, sharp striations, two or three of these adorn and follow the line of the ribs, and a portion of this structure is preserved on the siphonal costæ of the fragment delineated in fig. 5 of Pl. LXXVI. Most of the examples I have examined appear to have broken off at the line of junction of the body-chamber with the last septum. One specimen, a compressed fossil from Mossingen, in a brownish shaly clay, has much of the shell preserved, showing upon the convex sides of the ribs from two to four sharp, well-defined striæ, but in none of the examples has the sutural line been observed.

Affinities and Differences.—*Lytoceas torulosum* in many respects resembles *Lytoceas*

fimbriatum, but it is distinguished from that and other congeneric forms by its large convex ribs and deep valleys, and by the well-defined striations which adorn the convex surface of the ribs, whilst it wants the longitudinal striæ that are seen on the shells of *Lyt. fimbriatum* and *Lyt. cornucopia*; it is evidently a well-marked species of the group to which it belongs.

Locality and Stratigraphical Position.—I have only seen fragments of a mould referred to this species in connection with the *Harp. opalinum*-bed at Frocester Hill, Chideock Hill, and Burton-Bradstock, near Bridport, Dorsetshire, associated with *Harpoceras opalinum*, *Turbo capitaneus*, *Gervillia lata*, *Rhynchonella cynocephala*. This bed forms a thin stratum, rich in many well-preserved specimens of these mollusks.

Foreign Distribution.—The *Torulolum*-zone is very well exposed in many parts of Germany; the type specimen of *Lyt. torulosum* was found at Stufenberg. Professor Quenstedt collected it at Gomaringen, Asefingen, and Wutzch. In the vicinity of Kloster Banz a considerable number of the leading fossils of this zone have been collected, and many of them were figured in Goldfuss. It has been carefully described by Professor Lepsius in his 'Unter Elsass.' This zone is found in many of the Departments of France, as Jura and Doubs; Milhau, Aveyron; Lozère; at St. Quentin and Verpillière, Isère; and in the Sarthe and Calvados.

Family.—LYTOCERATIDÆ—continued.

Genus V—PHYLLOCERAS, *Suess.*, 1865.

Shell discoidal, highly involute, with delicate sculpture sometimes supporting contractions or elevations, or having the shell covered with fine striæ, which describe graceful curves inclined towards the aperture. Body-chamber short; aperture simple, with lateral or aural processes, directed forwards; suture-line highly tortuous, forming eight or nine lobes on each side of the mesial line; saddles bladder-shaped, with well-rounded terminations; body-chamber widely expanded and fan-shaped, with undulating radii, as seen in *Phylloceras heterophyllum*, *Sow.* (fig. 194).



FIG. 194.—*Phylloceras heterophyllum*, *Sow.*

Professor Neumayr distinguishes in the Dogger and Malm four subgroups, of which the following are the types:—1. *Phyll. heterophyllum*, *Sow.*; 2. *Phyll. taticum*, *Pusch*; 3. *Phyll. capitanei*, *Catullo*; 4. *Phyll. ultramontanum*, *Zieten*.

This genus first appears in the Trias, where we find *Phyll. debile*, *Hauer*, *Phyll. despectum*, *Mojs.*, *Phyll. Neojurensis*, *Quenst.*, *Phyll. occultum*, *Mojs.*, *Phyll. pumilum*, *Mojs.*, *Phyll. invalidum*, *Mojs.*

In the Middle Lias appear *Phyll. Loscombi*, *Sow.*, *Phyll. Buvignieri*, *d'Orb.*, *Phyll. Zetes*, *d'Orbig.*

In the Upper Lias *Phyll. heterophyllum*, Sow., *Phyll. subcarinatum*, Young.

In the Oxfordian we find *Phyll. tatricum*, Pusch; *Phyll. viator*, d'Orb.; *Phyll. Hommairei*, d'Orbig.; *Phyll. Zignodianum*, d'Orbig.

In the Cretaceous rocks we find *Phyll. subalpinum*, d'Orbig., *Phyll. Vellidæ*, d'Orbig.: and Professor Waagen has figured and described¹ several interesting species closely allied to European forms from the Upper-Jurassic rocks of Kutch, Western India.

PHYLLOCERAS LOSCOMBI, *Sowerby*. Pl. XL, figs. 4, 5.

AMMONITES LOSCOMBI,	<i>Sow.</i>	Mineral Conch., vol. ii, pl. 183, 1817.
GLOBITES —	<i>Haan.</i>	Ammon. et Goniatic., p. 147, 1825.
AMMONITES —	<i>d'Orbigny.</i>	Pal. Franç., Ter. Jurass., p. 262, pl. 75, 1842.
— LOSCOMBI,	<i>Morris.</i>	Catalogue of British Fossils, p. 173, 1843.
— HETEROPHYLLUS NUMISMALIS,	<i>Quenst.</i>	Cephal., p. 100, tab. vi, fig. 5, 1849.
— —	<i>Oppel.</i>	Mittl. Lias, p. 48, tab. ii, fig. 9, 1856.
— LOSCOMBI,	<i>Oppel.</i>	Juraformation, p. 162, 1856.
— —	<i>Dumortier.</i>	Dépôts Jurassiques Bassin du Rhône, t. iii, p. 78, 1869.
PHYLLOCERAS —	<i>Neumayr.</i>	Zeitschr. Deutsch. geol. Gesell., Bd. xxvii, p. 903, 1875.
— —	<i>Tate and Blake.</i>	Yorkshire Lias, p. 296, 1876.

Diagnosis.—Shell very thin, discoidal, compressed; whorls wide, four fifths involute; sides flattened and slightly convex, covered with delicate, transverse, biflexed striæ which, on passing over the narrow, round siphonal area, develop prominent folds; aperture oblong, widest near the spiral suture; umbilicus narrow, exposing the inner whorls.

Dimensions.—Transverse diameter 140 millimètres; width of umbilicus 20 millimètres; depth of the last whorl 75 millimètres; height of aperture 70 millimètres; transverse diameter 33 millimètres.

Description.—This beautiful shell is a very characteristic fossil of the "Green Ammonite-bed," Middle Lias, near Charmouth. It is here nearly always found firmly embedded in the matrix, so that a correct outline of the shell is seldom obtained. The specimen I have figured is one of the finest I have seen. The shell is extremely thin and lustrous, of a discoidal figure, and covered with delicate striæ on the body-chamber, and with small, biflexed ribs on the inner whorls. The shell is thickest around the spiral suture near the umbilicus, and some specimens have likewise an elevated ridge or longitudinal carina rising about the middle of the height of the whorl; from this elevation proceed a number of oblique striæ which extend backwards towards the area. In the two best specimens I possess the longitudinal carina and the oblique backward-directed striæ,

¹ 1. 'Palæontologia Indica,' Ser. ix. 2. (Jurassic fauna of Kutch) p. 25, pls. v—vii, ix, 1875.

are very plainly visible. None of the shells I have examined have the suture-line preserved; and, as Prof. d'Orbigny had examples showing this character, I give the chief points of his description. "The septa are symmetrical, divided on each side into six lobes and saddles formed of unequal parts. The siphonal lobe is much shorter than the principal lateral lobe, formed of three branches, of which the terminal one ends in three twigs. The siphonal saddle is as large as the principal lateral lobe, and terminates in five oval, spatuliform leaves. The principal lateral lobe is long and ornate; it has three branches without and two within, all very unequal. The second lateral has much the same figure as the principal lateral, but does not attain to one half its size. The three auxiliary lobes have irregular branches, and the three auxiliary saddles terminate in oval leaflets."

D'Orbigny likewise observed that "*A. Loscombi* is a very variable species. The mould is in general smooth, nevertheless some specimens are found, considered to be the young of this species, with slightly marked transverse constrictions very closely approximated. It is, perhaps, one of the forms which exhibits the most marked variation at different ages. Up to the diameter of 5 millimètres its whorls are only one half involute, the umbilicus is very wide, and the shell ornamented transversely by a spiral revolution of six, deep, transverse, oblique constrictions. These constrictions and this form continue for a longer or shorter time in different individuals; sometimes the constrictions disappear and the whorls enlarge up to the diameter of 8 millimètres, although in others this state continues up to the diameter of 20 millimètres: this is the extreme limit observed in which the shell preserves the ornamentation of youth." Terr. Jurass., tom. i, p. 265.

M. Dumortier found a fragment of this species 190 millimètres in diameter at Mazaugues, Var; which carried its lobes up to the last extremity, proving that it had attained to much larger dimensions. The shell was in part preserved, and permitted him to see the small lines radiating very equally and regularly and forming an elegant ornamentation; these lines, slightly flexed, are strongly inclined forward, and afterwards describe a round sinus on the area where they preserve all their value" ('Dépôts Jurassiques,' tom. iii, p. 78).

Affinities and Differences.—This species, both in its form and the structure of the suture-line, closely resembles the *Phylloceras heterophyllum*; it is readily distinguished from that species by its open umbilicus, the structure of the lobes, and by the siphonal lobe being formed of single elements, whilst in *Phyll. heterophyllum* they are in pairs.

Locality and Stratigraphical Position.—This Ammonite is a leading Mollusk of the Green Ammonite-bed, the zone of *Aeg. Davæi* in the Middle Lias. I have it in the same zone from Thackwell's brickfields, Leckhampton, and Professor Blake reports it from the same horizon in Robin Hood's Bay and Huntcliff, Yorkshire, where it is rare.

In France it has been collected in the Middle Lias which it characterises at Coutards and near Saint Amand, Cher.; Mulhausen, Bas-Rhin; Vieux-Pont and Bayeux, Calvados; Venavey, near Senur, Côte-d'Or; Saint Hélène, Saone-et-Loire; Mazaugues, Var.

PHYLLOCERAS BUVIGNIERI, *d'Orbigny*. Pl. LXXVI, figs 1—3.

AMMONITES BUVIGNIERI, *d'Orbigny*. *Paléont. Franç., Terr. Jurass.*, pl. 74, p. 61, 1842.

— — *Ralph Tate*. *Proc. Belfast Nat. Field Club*, Appendix I.

Irish Liassic Fossils, p. 6, 1870.

Diagnosis.—Shell discoidal, compressed; whorls extremely involute, umbilicus nearly occluded; sides smooth, convex, covered with delicate biflexed lines of growth, which become more developed near the border; siphonal area compressed, subcarinate, marked by angular striæ; aperture compressed, subangulate; suture-line very complicated, developing eight lobes.

Dimensions.—Transverse diameter 145 millimètres; height of the aperture 80 millimètres; greatest width of shell across umbilicus 47 millimètres; width of umbilicus 5 millimètres.

Description.—This appears to be a very rare Cephalopod, as I have not seen the shell in any of our museums, and find it noticed only in Tate's 'Catalogue of Irish Liassic Fossils.' The specimen figured came into my hands with a collection of Irish Liassic Ammonites obtained in the North of Ireland, and belonging to the Belfast Museum, sent to me purposely for the determination of the species.

The fossil is much injured, still it retains all the specific characters by which this beautiful Ammonite is distinguished. The shell is very much compressed and not carinated; the sides are smooth and delicately marked with very fine lines of growth, which become more developed and angular on the siphonal area. The whorls are compressed, convex, and extremely involute; the last whorl is very deep; it embraces almost entirely the inner whorls, and nearly occludes the umbilicus, leaving only a small aperture indicating its position (Pl. LXXVI, fig. 1). The siphonal area is compressed and bevelled on each side, and rounded in the middle (Pl. LXXVI, fig. 2); it is marked with well-marked angular striæ all directed forward toward the mouth (Pl. LXXVI, fig. 1).

The aperture is lanceolate and much compressed, forming a blunt angle before with two points behind.

