PALÆONTOGRAPHICAL SOCIETY.

VOL. XXVI.

SUPPLEMENT

TO THE

FOSSIL CORALS.

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ISSUED FOR 1872.

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AND

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

THE DATES OF ISSUE OF THE ANNUAL VOLUMES;

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

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

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„ XIX.*	„	1865	The Crag Foraminifera, Part I, No. 1, 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 Belemnitidæ, Part III, Liassic Belemnites, by Prof. Phillips, 13 plates.
„ XXI.*	„	1867	Flora of 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.

* These Volumes are issued in two forms of binding, first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous volumes are not in separate parts.

CATALOGUE OF WORKS—Continued.

Vol. XXII.* Issued for the Year	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 Belemnitidæ, 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 Belemnitidæ, Part V, Oxford Clay, &c., Belemnites, by Prof. Phillips, 9 plates. The Fishes of the Old Red Sandstone, Part I (concluded), by Messrs. J. Powrie and E. Ray Lankester, 9 plates. The Reptilia of the Liassic Formations, Part II, by Prof. Owen, 4 plates. The Crag Cetacea, No. 1, by Prof. Owen, 5 plates.
" XXIV.* "	1870	The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright, 10 plates. The Fossil Brachiopoda, Part VII, No. 4, Silurian, by Mr. Davidson, 13 plates. The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood, 5 plates. The Fossil Mammalia of the Mesozoic Formations, by Professor Owen, 4 plates.
" XXV.* "	1871	The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney, 6 plates. The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward, 5 plates. Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer, 7 plates and map. Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen, 3 plates The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs W. Boyd Dawkins and W. A. Sanford, 2 plates. The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins, 5 plates.
" XXVI* "	1872	Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan, with an Index to the Tertiary and Secondary Species, 7 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright, 5 plates. The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward, 10 plates. The Trigoniæ, No. I, by Dr. Lycett, 9 plates.

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* These Volumes are issued in two forms of binding, first, with all the Monographs stitched together and enclosed in The cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. one previous volumes are not in separate parts.

LIST OF MONOGRAPHS

Completed, in course of Publication, and in Preparation.

MONOGRAPHS which have been Completed:—

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne Edwards and J. Haime.
The Polyzoa of the Crag, by Mr. G. Busk.
The Tertiary Echinodermata, by Professor Forbes.
The Fossil Cirripedes, by Mr. C. Darwin.
The Tertiary Entomostraca, by Prof. T. Rupert Jones.
The Cretaceous Entomostraca, by Prof. T. Rupert Jones.
The Fossil Estheriæ, by Prof. T. Rupert Jones.
The Tertiary, Cretaceous, Oolitic, Liassic, Permian, Carboniferous, Devonian, and Silurian Brachiopoda, by Mr. T. Davidson.
The Mollusca of the Crag, by Mr. S. V. Wood.
The Great Oolite Mollusca, by Professor Morris and Mr. J. Lycett.
The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe.
The Fossils of the Permian Formation, by Professor King.
The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), by Professors Owen and Bell.
The Reptilia of the Cretaceous, Wealden, and Purbeck Formations, by Professor Owen.
The Fossil Mammalia of the Mesozoic Formations, by Professor Owen.

MONOGRAPHS in course of Publication:*—

The Flora of the Carboniferous Formation, by Mr. E. W. Binney.
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.
Supplement to the Fossil Corals, by Dr. Duncan.
The Echinodermata of the Oolitic and Cretaceous Formations, by Dr. Wright.
The Fossil Merostomata, by Mr. H. Woodward.

* 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.

MONOGRAPHS in course of Publication—*Continued.*

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

The Malacostracous Crustacea, by Professor Bell.

Supplement to the Crag Mollusca, by Mr. S. V. Wood.

The Trigoniæ, by Dr. Lycett.

The Eocene Mollusca, by Mr. S. V. Wood.

The Belemnites, by Professor Phillips.

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

The Reptilia of the Kimmeridge Clay, by Professor Owen.

The Reptilia of the Liassic Formations, by Professor Owen.

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

The Cetacea of the Crag, by Professor Owen.

* Unfinished through the death of the Author, but will be continued by Mr. H. Woodward.

MONOGRAPHS which are in course of Preparation :†—

The Flora of the Tertiary Formation, by Mr. W. S. Mitchell.

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

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

The Graptolites, by Professor Wyville Thomson.

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

The Palæozoic Polyzoa, by Dr. Duncan.

The Crinoidea, by Professor Wyville Thomson.

The Post-Tertiary Entomostraca, by the Rev. H. W. Crosskey and Messrs. G. S. Brady and D. Robertson.

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

The Bivalve Entomostraca of the Carboniferous Formations, by Messrs. T. Rupert Jones and J. W. Kirkby.

The Post-Tertiary Mollusca, by Mr. J. Gwyn Jeffreys.

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

The Purbeck Mollusca, by Mr. R. Etheridge.

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

The Rhætic Mollusca, by Mr. R. Etheridge.

The Liassic Gasteropoda, by Mr. Ralph Tate.

The Ammonites of the Lias, by Dr. Wright.

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

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

The Volume for	1847	was issued	to the	Members,	March, 1848.
„	1848	„	„	„	July, 1849.
„	1849	„	„	„	August, 1850.
„	1850	„	„	„	June, 1851.
„	1851	„	„	„	June, 1851.
„	1852	„	„	„	August, 1852.
„	1853	„	„	„	December, 1853.
„	1854	„	„	„	May, 1855.
„	1855	„	„	„	February, 1857.
„	1856	„	„	„	April, 1858.
„	1857	„	„	„	November, 1859.
„	1858	„	„	„	March, 1861.
„	1859	„	„	„	December, 1861.
„	1860	„	„	„	May, 1863.
„	1861	„	„	„	May, 1863.
„	1862	„	„	„	August, 1864.
„	1863	„	„	„	June, 1865.
„	1864	„	„	„	April, 1866.
„	1865	„	„	„	December, 1866.
„	1866	„	„	„	June, 1867.
„	1867	„	„	„	June, 1868.
„	1868	„	„	„	February, 1869.
„	1869	„	„	„	January, 1870.
„	1870	„	„	„	January, 1871.
„	1871	„	„	„	June, 1872.
„	1872	„	„	„	October, 1872.