The suture-line is very complex. The septa are symmetrical and divided on each side into eight lobes and into many saddles, formed of unequal parts. The siphonal lobe (fig. 3) is as long as and wider than the principal lateral lobe; it is much ramified and provided on each side with five branches, two of which are much larger than the others. The siphonal saddle is narrow and very irregularly divided into folioles, of which the central one is trilobed. The principal lateral lobe is formed of many irregular branches, four on the inner and five on the outer side of the lobe. The right lateral saddle, much higher than the siphonal, is much foliated, and terminates in three unequal leaves. The inner lateral lobe has a similar form, but is much smaller and shorter than the principal lateral lobe. The first auxiliary saddle divides into two, the others are very

irregular, both as regards the size and number of their folioles. The auxiliary lobes are placed at irregular distances apart and decrease in magnitude towards the innermost lobe, which is quite rudimentary.

Affinities and Differences.—*Phyll. Bwignieri* very much resembles *Amm. lynx*, d'Orb., in its compressed, extremely involute shell, with its almost occluded umbilicus, and in the style and structure of the suture-line; but though it wants the festooned carina, and has a narrower umbilicus than *Amm. lynx*, the affinities are very close indeed.

Locality and Stratigraphical Position.—This species is marked on the ticket, *Belemnites-acuteus* zone, Ballintoy. I have a small specimen of this species, 5 millimètres in diameter, which exhibits all the characters of the large and middle specimens. So it appears to retain its specific form through life, the only difference I detect is that the young shell is proportionately thicker and its siphonal area rounder than in the large figured example with its subcarinated area. The figured specimen belongs to the Belfast Museum.

PHYLLOCERAS ZETES, d'Orbigny, Pl. LXXVII, fig. 1—3.

AMMONITES HETEROPHYLLUS AMALTHEI, <i>Quenstedt</i> .	Cephalopoden, p. 100, pl. 6, fig. 1, 1846.
— ZETES, <i>d'Orbigny</i> .	Prodrome de Paléontologie, étage 9, No. 55, 1849.
— HETEROPHYLLUS AMALTHEI, <i>Oppel</i> .	Der mittlere Lias Schwabens, p. 47, 1853.
— ZETES, <i>Studer</i> .	Geologie der Schweiz, t. ii, p. 36, 1853.
— —	<i>Von Hauer</i> . Cephalopoden Nord-est Alpen, p. 56, pl. xviii, figs. 1, 3, 1856.
— —	<i>Oppel</i> . Die Juraformation, p. 169, 1856.

Diagnosis.—Shell compressed, discoidal, highly involute; umbilicus small, narrow, open, exposing the inner whorls. Shell very thin, marked with delicate hair-like lines, all inflected forward; sides flattened, smooth; siphonal area round; lobe-line very tortuous, developing from nine to eleven lobes.

Dimensions.—The figured specimen: transverse diameter 150 millimètres; height of the last whorl at aperture 100 millimètres; greatest width near the spine 45 millimètres; width of umbilicus 20 millimètres. A larger specimen in my collection measures as follows: transverse diameter 294 millimètres; height of last whorl at aperture 170 millimètres; greatest near spire 90 millimètres; width of umbilicus 30 millimètres.

Description.—The *Heterophyllida* form a remarkable natural group closely related to each other by form and structure, differentiated, however, by fairly-marked specific

characters. Professor Quensted described these Ammonites as one species, and named what he considered their varieties by the zones in which they were found, hence we have *Phyll. heterophyllus numismalis* = *Phyll. Loscombi*, Sow., *Phyll. heterophyllus amathei* = *Phyll. Zetes*, d'Orbig., *Phyll. heterophyllus Posidonæ* = *Phyll. heterophyllus*, Sow.

Phylloceras Zetes has a discoidal shell, much compressed and extremely involute, the last whorl enveloping nearly the entire disc. The sides are flat, and gently bevelled toward the siphonal area, which is narrow and round; the greatest width of the disc being around the umbilical elevation. The shell is extremely thin, and sculptured with very fine lines of growth, which are straight on the inner and gracefully bi-flexed on the walls of the body-chamber. The siphonal area is narrow and smoothly rounded, and the small syphon lies immediately beneath the shell (fig. 2), where the longitudinal line indicates its position. The umbilicus is narrow from the extreme involution of the spiral, which envelopes four fifths of the lateral surface of the whorls (see fig. 1). The suture-line is extremely complicated, but very beautiful in its tracery, forming nine lobes in its varied convolutions. The siphonal lobe is short and wide, having four lateral branches on each side, the innermost is small, the second and third have several branches, and the fourth or terminal one ends in two lanceolate twigs. The siphonal saddle is wider than the siphonal lobe, and ends in numerous folioles, which are larger on the inner than on the outer side of the saddle, from the root of which supplementary lobules arise (see fig. 3). The principal lateral lobe is very large, being much longer and wider than the siphonal, it has an arborescent appearance, having a thick stem with two lateral branches on each side, after which it bifurcates, and gives off two longer branches, the external branch bends over towards the siphon and sends out six branches, three long, extending into the siphonal saddle, and three smaller, bending towards the inner side. The inner terminal branch divides into two branchlets, which send out lanceolate terminations. The outer lateral saddle is long and narrow, and terminates in from six to eight long, narrow folioles. The inner lateral lobe is about the same length, but much narrower than the principal lateral, and composed of a central stem with five lateral branches on each side and a long terminal branch, each dividing into lanceolate points, having a style of incision much resembling the principal. The inner lateral saddle is much shorter and narrower than the outer lateral saddle, and terminates in three branched folioles; there are six auxiliary lobes, which much resemble each other in structure in having a solid stem with a number of sharp lanceolate lateral and terminal branches. The lobes diminish in length and width from without inwards, and the six auxiliary saddles have their sides foliated nearly after the same fashion.

The extremely complicated suture-line of this species produces one of the most beautiful foliated structures that I am acquainted with in Ammonites; a portion is delineated in fig. 3, and is beautifully drawn in Quenstedt's 'Cephalopoden,' tabl. vi, fig. 1.

Affinities and Differences.—This species very much resembles *Phylloceras hetero-*

phyllum, Sow., found in the Upper Lias of Whitby; the following differences I have long observed after a careful comparison of many good examples with each other:

1st. The shell is much more compressed in *Phyll. Zetes* than in *Phyll. heterophyllum*. The sides are much flatter, and the siphonal area narrower.

2nd. The umbilicus is wider in *Phyll. Zetes*, and permits all the inner whorls to be seen, whilst in *Phyll. heterophyllum* the umbilicus is almost occluded.

3rd. The suture-line consists of a much more angular tracery, a finer subdivision of the parts of the lobes, and much smaller folioles in the saddles than what we observe in *Phyll. heterophyllum*. Any one in the habit of studying these shells has no difficulty in deciding on the species from an examination of the suture-line alone. In figs. 3 and 4 I have given accurate drawings of the suture-line in the two species for comparison.

4th. The lines of growth on the shell are more marked in *Phyll. heterophyllum*, and the wonderful fan-like folded expansion of undulating ribs, which I have for the first time delineated in Pl. LXXVIII, fig. 1, and which characterise the body-chamber of *Phyll. heterophyllum* have not yet been observed in any of the fine examples of *Phyll. Zetes* hitherto collected.

Locality and Stratigraphical Position.—My specimens of *Phyll. Zetes* were obtained from the *Amal. spinatus*-bed at South Petherton, Somersetshire, and from the same horizon at Grettan, Gloucestershire. In Swabia, according to Dr. Oppel it is found at Breitenbach, with *Am. amaltheus gigas*, and in a rich pyritic bed at Bachs, and near Sondelfingen in the Baling region. Von Hauer obtained his fine example from the dark red limestone of Enzesfeld, North-eastern Alps. Studer reports many localities in the Bernese Alps of Switzerland, where he has found this species; and Meneghini collected a specimen in the Upper Lias of Sibilla and a broken fragment at Spezzia.

Dr. Oppel collected one specimen from the Middle Lias of Normandy. Its lobes are so different from those of the true *Phyll. heterophyllum*, Sow., that he was convinced a separation from that species was necessary, and this he carried out in his 'Jura-formation,' p. 169.

PHYLLOCERAS HETEROPHYLLUM, *Sowerby*. Pl. LXXVII, fig. 4; Pl. LXXVIII, figs. 1, 2.

AMMONIS CORNU,	<i>Martin Lister</i> . Synops conchyliorum, (Edit. alt.) tab. 1049, fig. 24. 1770.
— NAUTILITES,	<i>J. Baier</i> . Oryctogr. noric., p. 60, tab. ii, fig. 1, 1708.
AMMONITES HETEROPHYLLUS,	<i>Sowerby</i> . Mineral Conchology, pl. 266, 1820.
NAUTILUS WHITBIENSIS,	<i>Young and Bird</i> . Geol. Yorkshire Coast, Pl. xiii, fig. 1, 1822.
GLOBITES HETEROPHYLLUS,	<i>Haan</i> . Ammon. et Goniat., 148, 1825.
AMMONITES —	<i>Phillips</i> . Geology of Yorkshire, pl. xiii, fig. 2, 1829.
— —	<i>Hartmann</i> . Versteiner. Würtemb., p. 21, 1830.
— —	<i>Buckland</i> . Bridgewater Treatise, pls. 38, 39, 1836.

AMMONITES TERVERII,	d'Orbigny.	Paléont. Franç., Terr. Crét., t. i, p. 179, pl. 54, figs. 7—9, 1840.
— HETEROPHYLLUS,	—	Paléontol. Française, Terr. Jurassique, tom. i, p. 339, pl. 109, 1842.
— —	Simpson.	Ammonites Monogr., p. 7, 1843.
— —	Quenstedt.	Flözgeb. Würtemb., p. 259, 1843.
— —	Morris.	Catalogue British Fossils, p. 173, 1843.
— —	Quenstedt.	Cephalopoden, p. 99, pl. vi, figs. 1—5, 1849.
— —	Oppel.	Die Juraformation, p. 251, 1856.
— —	Quenstedt.	Der Jura, p. 252, pl. 36, fig. 4, 1858.
— —	Dumortier.	Dépôts Jurassiques, t. iv, p. 104, 1874.
PHYLLOCERAS HETEROPHYLLUM,	Neumayr.	Zeitschr. Deutsch. Geol. Gessellschaft, Bd. xxvii, p. 903, 1875.
— —	Tate and Blake.	Yorkshire Lias, p. 297, 1876.

Dimensions.—The figured specimen. Transverse diameter 410 millimètres.

Description.—The magnificent specimen figured in Pl. LXXVIII, fig. 1, is, as far as I know, a unicum, which I discovered in the collection of the late Mr. Marshall, of Whitby, jet-dealer, many years ago. It was so different to any other Ammonite I had ever seen that I at once secured it for my cabinet. My old friend, Dr. S. P. Woodward, was with me when I made the purchase, so that, when we had realised the rarity and value of the fossil I had bought, he pleaded hard with me to part with it to the National Collection, which I accordingly did. Up to that time the true anatomy of the shell of *Am. heterophyllus*, Sow., was unknown, as the specimens contained in public collections, and which had formed the subject of published figures of the species, were inner whorls, mostly destitute of the shell, so that when the body-chamber was seen *in situ* in the grand specimen we had found, its value became enhanced accordingly. My figure is drawn just half the natural size, and displays the body-chamber of the shell in all its beauty, with the test finely preserved and ornamented with striæ,—that important portion which had been unknown before. The inner whorls had been figured by Sowerby, Buckland, and d'Orbigny, but the fan-like body-chamber was absent in their specimens. M. Dumortier figured two fragments of the shell of the fan of this species as "*corps de nature inconnue*," and observed that the bodies, of which a drawing was given (Dép. Jurass., partie iv, p. 228, pl. xlviii) of the natural size, were found in Thiollière's collection; with the two specimens was a note in the handwriting of V. Thiollière:—'Mineral du Lias Supérieur de la Verpillière; fouilles près de Serres; donnés par M. Drian, Octobre, 1854.' "The principal fragment has the appearance of a leaf with very large undulations, the surface is covered with ribs, or regular flutings, up to the number of twenty or so on each undulation. On these ribs we notice the indications of smaller nodosities irregularly disposed; nevertheless, we think we recognise the tendency to a concentric serial disposition. The ribs and the large undulations have a fan-like disposition, as if they took their origin from a single point, which is absent from the

specimen under notice. The two fragments which I have examined appear to indicate a much larger total development. The reason which prevents us from attributing this fossil to the vegetable kingdom is the thickness of the body, which is from two to three millimètres, and which seems to diminish on leaving the base of the fan. Ought we to regard it as a fragment of the test of an unknown Ammonite of very large size?" This extract from the work of so good an observer proves the importance of having found the body-chamber *in situ*, thus settling the question of its true nature. During a visit I paid some time ago to the Woodwardian Museum, Cambridge, I found a portion of a very large fan of this shell, which was then unknown to the museum authorities. This I identified and described, and it has now passed out of the unknown into the region of known fossils.

The shell is somewhat compressed, and uncarinated, with a narrow umbilicus nearly hidden. The spire is composed of very involute whorls, which almost entirely embrace the preceding ones; and the whorls, which are always oval, rounded, and compressed, have their greatest width at the inner third near the spire, and they are especially wider here than at the entire half of the shell. The sides of the shell and area are covered with fine radiating lines which curve gently forward towards the aperture (Pl. LXXVIII, fig. 1). The size of the lines varies with the age of the shell; in youth they are extremely narrow, but in the middle-aged shells they become more and more developed. As old age advances the body-chamber of this grand shell (Pl. LXXVIII, fig. 1) assumes a fan-like structure, in consequence of the lines being grouped into bundles of fasciculi, which radiate outwards in gentle flexures from the umbilicus to the siphonal area, in elegant waved undulations, as shown in our plate of this fine specimen, now in the British Museum, reduced one half the natural size. It will be noted that the mould behind the suture-line is entirely smooth, whilst in front of that line it develops the undulating folds which produce the fan-shaped structure seen in the body-chamber of this magnificent specimen, and which I believe up to this hour is quite unique. The radiating undulations appear to exist on the body-chamber only inasmuch as on the moulds of the chambered portions of this fossil we fail to observe those radiating depressions which constitute so important a character in the body-chamber of this remarkable Cephalopod.

The suture-line forming the lobes is extremely complicated, and formed of single parts (Pl. LXXVIII, fig. 2). The siphonal lobe is shorter, but as wide as the principal lateral, and ornamented on each side with two branches, the inner being small, the outer much ramified. The siphonal saddle is wide, and terminates in five large, oval, unequal leaves.

The principal lateral lobe is very large, and provided on each side with three ramified branches, and a long terminal branch divided into three wide foliations; the lateral saddle, longer than the siphonal, terminates in six unequal leaves, the three internal leaves being smaller, whilst the three outer ones have large oval folioles which make conspicuous figures on the mould; the inner lateral lobe resembles the principal lateral in structure, but is not more than two thirds the size of the principal; the first and second auxiliary saddles are formed of five folioles, the others of only three. The

auxiliary lobes all preserve the same form, but become less and less complicated as we trace them from without inwards. When we describe a radial line from the digital points of the siphonal lobe to the digital points of the auxiliaries, it touches the points of all the others, and cuts the terminal branches of the principal lateral. The near approximation of the chambers, and the great development of the suture-line, produces on the surface of the mould of this Ammonite a number of figures which are as difficult to trace out as they are beautiful to behold.

Professor d'Orbigny had an opportunity of examining several young forms of this species, and stated that a shell ten millimètres in diameter had absolutely the same form and the same lobes as the adult, and was entirely smooth, and that it did not acquire striæ until it had attained a diameter of from twenty to thirty millimètres.

The mould is always entirely smooth. When the inner lamina of the shell was preserved he remarked that striæ were only slightly visible, but when the external layer of the shell existed the striæ were well shown.¹

The late Mons. Dumortier² observed of this Ammonite "that the veritable *A. heterophyllus*, Sow., is very different to the *A. Zetes* of the Middle Lias. The specimens of large size from Verpillière, Isère, are remarkably beautiful, both as regards their well-preserved forms as well by the perfection of the details of their ornaments;" and again, "upon some examples of moderate size we remark from six to seven radiated depressions, very slight upon the last whorl, but which terminate upon the siphonal contour by a round prominence and form a sinus in front. As all the other characters remain unaltered this peculiarity is to be considered as an accidental variety of *A. heterophyllus*." This was doubtless a mould of the fan-like portions of the body-chamber which had lost its shell, whilst the fragments which Dumortier figured as "*corps de nature inconnue*" were in fact the shell of the fan without the mould on which it rested.

Affinities and Differences.—In the Jurassic rocks we find five species of Ammonites, which may all be referred to the group *Heterophyllidæ*. 1st. *Phyll. Loscombi* of the Middle Lias, with a large umbilicus, without ribs in early life, and the suture forming six lobes. 2nd. *Phyll. Zetes*, d'Orbigny, from the Middle Lias (the *Amal. spinatus*-zone) distinguished from *Phyll. heterophyllum* by more compressed whorls, a wider umbilicus, and a different suture-line. 3rd. *Phyll. heterophyllum*, the type of the group, which has just been described in detail. 4th. *Phyll. Calypso*, from the Upper Lias, distinguished by the five flexed contractions observed on the last whorl of the spire. 5th. The *Phyll. taticum*, Pasch, from the Lower Oxfordian, with six to eight bent constrictions of the outer whorl, which is very involute and covered with a thick shell finely sculptured, with minute striæ. All these Jurassic *Heterophyllidæ* are very distinct from other members of the same natural family which are found in the Cretaceous formations.

Locality and Stratigraphical Position.—*Phylloceras heterophyllum*, Sow., is found in

¹ 'Paléontologie Française, Terr. Jurassiques,' tom. i, p. 340, 1842.

² 'Dépôts Jurassiques du Bassin du Rhône,' tom. iv, p. 105, 1874.

the Upper Lias at Whitby and Boulby, in Yorkshire; Lyme Regis, Dorsetshire; Dumbleton and Alderton, Gloucestershire. The Whitby specimens are by far the most beautiful and best preserved.

Foreign Distribution.—In France it has been collected at Fontaine-Étoupe-Four, Croiselle, Calvados; Charolles, Saône-et-Loire; Thouars, Deux-Sèvres; Cheville, Sarthe; Avallon, Yonne; Semur, Côte-d'Or; Mende, Lozère; Verpillière, Isère; Saint-Rambert, Ain; Gundershoffen, Haut-Rhin.

Luxembourg.—In the Marnes de Grande Cour.

In Germany.—In the Posidonomyen-schiefer of Altdorf, Bavaria, Boll, and Württemberg.

PHYLLOCERAS SUBCARINATUM, *Young and Bird*. Pl. LXXXI, figs. 1, 2, 3.

NAUTILUS SUBCARINATUS,	<i>Young and Bird</i> .	Geol. York. Coast, p. 255, pl. xii, fig. 7, 1822.
AMMONITES —	<i>Phillips</i> .	Geol. of Yorkshire, p. 167, pl. xiii, fig. 3, 1835.
— —	<i>Simpson</i> .	Monogr. on Ammonites, p. 8, 1843.
— —	<i>Morris</i> .	Catalogue of British Fossils, p. 145, 1843.
— —	<i>Catullo</i> .	Ammonit. delle Alps. Venete, pl. 13, fig. 3, 1846.
— —	<i>Bronn</i> .	Index Palæontologicus, p. 60, 1848.
— —	<i>Giebel</i> .	Fauna Vorwelt, Bd. iii, p. 747, 1852.
— —	<i>Morris</i> .	Catalogue of British Fossils, 2nd ed., p. 295, 1854.
— —	<i>Oppel</i> .	Die Juraformation, p. 251, 1855.
— —	<i>Simpson</i> .	Fossils of York. Lias, p. 37, 1855.
— —	<i>Guembel</i> .	Beschr. d. Bayr. Alpen, p. 474, 1861.
— —	<i>Oppel</i> .	Paläontol. Mittheilungen, p. 140, pl. 44, figs. 1, 2, 1862.

PHYLLOCERAS SUBCARINATUM, *Tate and Blake*. Yorkshire Lias, p. 297, 1876.

Diagnosis.—Shell discoidal, extremely involute, inner volutions nearly concealed, outer whorl one-half the diameter of disk; sides convex, inflated, covered with straight or slightly flexed obtuse irregular radii, obsolete near aperture; striæ very numerous, fine, annular, irregular, diverging; siphonal area wide, with central ridge, and two flattened bands on each side; umbilicus narrow and deep. Aperture ovate, widest at the spiral border and bevelled away towards the area.

Dimensions.—Transverse diameter 100 millimètres; breadth of area 18 millimètres; height of aperture 50 millimètres; width of whorl at the aperture 40 millimètres; width of umbilicus 15 millimètres.

Description.—*Phylloceras subcarinatum* has been long known to the Yorkshire naturalists, and is remarkable for its dissimilarity from other congeneric forms; still this

species has not been included in the classical works on Liassic Cephalopoda by Quenstedt, d'Orbigny, and Von Hauer, nor has it been noticed as a doubtful species, or one that had fallen under their observation in any way;—an omission which may perhaps be explained by the fact that it was very badly drawn in the two Yorkshire monographs in which it was first figured. Dr. Oppel correctly described this species and pointed out its affinities in his Juraformation, as he had obtained the fossil himself at Whitby from the dealers and showed me the purchased specimens. One of these he has figured most beautifully in his 'Paläontologische Mittheilungen,' pl. 44.

The shell is extremely thin and ornamented with numerous fine annular striæ, which pass over the area and encircle the whorl. The siphonal area is wide and has an obtuse ridge in the centre and two flat bands extended on each side of the carina, but without any groove or sulcus, such as exists on each side of the keel in the genus *Arietites*. The umbilicus is narrow and the inner whorls are much concealed (Pl. LXXXI, fig. 1). The aperture is ovate (Pl. LXXXI, fig. 2), widest across the inner or spiral side, and gradually tapering from thence towards the siphonal area (Pl. LXXXI, fig. 2). This area is extremely characteristic, having an obtuse ridge running round the middle line of the shell, with two lateral flat bands on each side (Pl. LXXXI, figs. 2 and 3), forming a structure by which this species is readily distinguished from all its congeners.

The suture-line is not exposed in a satisfactory manner in any of my specimens, the thin shell being so often retained in the matrix that the suture-lines cannot be traced.

Affinities and Differences.—The Ammonite which most nearly resembles *Phyll. subcarinatum* is the *Phyll. cycloides*, d'Orbigny, from the Inferior Oolite of Moutiers. The young forms of this species have a keel, lateral ribs, and a narrow umbilicus, but in later life the shell becomes smooth, the keel is less prominent, and the lateral bands are smoother, the ribs disappearing; with all its affinities *Phyll. cycloides* is, nevertheless, a very different form to *Phyll. subcarinatum*.

Locality and Stratigraphical Position.—It is obtained from the Alum-shale, near Whitby, in company with *Harpoceras bifrons*, *Harp. Lythense*, and *Stephanoceras commune*. This species is rare when compared with the other forms with which it is associated.

Dr. Oppel states that in the Munich Museum there is a specimen, named by Münster, from Altdorf, in Franconia, out of the *Monotis*-limestone; and in the Berlin Museum there is a specimen from the Iron-earth of Verpillière, near Lyons; so *Phyll. subcarinatum* is a leading fossil for the Upper Lias in France and Germany, as well as in the British Isles.

Family.—AEGOCERATIDÆ—continued.