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* OCTOBER, 1872): *showing in the* FIRST *column whether each Monograph hitherto published be* complete, *or in the* course of completion; *in the* SECOND *column, the yearly volumes which contain each particular Monograph (as a guide to binding the same); and in the* FOURTH *and following columns, the number of pages, plates, figures, and species described in the different Monographs.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
The Flora of the Carboniferous Strata, by Mr. E. W. Binney, in course of completion	1867, 1870, 1871	1868, 1871, 1872	96	18	110	15
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, in course of completion	1865	1866	78	4	211	43
Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, *complete* (*k*)	1849, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1855	406	72	800	319*g*
Supplement to the Fossil Corals, by Prof. Duncan, in course of completion	1865, 1866, 1867, 1868, 1869, 1872	1866, 1867, 1868, 1869, 1870, 1872	232	49	797	149
The Polyzoa of the Crag, by Mr. G. Busk, *complete*	1857	1859	115	22	641	122
The Tertiary Echinodermata, by Prof. Forbes, *complete*	1852	1852	39	4	144	44
The Oolitic Echinodermata, by Dr. Wright. Vol. I, *complete* (*l*)	1855, 1856, 1857, 1858	1857, 1858, 1859, 1861	474	43	724	109*h*
" " Vol. II, in course of completion	1861, 1864	1863, 1866	154	19	218	29
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, in course of completion	1862, 1867, 1869, 1870, 1872	1864, 1868, 1870, 1871, 1872	184	50	664	57
The Fossil Cirripedes, by Mr. C. Darwin, *complete*	1851, 1854, 1858*a*	1851, 1855, 1861	137	7	320	54
The Fossil Merostomata, by Mr. H. Woodward, in course of completion	1865, 1868, 1871, 1872	1866, 1869, 1872, 1872	180	30	219	35
The Tertiary Entomostraca, by Prof. Rupert Jones, *complete*	1855	1857	74	6	233	56
The Cretaceous Entomostraca, by Prof. Rupert Jones, *complete*	1849	1850	41	7	176	27
The Fossil Estheriæ, by Prof. Rupert Jones, *complete*	1860	1863	139	5	158	19*i*
The Trilobites of the Mountain-limestone, Devonian, Silurian, and other Formations, by Mr. J. W. Salter (incomplete through the Author's death)	1862, 1863, 1864, 1866	1864, 1865, 1866, 1867	216	31	703	114
The Malacostracous Crustacea (comprising those of the London Clay, Gault, and Greensands), by Prof. T. Bell, in course of completion	1856, 1860	1858, 1863	88	22	215	50
Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, *complete*	1850, 1852, 1853, 1854	1851, 1852, 1853, 1855	409	42	1855	160
" " Vol. II. The Permian and Carboniferous Brachiopoda, *complete*	1856*d*, 1857, 1858, 1859, 1860	1858, 1859, 1861, 1861, 1863	331	59	1909	157
" " Vol. III. The Devonian and Silurian Brachiopoda, *complete*	1862, 1863, 1865, 1866, 1868, 1870	1864, 1865, 1866, 1867, 1869, 1871	528	70	2766	321
The Trigoniæ, by Dr. Lycett, in course of completion	1872	1872	52	9	89	33
		CARRIED FORWARD...	4,003	569	12,982	1,913

Summary of the Monographs issued to the Members (*up to* OCTOBER, 1872)—*continued.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		Brought forward...	4,003	569	12,982	1,913
The Mollusca of the Crag, by Mr. S. V. Wood:—						
Vol. I. (Univalves), *complete*	1847, 1855*b*	1848, 1857	216	21	581	244
Vol. II. (Bivalves), *complete*	1850, 1853, 1855, 1858*c*	1851, 1853, 1857, 1861	344	31	691	253
Supplement to the Crag Mollusca, by Mr. S. V. Wood, in course of completion	1871	1872	130	7	221	111
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, in course of completion	1848, 1852, 1854, 1855, 1858	1849, 1852, 1855, 1857, 1861	332	33	578	161
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood, in course of completion	1859, 1862, 1870	1861, 1864, 1871	182	25	531	194
The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, *complete*	1850, 1853, 1854	1850, 1853, 1855	282	30	846	419
" " " Supplement by Dr. Lycett, *complete*	1861	1863	129	15	337	194
The Belemnites, by Prof. Phillips, in course of completion	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	128	36	622	69
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, *complete*	1853, 1854, 1855	1853, 1855, 1857	67	27	319	79
The Fossils of the Permian Formation, by Prof. King, *complete*	1849, 1854*e*	1850, 1855	287	29	511	138
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, in course of completion	1867, 1869	1868, 1870	62	14	195	21
The Reptilia of the London Clay [and of the Bracklesham and other Tertiary Beds], by Profs. Owen and Bell, *complete* ‡	1848, 1849, 1856*f*	1849, 1850, 1859	150	58	304	39
The Reptilia of the Cretaceous Formations, by Prof. Owen, *complete* ‡	1851, 1857, 1858, 1862	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden and Purbeck Formations, by Prof. Owen, *complete* ‡	1853, 1854, 1855, 1856, 1857, 1858, 1862, 1871	1853, 1855, 1857, 1858, 1859, 1861, 1864, 1872	170	65	260	17
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, in course of completion	1859, 1860, 1868	1861, 1863, 1869	16	6	23	3
The Reptilia of the Liassic Formations, by Prof. Owen, in course of completion	1859,‖ 1860,‖ 1863, 1869	1861, 1863, 1865, 1870	121	37	177	8
The Crag Cetacea, by Prof. Owen, in course of completion	1869	1870	40	5	43	7
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and Mr. W. A. Sanford, in course of completion	1864, 1867, 1868, 1871	1866, 1868, 1869	266	32	250	7
The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen, *complete*	1870	1871	115	4	247	30
		Total	7,224	1,103	20,237	3,933

a Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian. *e* Two corrections of Plates. *f* Supplement.
g Many of the species are described, but not figured. *h* British species only reckoned. *i* British species only reckoned. *k* A Supplement is now in course of publication.
l Wants Index. *m* Useful for establishing the dates of new species.
‡ Title-pages and Index will be found in the 1864 Volume, or may be had separately. ‖ Marked on outside label 'Reptilia of Oolitic Formations.'