Genus VI—HARPOCERAS, *Waagen*, 1869.

Family—FALCIFERI, *Von Buch*, 1832.
 — *d'Orbigny*, 1841.
 FALCIFEREN, *Quenstedt*, 1849.

Family—DISCI SIVE CLYPEIFORMES, *Giebel*, 1852.
 FALCIFERI, *Giebel*, 1852.
 — *Seebach*, 1864.

The Falciferi of Von Buch have long been recognised as a remarkable group of Ammonites, which have undergone several changes of nomenclature, still all authors agree on the special characters on which they were originally described and figured for the first time in the 'Ueber Ammoniten.' The external outline of their shells is of various forms, the ventral area is always keeled with a round or angular border; the sides of the whorls are ornamented with elegant falciform ribs of various degrees of thickness. The aperture of the shell is in general sickle-shaped, with lateral auricles and a long, pointed ventral process, as seen in one of the typical forms, *Harpoceras serpentinum*, *Reinecke* (fig. 194). The body-chamber is from one half to two thirds the length of the whorl. The suture-line is moderately ramified. The siphonal lobe is in general short and bifurcate, with divergent branches, and always shorter than the principal lateral lobe, which is usually largely ramified; the inner lateral lobe is much smaller than the principal, and succeeded by several still smaller auxiliaries.

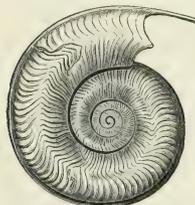


FIG. 194.—*Harpoceras serpentinum*, *Reinecke*.

The *Aptychus* is thin calcareous and bivalved, with a shelly coating and several longitudinal folds, as seen in *Harpoceras Levisoni* (Pl. LXI, fig. 4).

When the shell is preserved the radii on the sides of the whorls in many species are in the highest degree fine and delicate, as in *Harpoceras opalinum*. It is the external lamina of the shell which fills in all the unevenness between the thickness and divisions of the folds of the inner lamina. All these folds have a falciform figure; they first bend forward, then incline backward, and near the siphonal area again turn forward towards the aperture, so that a well-formed, strongly-bent sickle is described thereby. The siphonal area in general forms a sharp ridge, which sometimes contains the siphuncle and gives a marked character to the shell. The umbilicus is usually well open, although in a few species it is contracted. The *Falciferi* are very rich in species, which well characterise the horizons in which they are found.

The oldest forms are found in the Middle Lias. They are very numerous in the Upper Lias, which is the metropolis of the species; they are found in the Lower and Middle Jurassic rocks, finally disappearing in the Kimmeridge Clay with *Harpoceras Zio*, *Oppel*.

HARPOCERAS ANTIQUUM, *Wright*, nov. sp. Pl. LVII, figs. 1—4.

Diagnosis.—Shell discoidal, compressed, and carinated, volutions one-half involute, sides convex and flattened; ribs formed of many biflexed striæ, sometimes prominent, and always well bent forward towards the aperture; keel thick, prominent, and in parts crenated.

Dimensions.—Transverse diameter 180 millimètres; height of aperture 70 millimètres; thickness 40 millimètres; width of umbilicus 60 millimètres.

Description.—This shell very much resembles *Am. Normanianus*, d'Orb., in its style of ribbing; but, as the specimens that have come under my observation are all fragmentary and belong to a much larger and older specimen than d'Orbigny's figure, which was drawn natural size, the difference between my fragments and d'Orbigny's shell may be only those of increased age rather than of specific distinction. *Am. Normanianus* is much less involute, and has a wider umbilicus than *Harpoceras antiquum*. The discovery of younger and better specimens of this shell will enable future observers to solve the problem; as I have no trace of a suture-line on any of the fragments, one of our best guides is absent.

The shell is much compressed, carinated, and provided with a strong keel; the whorls are nearly one-half involute, and are thickest at the spiral suture; thence they diminish towards the siphonal area, which is narrow and lanceolate and terminates in a thick keel. The sides are traversed transversely by a number of unequal, highly flexed calciform ribs, made up apparently of a number of striæ, which unite in fasciculi, and form unequal, obtuse costæ on the sides. The keel is thick, cord-like, and prominent, and makes an important element in the structure of the shell. The test is very well preserved in some of the fragments, the transverse fracture of these exposes the crystalline structure of the thin shell, which does not exceed one millimètre in thickness. The structure and calciform flexures on the sides of the whorls are well seen in two fragments, delineated in Pl. LVII, figs. 3 and 4. Both of these specimens have the shell preserved, so that we have here the true character of the ribs, with their shelly covering transformed into ferrous disulphide (FeS₂), by which the microscope markings on the test are preserved. As the shell increases in size (Pl. LVII, fig. 1) the ribs lose their prominence, the siphonal area becomes thicker and rounder, and the keel is more defined.

Affinities and Differences.—This Ammonite is nearly allied to *Am. Normanianus*, d'Orb. It is, however, more regularly ribbed, the ribs remain single and do not bifurcate; the volutions are more involute, and the umbilicus wider than in that species. There is, however, a very near affinity between the forms, which can only be satisfactorily settled by a careful comparison of more specimens.

Locality and Stratigraphical Position.—This Ammonite was collected by the Rev. J.

E. Cross, F.G.S., and Peter Cullen, from a shaly ferruginous pyritic bed of clay in the north corner of Robin Hood's Bay, Yorkshire Coast, referred by them to the *Aeg. Jamesoni*-zone of the Middle Lias, and containing other fossils of this zone.

HARPOCERAS NITESCENS, *Young and Bird*. Pl. XLIX, figs. 2—7.

AMMONITES NITESCENS,	<i>Young and Bird</i> . Geol. Surv. York. Coast, p. 257, 1828.
—	<i>Simpson</i> . Monogr. Ammon., York. Lias, p. 45, 1843.
— RADIANS AMALTHEI,	<i>Oppel</i> . Mittl. Lias Schwabens, p. 51, tab. 3, fig. 1, 1853.
— NITESCENS,	<i>Simpson</i> . Fossils of Yorksh. Lias, p. 87, 1855.
— NORMANIANUS,	<i>Oppel</i> . Juraformation, p. 168 (non d'Orb.), 1856.
— FALCIFER,	<i>Quenstedt</i> . Der Jura, p. 173, tab. 22, fig. 28, 1856.
— ALGOVIANUS,	<i>Oppel</i> . Palaeontol. Mittheilung, p. 137, 1862.
—	<i>Regnès</i> . Géol. et Paléontol. Aveyron., pl. ii, fig. 1, 1868.
HARPOCERAS ALGOVIANUM,	<i>Tate and Blake</i> . Yorkshire Lias, p. 302, pl. viii, fig. 1, 1876.

Diagnosis.—Shell discoidal, compressed, carinated, and slightly involute; volutions six, inner very little concealed; sides of whorls flat, with from twenty-five to thirty straight, sharp ribs, developing a series of blunt tubercles near the siphonal area, and then bending forward to the keel, which is thick and prominent without lateral sulci; aperture oblong, with straight sides; suture-line very complicated.

Dimensions.—A prolonged search in the Whitby Museum during the summer of 1881, with Mr. Simpson, among some of the unfigured species of Lias Ammonites recorded in his list, afforded me an important insight into the characters of several of his species, and I had the pleasure of finding in the type specimen of *Am. nitescens* an unmistakable example of the *Am. Algovianus*, *Oppel*. I was anxious to have figured *Young's* type shell, but Mr. Simpson will not allow any specimen to leave the building; afterwards I had the good fortune to find a specimen of this shell in my friend Mr. Slatter's cabinet, collected from the *Anal. margaritatus*-bed in the Midland Counties, and figured in Pl. XLIX, figs. 2, 6, and 7. Much better examples of this species are found in the Marlstone near Chipping-Norton, where it occurs in a brown sandy bed, which has well preserved the shell-texture. I am indebted to Mr. James Windus of that town for the small specimen I have figured (3, 4, and 5), and which I have magnified two diameters, as the fossil was too small to exhibit its characters without enlargement.

The shell is compressed and carinated. The sides of the whorls are flat, and ornamented with straight, simple, angular, well spaced-out ribs, which develop a series of obtuse tubercles at the side of the area before they bend suddenly forward towards the aperture. In the centre of the siphonal area is a high, prominent, sharp keel, which conceals and overlaps the siphuncle that lies beneath, and this structure is very well shown in

Pl. XLIX, figs. 4 and 5, in which the shell is preserved and in the other specimen (figs. 6 and 7). Where the shell is absent all the sharp specific characters derived from the straight sharp ribs and high prominent keel are much modified.

The suture-line is well shown in both specimens; the siphonal lobe is short and narrow, with three digitations on its inner border; the siphonal saddle, large and wide, is divided into two segments by a short accessory lobe which issues from the bottom of the saddle; the outer foliole has three lobes, and the inner is larger and terminates in four; the principal lateral lobe is large, and has a stout thick stem, with three lateral digitations on each side, and one long terminal branch; the lateral saddle is rather smaller than the siphonal, and terminates in four folioles; the inner lateral lobe is about one third the size of the principal, with short side digitations; the inner saddle is larger than the lobe, and terminates in three small folioles; the auxiliary lobes and saddles are very small (fig. 3).

Affinities and Differences.—This species very much resembles *Harp. striatulum*, Sow., its ribs, however, are more straight and sharp, and they possess obtuse tubercles near the area, which are wanting in *Harp. striatulum*, the whorls are also more flattened and square, and the suture-line is more acute and intricate than in *Harp. striatulum*. This species differs from *Harp. Normanianum*, with which it was formerly confused, in having simple, straight, sharp, tuberculated ribs, all of which are undivided, and it has the keel much higher, sharper, and more prominent.

Locality and Stratigraphical Position.—*Harpoceras nitescens* is found in the Marlstone beds at Hawsker, Staithes, Saltburn, and Rockcliff, Yorkshire, where it is rare. In Chipping Norton it occupies the same horizon, associated with several species of Mollusca that are found in the *Amal. margaritatus*-zone as *Pecten æquivalvis*, *Monotis cygnipes*, *Pinna folium*, *Modiola scalprum*, *Cardium truncatum*, *Pholadomya ambigua*, *Trochus imbricatus*, *Cryptænia expansa*, *Cryptænia complanata*, *Belemnites Milleri*, as reported to me by Mr. Windus.

HARPOCERAS SERPENTINUM, *Reinecke*. Pl. LVIII, figs. 1—3.

ARGONAUTA SERPENTINUS,	<i>Reinecke</i> .	Naut. et Argon., p. 89, No. 2, pl. xiii, figs. 74, 75, 1818.
— CÆCILIA,	—	Ibid., p. 90, No. 3, pl. xiii, figs. 76, 77, 1818.
AMMONITES SERPENTINUS,	<i>Schlotheim</i> .	Die Petrefactenkunde, p. 64, No. 6, 1820.
— CAPELLINUS,	—	Ibid., p. 65, No. 7, 1820.
— STRANGWAYSII,	<i>Sowerby</i> .	Min. Conchol., vol. iii, p. 99, pl. 254, figs. 1—3, 1821.
— FALCIFER,	—	Ibid., vol. iii, p. 90, pl. 254, fig. 2, 1821.
— MULGRAVIUS,	<i>Young and Bird</i> .	Geol. Survey, York. Coast, p. 251, pl. xiii, fig. 8, 1822.

PLANITES SERPENTINUS,	<i>De Haan.</i>	Amm. et Goniât., p. 89, No. 20, 1825.
AMMONITES CÆCILIA,	—	Ibid., p. 112, No. 21, 1825.
— MULGRAVIUS,	<i>Phillips.</i>	Geology of Yorkshire, p. 136, 1829.
— FALCIFER,	<i>Zieten.</i>	Versteiner Würtemb., pp. 9, 16, tabs. vii, fig. 4, and xii, fig. 2, 1830.
— SERPENTINUS,	<i>Roemer.</i>	Versteiner. Nord-Deutsche Oolithgeb., p. 185, 1836.
— —	<i>d'Orbigny.</i>	Pal. Franç., Terr. Jurass., tom. i, 215, pl. 55, 1842.
— —	<i>Quenstedt.</i>	Flözgebirge Würtembergs, p. 258, 1843.
— —	<i>Quenstedt.</i>	Die Cephalopoden, tab. vii, fig. 3, 1849.
— —	<i>Chapuis et Devalque.</i>	Terr. second. Luxemb., p. 68, pls. ix, fig. 4, and x, fig. 1, 1854.
— —	<i>Morris.</i>	Catalogue of British Fossils, p. 295, 2nd ed., 1854.
— MULGRAVIUS,	<i>Simpson.</i>	Fossils of Yorksh. Lias, p. 73, 1855.
— SERPENTINUS,	<i>Dumortier.</i>	Dépôts Jurassiques du Bassin du Rhône, p. 50, 1874.
HARPOGERAS SERPENTINUM,	<i>Neumayr.</i>	Zeitschr. Deutsch. geol. Gesellsch., Bd. xxviii, p. 909, 1875.
— —	<i>Tate and Blake.</i>	Yorkshire Lias, p. 307, 1876.

Diagnosis.—Shell discoidal, depressed, and carinated; whorls flat, with lateral sulcus. upper border sloping towards the siphonal area, inner border abruptly truncated at the umbilical margin; ribs 100, transverse, rugose, and undulated; curved forward in the middle, and abruptly truncated at the umbilical margin; siphonal area rounded, sloping, with a subacute elevated carina in the middle, towards which the lateral ribs bend forward. Suture-line tortuous, forming four lobes. Aperture with lateral processes, and a long projecting abdominal spine.

Dimensions.—Transverse diameter 180 millimètres; height of last whorl 60 millimètres; width of ditto 30 millimètres; width of umbilicus 80 millimètres.

Description.—This beautiful Ammonite is a capital leading fossil for the determination of the horizon in which it is found; the shell has received so many different names that it is well to master the synonymy of the species. In early life and before the ribs have acquired their special form, it is readily mistaken for *Harp. radians*; when it has attained a diameter of forty millimètres the ribs become flexed and curved in the middle; and they retain this form until old age, when the ribs gradually disappear, and the last whorl bears a smooth shell.

An adult form of this Ammonite was well figured by Reinecke in 1818 as *Argonauta serpentinus*, and the young form as *A. Cæcilia*. Sowerby, in 1821, figured an adult specimen from the Upper Lias of Ilminster as *Am. Strangewaysi*, and the young form thereof as *Am. falcifer*. The following year Young and Bird figured it as *Am. Mulgravius*.

The shell is compressed, discoidal, strongly carinated, and provided with a prominent carina; the whorls are flattened and slightly convex; their sides covered with numerous

rugose, highly-flexed ribs (fig. 1), which proceed from the umbilical margin, pass forward, and at about two-fifths of their length form a prominent curve backwards; then again turn forwards in a graceful bend towards the siphonal area, sweeping away towards the aperture by the side of the subacute keel (fig. 2). The whorls are flattened, and about one fourth involute, down the middle of the sides is a shallow depression or lateral sulcus, into which the curved portion of the ribs dips; the siphonal area is narrow, and formed by the forward bending of the ribs, and the straight, prominent, elevated keel, which is not distinct from the ribs, but appears to be formed by their union. The spire is composed of five or six whorls, which are all fully exposed in the wide umbilicus, the amount of involution being about one fourth part of their height which leaves all the inner volutions fully exposed. The spiral margin of the whorls is very acute, abrupt, and angular, imparting a remarkable stair-like character to the umbilicus of this species.

The aperture is oblong and compressed; the sides have two lateral lappets as shown in the woodcut (Fig. 194), and the abdominal portion extends outwards in the form of a long projecting spine, intimately associated with the lateral curving forward and retreating backward of the inflected ribs.

The suture-line is very complicated (figs. 1 and 3); the siphonal lobe is narrow, and much shorter than the superior lateral, it is ornamented on each side with five digitations, and is larger at the base than at the summit of the lobe.

The siphonal saddle is two-fifths wider than the principal lateral lobe, and is divided into two unequal portions, by a long accessory lobe, the internal being the largest, much resembling in size and structure the inner lateral lobe. Each of the compartments of the siphonal saddle terminates in six or seven folioles.

The principal lateral lobe has a large complicated structure, having a thick stem, ornamented on each side with five or six long digitations, the internal branches being the longest, with a large terminal tuft at the summit.

The lateral saddle is much smaller than the principal lateral lobe, and has a very irregular form from the unequal size of its folioles. The internal lateral lobe is much smaller than the principal lateral, being about one third the width and one half the length of that large lobe. It has a very irregular form, with two lateral and one terminal bifid branches.

The first auxiliary saddle, having a similar form, is about one half the size of the lateral saddle. The two auxiliary lobes are small, the largest resembles in miniature the principal, and the smaller is simple and bifid. The chief character to be noted in the suture-line of this species is the excessive development of the principal lateral lobe and the great size of the siphonal saddle, with its long accessory lobule. This structure is very fairly delineated in the suture-line drawn *in situ* on the side of fig. 1 and in the outline of fig. 3.

Affinities and Differences.—This Ammonite resembles *Harpoceras radians*, *Harpoceras*

bifrons, and *Harpoceras Levisoni*; it is distinguished from *Harpoceras radians* by having wider and flatter whorls, a less circumscribed keel, with less prominent ribs, a lateral sulcus, and a different suture-line. It is distinguished from *Harpoceras bifrons* by having wider whorls, smaller and more numerous rugose ribs, with a much smaller and shallower lateral sulcus, the want of the tricarinated and bisulcated siphonal area, and a difference in the structure of the lobes and saddles. It differs from *Harpoceras Levisoni* in having wider and less involute whorls, of the same form and structure in youth as in adult age; whilst in *Harp. Levisoni* the young shell has large obtuse ribs, and a carina with lateral sulci, and style of building resembling the young shells of the genus *Arietites*.

Locality and Stratigraphical Position.—*Harpoceras serpentinum* has been collected from the zone of *Harpoceras bifrons* at Stinchcombe, Frocester, and Stroud, in Gloucestershire; Bloxam, Oxfordshire; and many localities in Rutland; from the Santon Railway-cutting, in north-west Lincolnshire; and from numerous exposures of the Upper Lias on the Yorkshire coast, and known there under the names *A. Mulgravius* and *falcifer*.

Foreign Correlations.—I have devoted several pages of this work to the correlations of the Upper-Lias beds of north and south Germany, and several of the departments of France, and I must refer to pages 129—136 for ample details on the correlation of the *Harp.-serpentinum* beds in these countries.

HARPOCERAS BIFRONS, *Bruguière*, 1792. Pl. LIX, figs. 1—4.

CORNU AMMONIS,	<i>Lister.</i>	Hist. Animal. Angliæ, tab. vi, fig. 2, 1678.
—	<i>Baier.</i>	Oryctogr. noric., p. 65, tab. iii, fig. 9, 1708.
—	<i>Rumphius.</i>	Thesaurus, tab. 60, fig. A.D., 1739.
—	<i>Lister.</i>	Synop. Conch. (Edit. alt.) tab. 1041, fig. 20, 1770.
—	<i>Walcott.</i>	Petrifactions near Bath, p. 32, fig. 41, 1775.
AMMONITES BIFRONS,	<i>Bruguière.</i>	Encycl. Méthod., tom. i, p. 40, 1792.
—	<i>Bosc.</i>	Buffon de Dèterville, tom. v, p. 176, 1801.
—	<i>Schlotheim.</i>	Taschenbuch, p. 35, 1813.
—	<i>WALCOTT, Sowerby.</i>	Mineral Conchology, vol. ii, p. 7, pl. 106, 1815.
—	<i>HILDENSIS, Young and Bird.</i>	Geol. Yorksh. Coast, pl. xii, fig. 1, 1822.
—	<i>BIFRONS, Haan.</i>	Amm. et Goniât., p. 108, No. 13, 1825.
—	<i>Deshayes.</i>	Coquilles character., p. 236, pl. 7, fig. 7, 1831.
—	<i>Giebel.</i>	Fauna der Vorwelt, Bd. iii, p. 518, 1852.
—	<i>d'Orbigny.</i>	Paléont. Française, Terr. Jurass., p. 219, pl. 56 1842.
—	<i>Quenstedt.</i>	Cephalopoden, p. 108, t. 7, figs. 13, 14, 1849.
—	<i>Chapuis et Dewalque.</i>	Terr. second. Luxemb., p. 66, pl. ix, fig. 3, 1854.
—	<i>WALCOTT, Simpson.</i>	Foss. Yorksh. Lias, p. 99, 1855.

- AMMONITES BIFRONS, *Dumortier*. Dépôts Jurassiques, partie iv, p. 48, pl. ix, figs. 1, 2, 1874.
- HARPOCERAS — *Neumayr*. Zeitschr. Deutsch. geol. Gesellsch., Bd. xxvii, p. 908, 1875.
- — *Tate and Blake*. Yorkshire Lias, p. 307, 1876.

Diagnosis.—Shell discoidal, compressed; siphonal area tricarinated and bisulcated; whorls compressed, slightly biconvex, with a deep longitudinal sulcus occurring at two-thirds distance from the siphonal area and intersecting the ribs; ribs strong, obtuse, biflexed, and curved against the line of the sulcus; whorls one-third involute, outer two-thirds most strongly ribbed; aperture quadrate, elongate, lateral walls vertical with projecting convex lappets, outer abdominal margin having an elongated process (Pl. LIX, fig. 1).

Dimensions.—Transverse diameter 155 millimètres; height of whorl near aperture 40 millimètres; width of umbilicus 80 millimètres; height of aperture 38 millimètres; transverse diameter of aperture 30 millimètres; thickness of shell across the last septum 28 millimètres; length of the body-chamber three-fourths the length of the last whorl.

Description.—Although it is now two centuries ago since this common Ammonite was first figured by Lister, no such accurate delineation of this beautiful form has ever before been drawn as that given in Plate LIX, which displays the whole external anatomy of the shell, shows the length of the body-chamber, and the processes of the aperture. I collected this specimen a few years ago at Whitby, but I have never found a second example as perfect as this type.

The shell is discoidal and much compressed; the siphonal area is tricarinated, the median carina most elevated, the two lateral carinæ less so and separated from the median carina by two well-marked grooves; the whorls are compressed and exhibit at their inner third a deep longitudinal sulcus, which divides the side of the whorl into two convex portions, the outer portion is covered with sixty obtuse convex ribs, the concavities of which are directed towards the aperture; the inner portion is narrower and more convex, being limited by the sulcus, and shows feeble traces of very small ribs; it is this portion of the whorl that forms the prominent ornament of the umbilicus (see figures 3 and 4). This style of double ribbing is well developed in the two fragments which, covered with the mother-of-pearl coating of the shell, have preserved their markings in great perfection.

The aperture is quadrate, elongated, and compressed at the sides, and its transverse section (fig. 2) exhibits at the summit two slight sinuosities, and at the base a grooving formed by the return of the spine; the walls of the aperture (fig. 1) show short convex lateral lappets on each side, and the outer abdominal portion a long projecting process. On this figure likewise is delineated the true position of the last septum, marked by the suture-line, and showing from its position that the body-chamber occupied three fourths of the last whorl.