STRATIGRAPHICAL TABLE *exhibiting the* BRITISH FOSSILS *already figured and described in the* ANNUAL VOLUMES (1847—1872) *of the* PALÆONTOGRAPHICAL SOCIETY.

	PLANTS.	PROTOZOA.		RADIATA.		ARTICULATA.						MOLLUSCA.				VERTEBRATA.		
		Sponges.	Foraminifera.	Corals.	Echinodermata.	Cirripedes.	Cypridæ, Cytherinæ, &c.	Estheriæ.	Merostomata.	Trilobites.	Malacostracous Crustacea.	Polyzoa.	Brachiopoda.	Monomyaria, Dimyaria, and Gasteropoda.	Cephalopoda.	Fishes.	Reptiles.	Mammalia.
Pleistocene ...	...	...	...	...	......	......	...	...	......	......	...	...	......	......	...	...	......	1864, 1867, 1868, 1871
Crag	...	...	1865	1849	1852	1851, 1854	...	...	......	......	...	1857	1852	1847, 1850, 1853, 1855, 1871	...	...	......	1869
Eocene	...	...	...	1849 1865	1852	1851, 1854	1855	...	......	......	1856	...	1852	1852, 1854, 1855, 1858, 1859, 1862 1870	1848	...	1848, 1849, 1856	
Cretaceous ...	...	...	...	1849 1868 1869	1862, 1867, 1869, 1870, 1872	1851, 1854	1849	...	......	......	1860	...	1852, 1854	1872	1853 1854 1855	...	1851, 1857, 1858, 1862	
Wealden	...	...	...	...	......	......	...	1860	......	......	...	...	......	......	...	...	1853, 1854, 1855, 1856, 1857, 1862, 1871	
Oolitic	...	...	...	1851 1872	1855, 1856, 1857, 1858, 1861	1851	...	1860	......	......	...	...	1850, 1852	1850, 1853, 1854 1872	1850 1861 1868 1869	...	(Purbeck) 1853, 1858 (Kim. Clay), 1859, 1860, 1868	1870
Liassic	...	...	...	1851 1866 1867	1855, 1856, 1858, 1861, 1864	......	...	...	......	......	...	...	1850, 1852	......	1863 1864 1866 1868	...	1859, 1860, 1863, 1869	
Triassic	...	...	...	...	......	......	...	1860	......	......	...	...	......	......	......	......	......	1870
Permian	1849	1849	1849	1849 1852	1849	......	1849	1860	......	......	...	1849	1849, 1856	1849	1849	1849	1849	
Carboniferous	1867 1870 1871	...	...	1852	......	......	...	1860	1872	......	...	...	1856, 1857, 1858, 1859, 1860					
Devonian	...	...	...	1853	......	....	...	1860	1865, 1868, 1872	1862	...	...	1862, 1863	......	...	1867 1869		
Silurian	...	...	...	1854	......	......	...	...	1868, 1871, 1872	1862, 1863 1864, 1866	...	...	1865, 1866 1868, 1870					
Cambrian	...	...	...	...	......	......	...	...	......	1864								

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

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1872.

LONDON:

MDCCCLXXII.

A MONOGRAPH

OF THE

BRITISH FOSSIL CORALS.

SECOND SERIES.

BY

P. MARTIN DUNCAN, M.B. Lond., F.R.S., F.G.S.,

PROFESSOR OF GEOLOGY TO, AND HONORARY FELLOW OF, KING'S COLLEGE, LONDON.

Being a Supplement to the

'Monograph of the British Fossil Corals,' by MM. Milne-Edwards *and* Jules Haime.

PART III.

Corals from the Oolitic Strata.

Pages 1—24; Plates I—VII.

(With a General Index to the Tertiary, Cretaceous, Oolitic, and Liassic Corals.)

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1872.

CONTENTS.

A MONOGRAPH

OF THE

BRITISH FOSSIL CORALS.

(SECOND SERIES.)

PART III.

1.—INTRODUCTION.

THIS Part concludes the description of the new species of Fossil Corals which have been discovered in the Secondary rocks of Great Britain and Ireland since the appearance of the Monograph by Messrs. Milne-Edwards and Jules Haime, of which this work forms the continuation.

It treats of the Corals from those Jurassic strata which are popularly known as the Oolites; and it will, of course, precede, in the arrangement of the volume, the parts relating to the Liassic Corals, which have already been published.

The following authors have contributed to our knowledge of the Oolitic Corals:—R. Plot, 'Nat. Hist. Oxfordshire,' 1676. J. Walcott, 'Descr. and Fig. of Petref. found near Bath,' 1779. Parkinson, 'Organic Remains,' 1808. W. Smith, 'Strata Identified,' 1816. W. Conybeare and W. Phillips, 'Outlines of the Geol. of Eng. and Wales,' 1822. Fleming, 'British Animals,' 1828. G. Young, 'Geol. Survey of York,' 1828. J. Phillips, 'Geol. of Yorkshire,' 1829. R. C. Taylor, 'Mag. Nat. Hist.,' 1830. S. Woodward, 'Synopt. Table of Org. Rem.,' 1830. E. Bennet, 'Cat. Org. Remains, Wilts,' 1837. Fitton, "Strata below the Chalk," 'Geol. Trans.,' 2nd series, 1843. Morris, 'Cat. of British Fossils,' 1843. M'Coy, 'Ann. Nat. Hist.,' 1848 (several essays). MM. Milne-Edwards and Jules Haime, 'Monog.' (Pal. Soc.), 1851. T. Wright, M.D., F.G.S., 'Cotteswold Club Trans.,' 1866.