Professor d'Orbigny made some instructive observations on the morphology of this

species, he noticed that, as in other carinated Ammonites, the keel did not appear until the shell had attained the size of from two to four millimètres in diameter, and commenced to develop at the same time, the folds on the sides of the whorl indicating the appearance of the ribs. The deep lateral sulcus made its appearance when the shell had attained seven millimètres in diameter. The then shell continued to grow with all its ornaments. The whorls were proportionally larger in the young than in adult specimens. Soon the ribs became less prominent, and the sides less inflated, and when the diameter of 1.40 millimètres had been reached the ribs entirely disappeared, and the shell appeared almost smooth, and the lateral sulcus was then only feebly marked and less shallow than in early life.

Affinities and Differences.—*Harpoceras bifrons* makes one of the remarkable group *Falciferi*, among which there are many characters common to the whole. It resembles very much *Harpoceras serpentinum*, and is regarded by some as only a variety of that species; there are, however, several organic features which distinguish them: 1. The three carinæ on the siphonal area and the two lateral sulci on each side of the median keel; 2. The deep longitudinal sulcus which divides the whorls along their length, the outer two thirds of the side having convex ribs, and other narrow portions being inflated and smooth; 3. The suture-line is very different also in the two forms. It has many affinities with *Harpoceras Levisoni*; these, however, will be pointed out in the following article, which will embrace the history of that species.

Locality and Stratigraphical Position.—This is one of the characteristic fossils of the Upper Lias, and is the type form of the zone it represents; it is found at Crickley, Frocester, and Stinchcombe Hills sections, and at Alderton, Grettan, Dumbleton, Gloucestershire; at Bloxam, Oxfordshire; several localities in Rutland, Santon, north-west Lincoln; and Whitby, Yorkshire, the metropolis of the species; from the last locality my beautiful figured specimen was obtained.

Foreign Distribution.—I must refer to my 'Correlation of the *Harp. bifrons*-zone,' pp. 127—136 of this Monograph, for an exhaustive account of the distribution of this horizon of life in north and south Germany, France, and Switzerland.

HARPOCERAS LEVISONI, *Simpson*. Pl. LX figs. 1 and 2; and LXI, figs. 1—6.

- AMMONITES LEVISONI, *Simpson*. Monogr. on Ammonites of Yorksh., p. 99, 1855.
 — BOREALIS, *Seebach*. Der Hannover. Jura, p. 140, taf. vii, fig. 5, 1864.
 — COMENSIS, *Reynès*. Géol. et. Paléontol. Aveyron, pl. 5, fig. 6, 1868.
 — LEVISONI, *Dumortier*. Dépôts Jurass., part. iv, p. 49, pl. ix, figs. 3, 4, 1874.
 HARPOCERAS — *Tate and Blake*. Yorksh. Lias, p. 307, 1876.

Diagnosis.—Shell discoidal, compressed, carinated, with a very wide umbilicus;

whorls flat on the sides, ribs obtuse, sigmoidal, equal in width to the intervening valleys. Carina thick and slightly elevated, with indistinct furrows on each side; inner whorls strongly ribbed, outer much smoother; aperture quadrate, with lateral lappets and an abdominal projection.

Description.—This form is nearly allied to the preceding species. The shell is compressed, discoidal, and carinated. The whorls are narrow, and about one-third involute. The sides are flat, and ornamented with broad, obtuse, sigmoidal ribs, separated by valleys of a like breadth. The ribs are thicker and more prominent in the inner whorls, but the last whorl of the adult shell has very obtuse distant undulations, which gradually become by degrees a nearly smooth surface. The inner or spiral side of each whorl is well rounded down at right angles to the previous one, so that the wide umbilicus of this species presents a succession of flat terraces of a stair-like form. The siphonal area is round, with a smooth, thick, low carina rising in the middle of two indistinct depressions, one on each side. The evolution of this Ammonite differs from some of its congeneric forms. In early life the suture-line develops on each side three lobes and three saddles composed of single parts. The siphonal lobe, a little narrower and shorter than the principal lateral lobe, is divided by the median line up to one third of its height, and presents only one chief terminal point and several lateral digitations. The dorsal saddle very wide, almost twice the size of the principal lateral lobe, is divided by a small accessory lobe into two portions, each of which terminates in obtuse shallow folioles. The principal lateral lobe is an elongated mass, ornamented on each side with three or four simple digitations, and terminates in several branches, of which the two central are the longest. The lateral saddle is long and narrow, about half the width of the siphonal; it lies in the sulcus, and is seen with difficulty; it terminates in a few obtuse shallow folioles. The internal lateral lobe is small, about one fourth the size of the principal, it bends inwards, and has a few lateral digitations, terminating in a longer lanceolate process. The auxiliary saddle is very short and bilobed. The auxiliary lobe is less than the internal lateral, and is armed with lateral digits and a terminal point; it lies well down towards the spiral suture on the slope of whorl.

A radial line stretched from the extremity of the siphonal lobe cuts the three last digitations of the principal lateral lobe, but does not approach any of the others.

In its morphology this species forms a remarkable contrast to *Harp. bifrons*; when of the diameter of forty-five millimètres, it possesses thick, prominent ribs, has a low keel, and two sulci on the area, and in this condition it very much resembles an *Arietites*, as shown in Pl. LXI, figs. 1 and 2. The next volution exhibits the ribs more obtuse and distant from each other; and in the following volution the ribs have a highly sigmoidal curve, are well inclined backwards, and then curved forwards upon the area. This style of ribbing is very well shown in the beautiful shell figured in Pl. LXI, figs. 5 and 6, from the Upper Lias of Ilminster. The fine large adult shell, which forms the subject of

Pl. LX has a singular history. One half of this specimen was discovered at Grettan, Gloucestershire, a long time ago, in the turning over of a heap of rubbish, from whence it came into my hands. I found the inner costated whorls of its early condition very well displayed in the fragment, and a portion of its adult state as well. I promised my collector a good fee if he would find the rest of the fossil, which I was certain, from the fractured surface, remained in the heap; after a two days' search a second fragment was found, which when placed in position still left a gap. Again I renewed my promise, and another long search over the stuff disclosed the third missing fragment. Soaking the mutilated specimen in boiling water I detached all the fragments, and having cleaned their fractured surfaces, cemented them together and produced the fine *Harpoceras Levisoni* figured in Pl. LX. The shell is converted into crystallised carbonate of lime, which completely conceals the mould and much of the suture-line; this line, however, is shown in the young ribbed shell (Pl. LXI, fig. 3).

The siphonal lobe is long, the sides present several digitations, and it terminates in a long divergent branch. The siphonal saddle is twice the width of the lobe, it has an accessory lobule arising in the middle, and dividing the space into two compartments, which terminate in many shallow folioles. The principal lateral lobe is a large mass with four or five lateral digitations, and a round head surmounted by four digitations (Pl. LX, fig. 1, and Pl. LXI, fig. 3). The lateral saddle is smaller than the siphonal, it is unequal in form, inclines towards the principal lobe, and terminates in five or six shallow, obtuse folioles. The inner lateral lobe is much smaller than the principal, it has several lateral digitations, and a terminal lanceolate one. The auxiliary lobes and saddles were small and imperfectly shown in the specimen examined.

In the outer portion of the body-chamber of one specimen (Pl. LXI, fig. 4) is one half of the *Aptychus*. This body is covered with oblique ribs, and lies in the longitudinal line of the shell.

The aperture is elongated (Pl. LXI, fig. 6), flattened on the sides, and rounded at the outer margin; at the lower portion of the side near the spire is a projecting convex lateral lappet (fig. 5), with a concavity, above which it ends in a long projecting abdominal process, well delineated in Pl. LXI, figs. 5 and 6.

Plate LXI, figs. 1 and 2, are accurate delineations of a young shell sent to me for determination more than thirty years ago. The build of this shell with its fifteen robust prominent oblique ribs and deep intervening valleys (fig. 2), and broad siphonal area, having a central keel and lateral furrows, so closely resembled an *Arietites* that I thought a mistake had been made when it was said to have been collected from the Upper Lias of Ilminster, and I told my friend, the late Dr. Lycett, who sent the small-ribbed Ammonite to me for determination, that, if there was no mistake about its horizon, it must be the young form of some larger Ammonite, which at that time we did not know. It was not until many years afterwards, when I found a similar Ammonite in the interior whorls of an undoubted *Harp. Levisoni* that the real truth dawned upon me.

PLATE LXX.

Zone of Amaltheus margaritatus.

Fig. 1. AMALTHEUS ENGELHARDTI, *d'Orbigny*. Side view, natural size. My collection.

Fig. 1

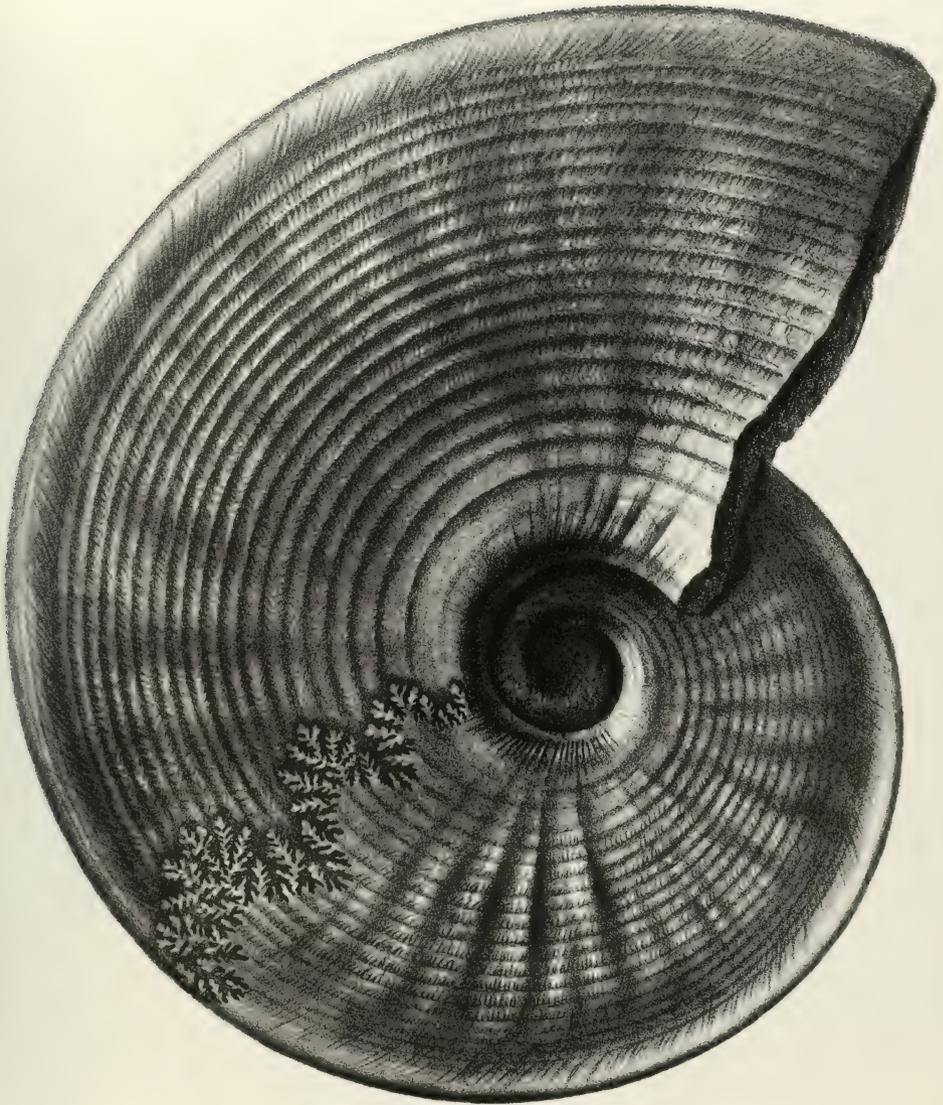


PLATE LXXI.

Zone of Amaltheus margaritatus.

Fig. 1. LYTOCERAS FIMBRIATUM, *Sowerby*. Side view, natural size. My collection.