An analysis of the work of these authors, with the exception of that of Dr. Wright, is found scattered over the pages of MM. Milne-Edwards and Jules Haime's "Monograph of the Oolitic Corals," Pal. Soc., 1851. No new species of fossil Corals have been described from the Oolitic rocks since that date until very recently. During the last year or two, however, I have added to the species already known five from the Great Oolite, and thirteen from the Inferior Oolite. A careful study of the *Thecosmiliæ* of the Inferior Oolite at Crickley has enabled me to distinguish five very remarkable varieties of *Thecosmilia gregaria*, M'Coy, sp., and to satisfy myself that the relations of the *Thecosmiliæ* of the Lias to the genera *Isastræa, Latimæandra,* and others were repeated in the Inferior Oolite. There are specimens of *Thecosmilia gregaria* in Dr. Wright's collection which, had I not had a considerable series to examine from other sources, might have been associated with Reuss's new genus *Heterogyra*, together with *Symphyllia* and *Latimæandra.* The relation of these genera (except *Heterogyra*) to *Montlivaltia* has been noticed in the first Report (Brit. Assoc. Report, Norwich, p. 106 *et seq.*), and there is a clear proof that the same phenomena of evolution may occur consecutively. That is to say, the St. Cassian *Montlivaltiæ* and *Thecosmiliæ* varied and became permanent, compound, and serial Corals of such genera as *Elysastræa, Isastræa,* and *Latimæandra;* then the Liassic *Thecosmiliæ* did the same; and now it is evident that a *Montlivaltia* of the Inferior Oolite occasionally took on fissiparous growth, and superadded to others a marginal gemmation and a serial growth, and evolved forms which cannot be distinguished from those of the genera above mentioned and *Symphyllia* and *Heterogyra.* There was evidently an inherent power of variation which declared itself in the same direction during the ages which witnessed the formation of the St. Cassian and the Liassic and the Lower Oolitic deposits; and it is impossible to deny a genetic value to these oft-repeated structural phenomena.

One of the *Thecosmiliæ* from the Inferior Oolite at Crickley, which I have named *Thecosmilia Wrighti,* is very closely related to one of the Lower Liassic species.

It is interesting to find the genus *Cyclolites* represented in the Inferior Oolite by two well-marked species, one of which is like the rest of the forms of the genus in shape, and the other is exceptional in its trochoid form. This last species has, however, all the other characteristics of the genus. The *Cyclolites* are extinct; they flourished in the earlier Cretaceous seas, and lasted during the Miocene. MM. Milne-Edwards and Jules Haime ('Hist. Nat. des Corall.') mention that the genus originated in the Jurassic age, but they produce no evidence to substantiate the assertion.

A form belonging to a new genus of the *Fungidæ* was found by Mr. Mansel at East Coker in the Inferior Oolite In general shape and in the arrangement of the calices the specimen resembles *Dimorphastræa;* but the existence of synapticulæ between the septa and between the costæ necessitates its association with the *Fungidæ.* There is a central calice, and the others are in a circle around it, being separated by long horizontal septo-costal prolongations; the whole is surrounded by an epitheca, and forms a turbinate shape, the free surface being flat and circular. This genus, which I have called *Dimorphoseris,* foreshadows the genera *Cyathoseris* and *Trochoseris* of the Lower Chalk.

Mr. Leckenby discovered the interesting specimens upon which I have founded the genus *Gonioseris*, one of the most extraordinary forms of the *Fungidæ* as yet described.

There are several new species of the genus *Thamnastræa*. *Thamnastræa Browni*, nobis, is remarkable for having in some specimens a long stalk surmounted by a knob-shaped head. The calices are small on the stalk, and very large on the head; so that when the form is examined before it is mature, there is a danger of producing two species instead of one. The stalk often attains the height of three or four inches, In other specimens there is no stalk, and the knob-shaped corallum is sessile.

A large specimen of *Thamnastræa Manseli,* nobis, Inferior Oolite, is pedunculate, short, and very expanded superiorly; the epitheca is well preserved, and the endothecal dissepiments can be seen. This is a very satisfactory species, and I have had it very carefully drawn, so that the suspiciously synapticular endotheca can be proved to be really dissepimental.

A specimen of *Cladophyllia Babeana* is remarkable from the disposition of the Corallites to combine and form serial and fissiparous calices as in *Thecosmilia*. Plate III, figs 1—4.

I am under great obligations to Dr. Holl, F.G.S., Mr. Mansell, F.G.S., Mr. R. Tate, F.G.S., Dr. Wright, F.G.S., Mr. T. C. Brown, Mr. Leckenby, F.G.S., and many other geologists, for the kind loan of specimens.

II. List of Species already described.

MM. Milne-Edwards and Jules Haime described the following Oolitic species[1] in their 'Monograph' (Pal. Soc.), 1851 :

Portland Stone.

1. *Isastræa oblonga*, Fleming, *sp.*

Coral Rag.

1. *Stylina tubulifera*, Phillips, *sp.*
2. — *De-la-Bechi*, Ed. & H.
3. *Montlivaltia dispar*, Phillips, *sp.*
4. *Thecosmilia annularis*, Fleming, *sp.*
5. *Rhabdophyllia Edwardsi*, M'Coy, *sp.*
6. *Calamophylla Stokesi*, Ed. & H.
7. *Cladophyllia cæspitosa*, Con. & Phil., *sp.*
8. *Goniocora socialis*, Römer, *sp.*
9. *Isastræa explanata*, Goldfuss, *sp.*
10. — *Greenoughi*, Ed. & H.
11. *Thamnastræa arachnoides*, Parkins, *sp.*
12. — *concinna*, Goldfuss, *sp.*
13. *Comoseris irradians*, Ed. & H.
14. *Protoseris Waltoni*, ,,

Great Oolite.

1. *Stylina conifera*, Ed. & H.
2. — *solida*, M'Coy, *sp.*
3. — *Ploti*, Ed. & H.
4. *Cyathophora Luciensis*, d'Orb., *sp.*
5. — *Pratti*, Ed. & H.
6. *Convexastræa Waltoni*, ,,
7. *Montlivaltia Smithi*, ,,

[1] There are three species common to the Great Oolite and the Inferior Oolite, and one is common to the Coral Rag, the Great and the Inferior Oolite.

8. *Montlivaltia Waterhousei*, Ed. & H.
9. *Calamophyllia radiata*, Lamouroux, *sp.*
10. *Cladophyllia Babeana*, Ed. & H.
11. *Isastræa Conybeari*, „
12. — *limita*, Lamouroux, *sp.*
13. — *explanulata*, M'Coy, *sp.*
14. — *serialis*, Ed. & H.
15. *Clausastræa Pratti*, „
16. *Thamnastræa Lyelli*, „
17. — *mammosa*, „
18. — *scita*, „
19. — *Waltoni*, „
20. *Anabacia orbulites*, Lamouroux, *sp.*
21. *Comoseris vermicularis*, M'Coy, *sp.*
22. *Microsolena regularis*, Ed. & H.
23. — *excelsa*, „

Inferior Oolite.

1. *Discocyathus Eudesi*, Michelin, *sp.*
2. *Trochocyathus Magnevillianus*, Michelin, *sp.*
3. *Axosmilia Wrighti*, Ed. & H.
4. *Montlivaltia trochoides*, „
5. — *tenuilamellosa*, Ed. & H.
6. — *Stutchburyi*, „
7. — *Wrighti*, „
8. — *cupuliformis* „
9. — *De-la-Bechi*, „
10. — *lens*, „
11. — *depressa*, „
12. *Thecosmilia gregaria*, M'Coy, *sp.*
13. *Latimæandra Flemingi*, Ed. & H.
14. — *Davidsoni*, „
15. *Isastræa Richardsoni*, „
16. — *tenuistriata*, M'Coy, *sp*
17. — *Lonsdalei*, Ed. & H.
18. *Thamnastræa Defranciana*, Michelin, *sp.*
19. — *Terquemi*, Ed. & H.
20. — *Mettensis*, „

21. *Thamnastræa fungiformis*, Ed. & H.
22. — *Maccoyi*, ,,
23. *Anabacia hemisphærica*, ,,

Mr. Walton has forwarded me *Zaphrentis ? Waltoni*, Ed. & H., from the Inferior Oolite at Dundry, which MM. Milne-Edwards and Jules Haime felt inclined to think was a *remanié* fossil. There is no doubt about the specimen being a *Zaphrentis*, and it is clear that it was derived from an older rock.

III. List of New Species.

Great Oolite.

Thecosmilia obtusa, D'Orb.
Cyathophora insignis, Duncan.
— *tuberosa* ,,
Isastræa gibbosa ,,
Thamnastræa Browni ,,

Inferior Oolite.

Montlivaltia Holli, Duncan.
— *Painswicki*, Duncan.
— *Morrisi* ,,
Thecosmilia Wrighti ,,
Symphyllia Etheridgei, ,,
Thamnastræa Walcotti, ,,
— *Manseli*, ,,
Gonioseris angulata, ,,
— *Leckenbyi*, ,,
Dimorphoseris oolitica, ,,
Cyclolites Lyceti, ,,
— *Beani*, ,,
Podoseris constricta ,,

Including M. d'Orbigny's species there appear to be eighteen new forms which may be added to those formerly described by MM. Milne-Edwards and Jules Haime in their Monograph of the Oolite Corals (Pal. Soc.).

IV. List of all the Species described.

The Oolite fauna may be described as follows :—

	Species.
Portland Stone	1
Coral Rag	14
Great Oolite	28
Inferior Oolite	36
	79

Portland Oolite.

Isastræa oblonga, Fleming, *sp.*

Coral Rag.

Stylina tubulifera, Phillips, *sp.*
— *De-la-Bechi*, Ed. & H.
Montlivaltia dispar, Phillips, *sp.*
Thecosmilia annularis, Fleming, *sp.*
Rhabdophyllia Edwardsi, M'Coy, *sp.*
Calamophyllia Stokesi, Ed. & H.
Cladophyllia cæspitosa, Con. & Phil., *sp*,
Goniocora socialis, Römer, *sp.*
Isastræa explanata, Goldfuss, *sp.*
— *Greenoughi*, Ed. & H.
Thamnastræa arachnoides, Parkinson, *sp.*
— *concinna*, Goldfuss, *sp.*
Comoseris irradians, Ed. & H.
Protoseris Waltoni, „

Great Oolite.

Stylina conifera, Ed. & H.
— *solida,* M'Coy, *sp.*
— *Ploti*, Ed. & H.
Cyathophora Luciensis, d'Orb., *sp.*
— *Pratti,* Ed. & H.

Cyathophora insignis, Duncan.
— *tuberosa* „
Convexastræa Waltoni, Ed. & H.
Montlivaltia Smithi „
— *Waterhousei* „
Thecosmilia obtusa, d'Orb.
Calamophyllia radiata, Lamouroux, *sp.*
Cladophyllia Babeana, d'Orb., *sp.*
Isastræa Conybeari, Ed & H.
— *limitata*, Lamouroux, *sp.*
— *explanata*, M'Coy, *sp.*
— *serialis*, Ed. & H.
— *gibbosa*, Duncan.
Clausastræa Pratti, Ed. & H.
Thamnastræa Lyelli, „
— *mammosa*, „
— *scita*, „
— *Waltoni* „
— *Browni*, Duncan.
Anabacia orbulites, Lamouroux, sp.
Comoseris vermicularis, M'Coy, *sp.*
Microsolena regularis, Ed. & H.
— *excelsa*, „

Inferior Oolite.