Fig. 1

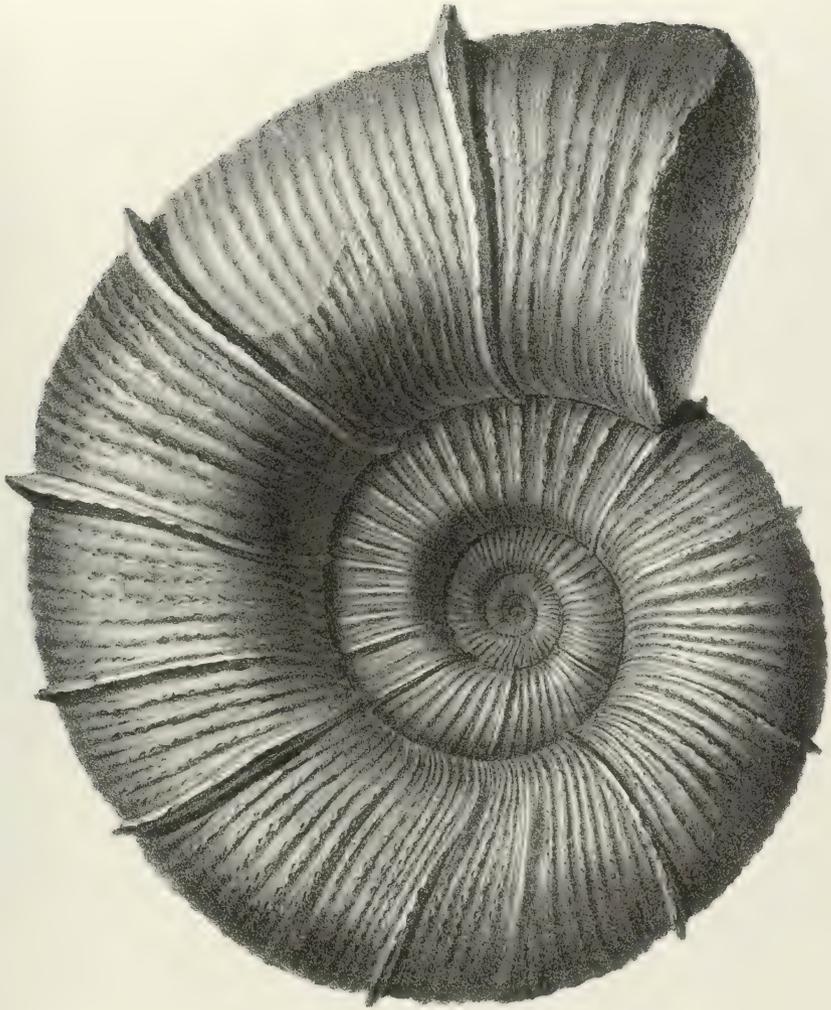


PLATE LXXII.

Zone of Amaltheus margaritatus.

- | | | |
|---------|-------------------------------------|---|
| Fig. 1. | LYCERAS FIMBRIATUM, <i>Sowerby.</i> | Lateral view, natural size, showing radii and fimbriæ. My collection. |
| 2. | — — — | Front view showing aperture. |
| 3. | — — — | Abdominal view, siphonal area, radii and fimbriæ natural size. |
| 4. | — — — | Accurate delineation of the complicated suture line, magnified. |

Fig 4

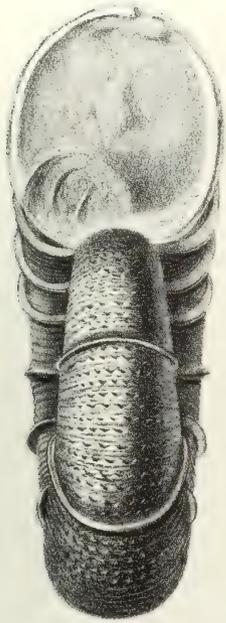
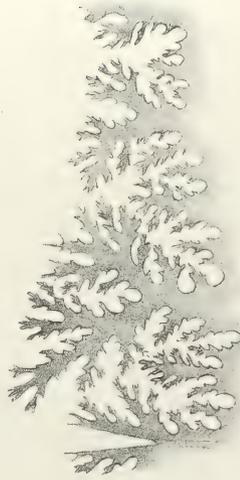


Fig 2

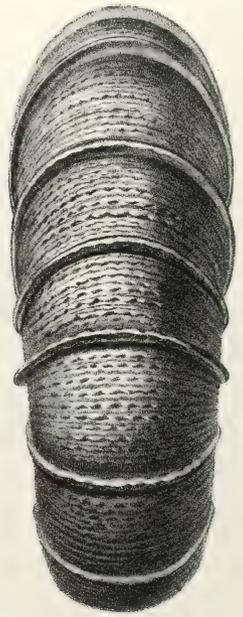


Fig 3

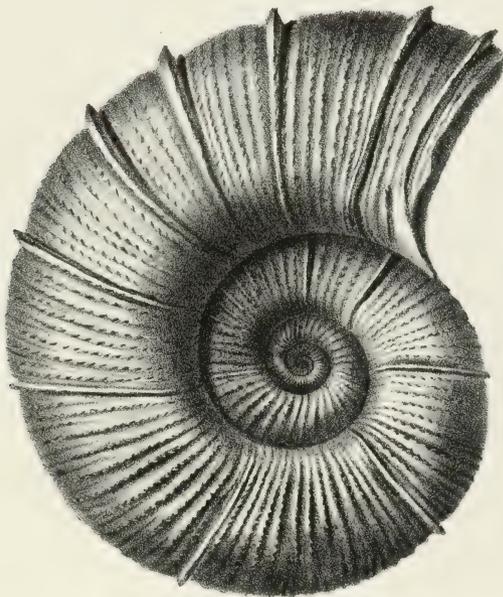


Fig 1.

PLATE LXXIII.

Zone of Harpoceras bifrons.

- Fig. 1. LYTOCERAS CORNUCOPIA, *Young*. Side view, one half natural size. Geneva
Museum.
- | | | | | |
|----|---|---|---|---|
| 2. | — | — | — | Front view showing siphonal area and aperture. |
| 3. | — | — | — | Suture line showing extreme complication,
magnified. |

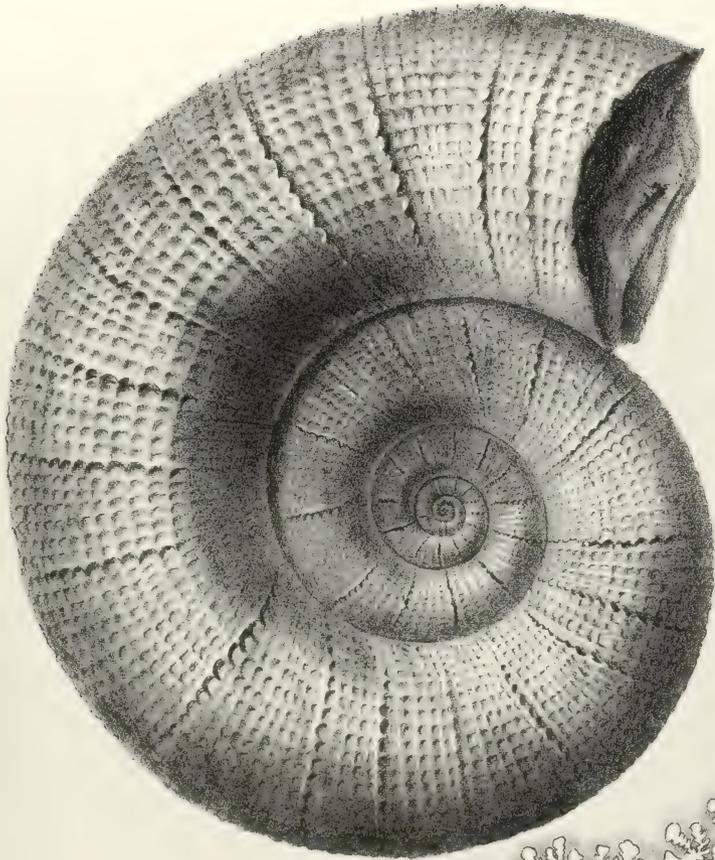


Fig 2

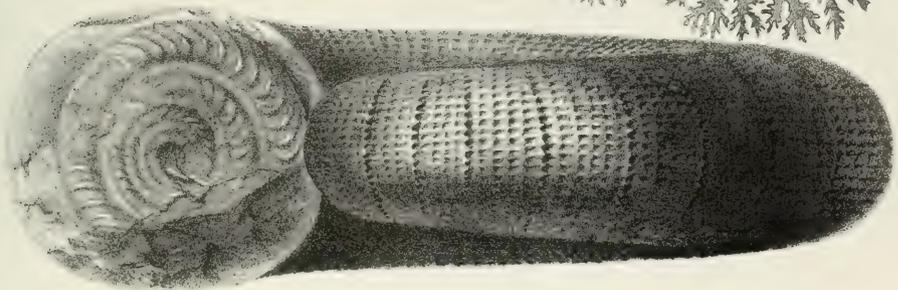


Fig 3

PLATE LXXIV.

Zone of Lytoceras Jurense.

- Fig. 1. HARPOCERAS RADIANUS, *Reinecke*. Side view, natural size. My collection.
2. — — — Front view, showing carina, siphonal area, and aperture.
3. LYTOCERAS JURENSE, *Zieten*. Side view, natural size. My collection.
4. — — — Front view of same.
5. — — — Abdominal view of same.

Fig. 2

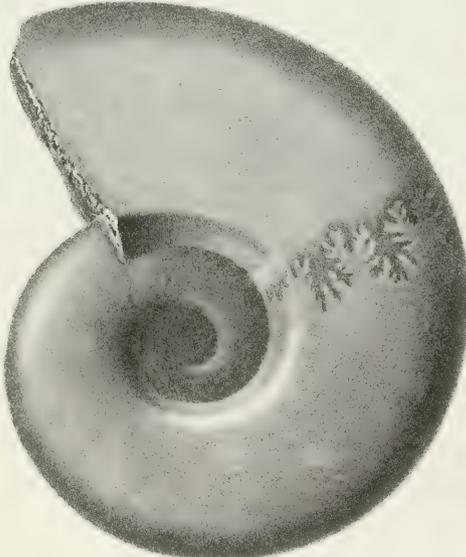
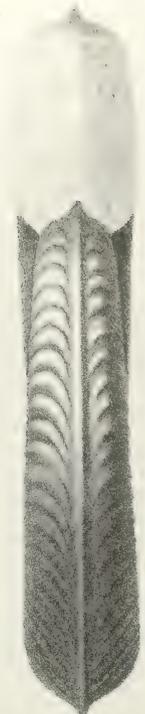


Fig. 4

Fig. 5

Fig. 3

PLATE LXXV.

Zone of Lytoceras Jurensis.

- Fig. 1. HARPOCERAS INSIGNE, *Schübler*. Abnormal young form, side view, natural size. My collection.
2. — — — Front view of same fossil.
3. — — — Abdominal view of do.
4. LYTOCERAS HIRCINUM, *Schlotheim*. Side view, natural size. School of Mines Museum.
5. — — — Abdominal view of same. do.
6. — — — Lateral view of another specimen, natural size. My collection.
7. — — — do. variety do. do.
8. HARPOCERAS AALENSE, *Zieten*. Lateral view, showing entire side processes to the aperture. Prof. Waagen's collection.
9. — — — Side view with prominent folds, natural size. My collection.
10. — — — do. do. Shell and position of suture line, natural size.