Discocyathus Eudesi, Michelin, *sp.*
Trochocyathus Magnevillianus, Michelin, *sp.*
Axosmilia Wrighti, Ed. & H.
Montlivaltia trochoides, „
— *tenuilamellosa*, Ed. & H.
— *Stutchburyi*, „
— *Wrighti*, „
— *cupuliformis*, „
— *De-la-Bechi*, „
— *lens*, „
— *depressa*, „
— *Holli*, Duncan.
— *Painswicki*, „
— *Morrisi*, „

Thecosmilia gregaria,[1] M'Coy, *sp.*
— *Wrighti*, Duncan.
Latimæandra Flemingi, Ed. & H.
— *Davidsoni*, „
Symphyllia Etheridgei, Duncan.
Isastræa Richardsoni, Ed. & H.
— *tenuistriatae*, M'Coy, *sp.*
— *Lonsdalei*, Ed. & H.
Thamnastræa Defranciana, Michelin, *sp.*
— *Terquemi*, Ed. & H.
— *Mettensis*, „
— *fungiformis*, „
— *Maccoyi*, „
— *Walcotti*, Duncan.
— *Manseli*, „
Gonioseris angulata, „
— *Leckenbyi*, „
Anabacia hemisphærica, Ed. & H.
Dimorphoseris Oolitica, Duncan.
Cyclolites Lyceti, „
— *Beani*, „
Podoseris constricta, „

V.—General relation of the Oolitic Coral-faunas.

The Oolitic Corals, as a whole, indicate the geographical conditions incident to reefs and atolls, and do not represent those bathymetrical states which the Upper and Middle Liassic coralliferous strata appear to have illustrated. A deep oceanic coral-fauna is not found amongst the relics of the Oolites, and the forms characteristic of the reefs are positively aggregated in an upper and lower mass at Crickley in the Inferior Oolitic beds.

Dr. Wright noticed some years since[2] an Oolitic coral-reef near Frith Quarry, on the northern spur of Brown's Hill, about two miles from Stroud. There is a corresponding

[1] The numerous forms I consider to belong to *Thecosmilia gregaria* are not mentioned or considered as species, although they have a very fair claim. There are three varieties very Symphyllian, and two very Heterogyran in their aspect, Pl. VII, figs. 12—15. There is a well-marked variety of *Montlivaltia trochoides* at Painswick in the Inferior Oolite.

[2] Dr. Wright has kindly sent me these details. See 'On Coral Reefs,' by T. Wright, M.D., F.G.S., Cotteswold Club. Transact.

reef on the opposite side of the valley, the whole of the intervening space having been excavated by denudation. The coral-bed consists of large masses of coralline limestone imbedded in a fine-grained cream-coloured mudstone. The corals are in a highly crystalline state, so that the genera and species are determined with difficulty. The bed is from fifteen to twenty feet in thickness, and forms one of the finest examples of fossil coral-reefs that Dr. Wright is acquainted with in the district. The bed may be traced along the escarpment, in a north-westerly direction, for several miles, to Witcomb and Crickley on the west, and to near Cubberley and Cowley on the east, where it was worked several years ago. Judging from the thickness of the bed, and the abundance of corals it contains, it must have formed a barrier-reef of considerable magnitude in the Jurassic sea. The following is a section showing the relative position of the Lower Coral-reef.

Section of the Lower Coral-reef, in the Inferior Oolite, at the Quarry, North Frith Wood, near Brown's Hill, Gloucestershire.

Lithological Characters and Thickness.	Beds.	Organic Remains. Leading Fossils.
	Upper Freestones.	
Cream-coloured Marl, with several inconstant layers of Mudstone, upper part passing into a loose, friable Freestone, with large *Terebratula fimbria*. From 20 to 25 feet.	Oolite-marl. Middle Coral-bed.	*Thamnastræa, Isastræa, Axosmilia, Terebratula fimbria, T. carinata, T. maxillata, Rhynchonella Lycetti, Lucina Wrighti, Lima pontonis.*
Fine-grained oolitic Limestone, very white, and emitting a metallic ring when struck with a hammer. 40 to 50 feet.	Freestones.	Shelly fragments, not determinable.
Coarse brown ferruginous Oolite.	Lower Ragstones.	*Terebratula plicata.*
Masses of Coralline Limestone, imbedded in a light-coloured Mudstone; the Corals highly crystalline, forming the chief part of the bed. 15 to 25 feet.	Lower Coral-reef.	*Latimæandra, Thamnastræa, Isastræa, Axosmilia, Thecosmilia, Pecten Dewalquei, Trichites, Lucina Wrighti.*
Brown ferruginous pisolitic rock. Pea-grit structure not much exposed.	Pea-grit.	*Lima sulcata, Hinnites abjectus, Ceromya Bajociana, Avicula complicata, Nerita costata, Trochotoma carinata, Pygaster, Hyboclypus, Diadema.*

The Middle Coral-bed is included in the Oolite-marl, and in some localities, as at Frith, Leckhampton, Sheepscombe, and others, it contains masses of corals.

The Upper Coral-reef occupies the horizon of the Upper Trigonia Grit, and is very well exposed in many sections. That of Cleeve Hill has yielded the best corals. The following section is open near Frith. Ascending the bank above this quarry for a short distance some fields or arable land are passed over, on which are several heaps of the Upper Ragstones, with *Trigonia costata, Gryphæa subloba,* and other shells of the higher zone. Walking in the direction of the Grove, after passing over the summit of the hill and descending a short distance, a good section of the upper reef may be seen in the Slad Valley.

Section of the Quarry at Worgin's Corner, Upper Zone of Inferior Oolite.[1]

Lithology.	Beds.	Organic Remains.
Masses of Coralline Limestone, 4 feet thick.	UPPER CORAL-REEF.	*Thamnastræa, Isastræa, Thecosmilia, Magnotia Forbesi, Stomechinus intermedius, Pecten, Trigonia costata.*
Hard shelly Limestone, full of the shells of Brachiopoda, 5 feet.	TEREBRATULA-GLOBATA BED.	*Terebratula globata, Rhynchonella spinosa, Pholadomya fidicula, P. Heraulti, Ostræa, Gervillia, Trichites.*
Hard shelly sandy Oolite, full of *Gryphæa*, 6 feet.	GRYPHÆA BED.	*Gryphæa subloba, Lima proboscidea.*

The remarkable varieties of *Thecosmilia gregaria,* which resemble the genus *Symphyllia* and *Heterogyra,* are found principally in the lower reef, but they exist in the upper also. Some species appear to be peculiar to the different reefs, but it is unsafe to form lists at present. There is evidently a considerable affinity between the faunas of the reefs, and there is nothing to indicate anything more than a temporary absence from and a return of the species to an area.

[1] See Dr. Wright's pamphlet, from which the whole of this description is abstracted.

The corals of the Great Oolite are found in the Upper Ragstones underlying the Bradford Clay. Near Bath large masses of *Calamophyllia radiata* are associated with the roots, stems, and heads of *Apiocrinites rotundus*, Mill., which flourished like a miniature forest on the reef, and luxuriated amongst the polypes until the clear water was invaded by a current charged with mud, which destroyed the Encrinites and the Corals also.[1]

The Coral Rag in Wiltshire is divisible into (1) Upper Calcareous Grit, (2) Coral Rag, (3) Clay, (4) Lower Calcareous Grit. It is in the Coral Rag proper (2) that the Coral-beds are found. Of these Mr. Lonsdale[2] remarks: "The irregular beds of Polyparia consist of nodules or masses of crystallized carbonate of lime, which afford, invariably, evidences of the labours of the Polypus; and associated with them are others of earthy limestone, which bear only partial proofs of an organic origin. The whole are connected by a pale bluish or yellowish stiff clay. It happens frequently that a bed is composed of one genus of Polyparia."

In Yorkshire the Coralline Oolite is well developed, and several reefs are found at Hackness, Ayton, Seamer, &c. John Leckenby, Esq., F.G.S., of Scarborough, gives the following details (see Dr. Wright, *op. cit.*):—

"In various parts of the district occupied by the Coralline Oolite around Scarborough are found patches of coral-reef, sometimes occupying an area of fully an acre; and, although never attaining an altitude so high as the beds on the inclined surfaces of which they rest, they are truly the uppermost beds of the formation.

"They are sometimes from ten to fifteen feet in thickness, and consist of a series of layers of crystallized coral, from eighteen to twenty-four inches in thickness, of the species *Thamnastræa concinna*, Goldf. (which is the *Th. micraston*, Phillips), each layer being separated by rubbly clay and mud, in all probability the decomposition of each successive reef. The rock is quarried to supply material for repairing the roads of the district; but it is by no means so well adapted for the purpose as the adjacent calcareous grit, which, at the cost of a little additional labour, would furnish a material much more durable. The crystalline coral-reef is quickly ground to powder, and its use affords less satisfaction to the traveller than to the geologist, as the blocks which are stored up for use along the sides of the road yield many a handsome specimen to adorn his collection.

"The largest deposit is near the village of Ayton: there are others not quite so extensive; one near the village of Seamer, another close to the hamlet of Irton, and others in the neighbourhood of Wykeham and Bromptom—the intervening distances being about a mile in every case."

Messrs. Leckenby and Cullen visited the coral-reefs of the Coralline Oolite near Scarborough with Dr. Wright, who writes as follows:—

[1] Dr. Wright, *op. cit.*

[2] "Oolitic District of Bath," 'Trans. Geol. Soc.,' 2nd ser. vol. iii, p. 261.

"One quarry, near Ayton, which may be considered as a type of the others, consisted of masses of crystalline coralline limestone, the beds having an irregular undulating appearance. The corals appear to have grown in areas of depression of the coralline sea; the rock consists of large masses of highly crystalline limestone, forming nodulated eminences and concave curves, in beds of from twelve to eighteen inches in thickness, having a stratum of yellowish clay filling up the hollows, and forming a horizontal line again to the stratification; then follows another stratum of crystalline limestone, which assumes the same nodulated condition as the one below it, the surface of the coral masses, where exposed, showing that the whole is almost entirely composed of a small-celled *Astræa, Thamnastræa concinna,* Goldf. (*Th. micraston,* Phillips), in some altered condition; the reef is exposed to about ten feet in section, and rests on another, forming the floor of the quarry, and which descends many feet deeper. The corals are bored by *Gastrochænæ,* and numerous shells were seen imbedded in the coral mass, which had nestled in the crannies of the reef."