Fig 3



Fig 1

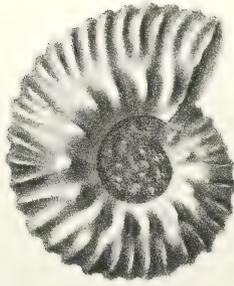


Fig 2



Fig 5



Fig 4

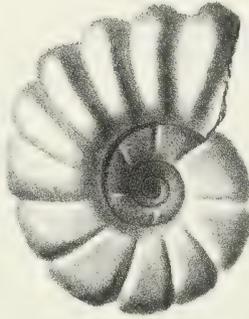


Fig 7



Fig 6



Fig 8

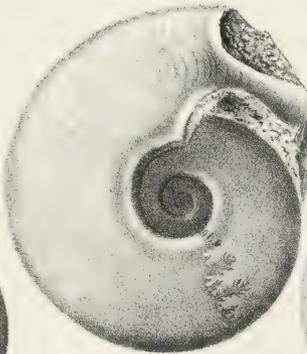


Fig 10

Fig 9

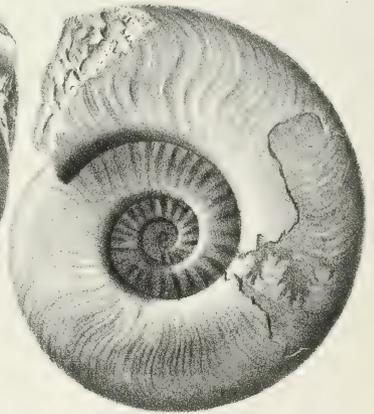


PLATE LXXVI.

- Fig. 1. PHYLLOCERAS BUVIGNIERI, *d'Orbigny*. Side view, natural size. Belfast Museum.
 2. — — — Siphonal area, natural size.
 3. — — — Suture-line magnified.
 4. LYTOCERAS TORULOSUM, *Schübler*. Fragment, natural size. My collection.
 5. — — — Siphonal area showing shell and striæ.
 do. do.
 6. — HIRCINUM, *Schlotheim*. Showing striæ and fimbriæ, natural size.
 My collection.

Fig 4



Fig 6



Fig 5



Fig 2

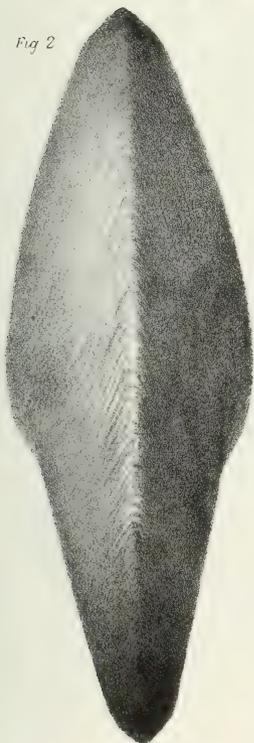


Fig 1

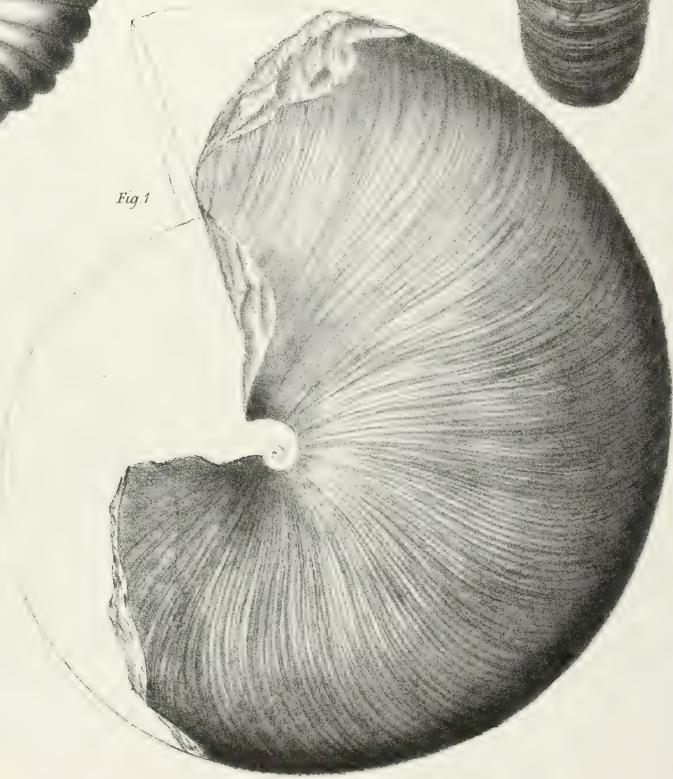


Fig 3



PLATE LXXVII.

- Fig. 1. PHYLLOCERAS ZETES, *d'Orbigny*. Side view, natural size. My collection.
2. — — — Front view, siphonal area and aperture.
3. — — — Suture-line, magnified.
4. — HETEROPHYLLUM, *Sowerby*. Suture-line magnified to compare
with that of *Phylloceras Zetes*.

Fig 1

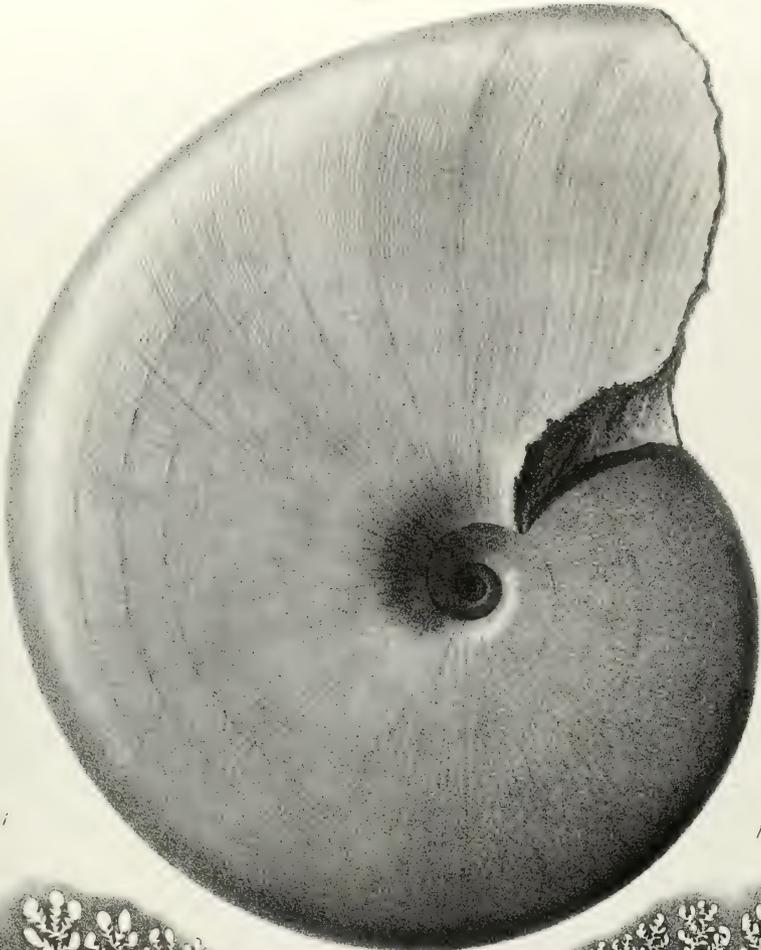


Fig 1

Fig 3

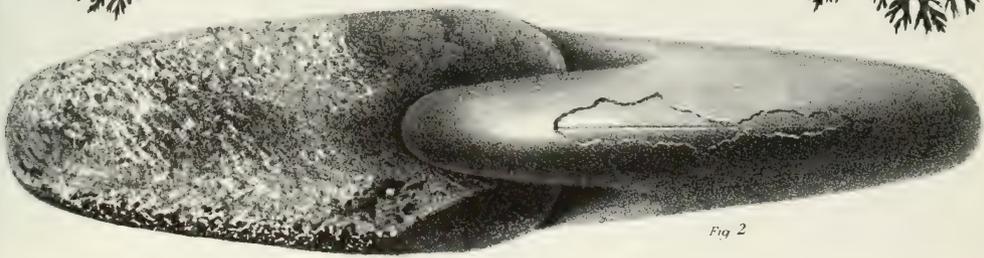
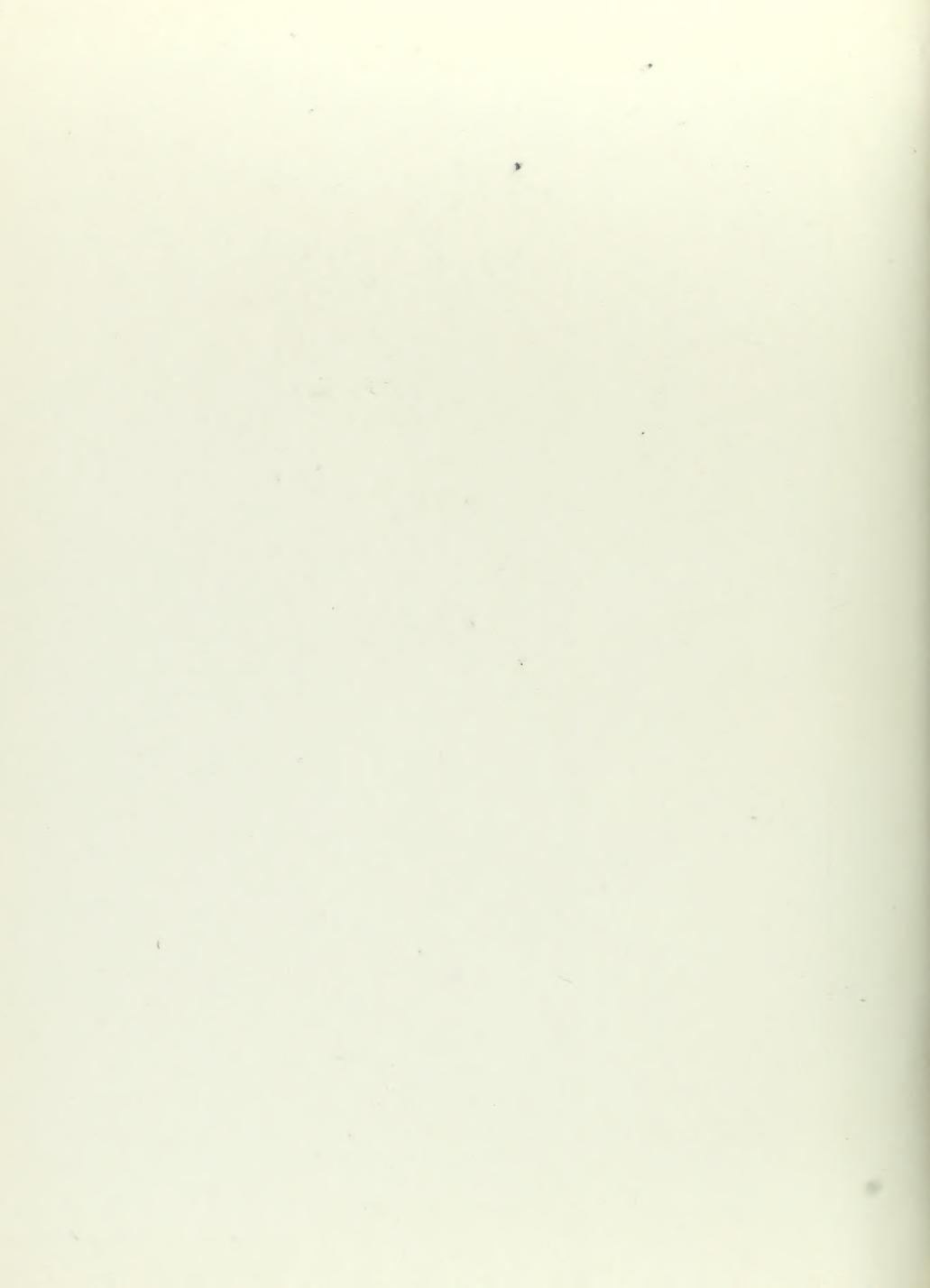


Fig 2



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