Dr. Wright sums up with regard to the French, German, and British strata of the Étage Corallien as follows:—

"From this general view of the geographical distribution of the Coralline Zone, it would appear that this formation was composed of a series of coral-reefs in the Jurassic sea, which, during the period of their construction, occupied a large portion of the region now constituting the soil of modern Europe; and that the bed of the Jurassic sea was a slowly subsiding area of great extent, like many parts of the Coral Sea in the Indo-Pacific Ocean of our day."[1]

The restriction of species to very definite areas, and to limited zones amongst these succeeding coral-reefs, is very remarkable, and, as was noticed to occur in the Lias, the corals are occasionally persistent, and are associated with different molluscan species. But the physico-geological changes which produced new reefs must have been preceded by considerable geographical changes, for, as a rule, the species of the grand divisions of the Jurassic system are different. *Thecosmilia Wrighti* of the lower reef of the Inferior Oolite has considerable resemblance to the *Thecosmiliæ* of the Inferior Lias; but no Liassic species pass upwards into the Oolites. Only four species are common to the Inferior and Great Oolites, and one to the Coral Rag and Great Oolite; yet there was a succession of the physico-geographical conditions favorable for the formation of reefs on the same area. The existence of reefs in so high a latitude during the Oolitic Period, and their formation by polypes whose genera were all extinct during the early Cainozoic Period, but which are clearly represented by allied genera in the existing reefs, are very suggestive. These were the last reefs of the British area; for there are no traces of agglomeration of reef-building genera in the Lower Greensand, the Gault, Upper Greensand, Chalk, or Tertiary formations. The nearest approach to a reef must have been in the Lower Oligocene

[1] Dr. Wright, *op. cit.*

period, when the Tabulate Corals and *Solenastraeæ* of Brockenhurst formed a small outlier of the European coral sea of the time between the Nummulitic and the earliest Falunian age.[1]

VI. Description of New Species from the Great Oolite.

MADREPORARIA APOROSA.

Family—ASTRÆIDÆ.

Genus—Thecosmilia.

1. Thecosmilia obtusa, *D'Orbigny*, sp. Pl. I, figs. 1—4.

The corallum is short.

The calices sometimes remained united in short series.

The fossula is shallow.

Some sixty septa may be counted in the series. The margin of the septa is oblique and delicately toothed; and their sides are covered with delicate striæ, which are radiating and projecting.

The English locality is in the Great Oolite, Cirencester. MM. Milne-Edwards and Jules Haime give the following French localities:—Villers (Calvados), Neuvizi (Ardennes) in the Group Oolite Moyen.

In the Collection of T. C. Brown, Esq.

Genus—Cyathophora.

2. Cyathophora insignis, *Duncan.* Pl. I, figs. 9—11.

The corallum is massive, and in layers.

The calices are unequal, not equally distant from each other, circular, and they do not project above the inter-calicular surface generally, but in some instances they form cribriform projections.

The costæ cover the inter-calicular surfaces, are sub-equal, wavy, and long.

The septa are very short, and do not reach far into the calice; there are three cycles in six systems, and the primary septa, which do not project much more than the secondary, are the largest.

[1] P. M. Duncan, "Coral Faunas of Western Europe," &c., 'Quart. Journ. Geol. Soc.,' No. 101, p. 51.

The base of the calicular fossa is formed by a broad tabulate dissepiment.

Diameter of the calices $\frac{1}{20}$th to $\frac{1}{8}$th inch.

Locality. Great Oolite, Cirencester.

In the Collection of T. C. Brown, Esq.

3. CYATHOPHORA TUBEROSA, *Duncan.* Pl. III, figs. 15—18.

The corallum is tuberose, and the base is contracted and small.

The corallites are numerous, not crowded, unequal, and are separated by much exotheca.

The calices are circular, slightly crateriform, and raised, and the primary septa encroach upon the central space, which is shallow.

The costæ are unequal and long, and the calicular wall projects between the primary and secondary septa to produce tertiary costæ, which have no corresponding septa.

The septa are unequal, and there are six systems and two cycles.

Height of corallum $1\frac{1}{2}$ inch. Breadth of calices $\frac{1}{10}$th inch.

Locality. Great Oolite, Cirencester.

In the Collection of T. C. Brown, Esq.

Genus—ISASTRÆA.

4. ISASTRÆA GIBBOSA, *Duncan.* Pl. II, figs. 10, 11.

The corallum is gibbous, and the corallites are excessively crowded.

The calices are depressed, irregular in shape, and have a broad margin, and are shallow.

The septa are sub-equal, crowded, short, and marked with lateral ornamentation of a moniliform character. There are six systems and three cycles.

The central fossa is encroached upon by the larger septa, which do not meet with their central margins.

Diameter of largest calices $\frac{1}{8}$th inch.

Locality. Great Oolite, Cirencester.

In the Collection of T. C. Brown, Esq.

FAMILY—FUNGIDÆ.

Genus—THAMNASTRÆA.

1. THAMNASTRÆA BROWNI, *Duncan*. Pl. II, figs. 1—5.

The corallum is variable in shape, and appears in two series of orms: 1st, as a nearly globular mass with a very small base; 2nd, as a pillar-shaped corallum, terminating in a knob.

The calices are large, and have wide and rounded margins; they are shallow, and do not present any appearance of columellæ.

The septa are large, unequal, broadly dentate, arched, and not crowded. There are six systems and four incomplete cycles.

The costæ pass down the base of the corallum in long, parallel, wavy lines; they are sub-equal, broadly dentated above, and most so below, where they become more equal and more level.

The epitheca is scanty, but covers the costæ here and there.

Breadth of calices $\frac{3}{10}$ths inch.

Locality. Great Oolite, Cirencester.

In the Collection of T. C. Brown, Esq., and in the British Museum.

VII. DESCRIPTION OF NEW SPECIES FROM THE INFERIOR OOLITE.

FAMILY—ASTRÆIDÆ.

Genus—MONTLIVALTIA.

1. MONTLIVALTIA HOLLI, *Duncan*. Pl. I, figs. 5—8.

The corallum is cornute, tall, and slightly compressed laterally.

The epitheca is very strong and plain, but marked with transverse folds and slight costal striæ.

The calice is elliptical, rather deep, open, and has a thin margin.

The septa are very unequal as regards the higher orders, but the primary and secondary are equal, slightly exsert, and convex on the upper margin. They are moderately prominent in the calicular fossa. The other septa are much smaller. There are six systems and four cycles in each and part of the fifth. The appearance is that of twelve systems of three cycles.

Height of corallum $1\frac{1}{2}$ inch. Length of calice $\frac{6}{10}$ths inch.

Locality. Oolite-marl, Painswick.

In the Collection of Dr. Holl, F.G.S.

Calicular gemmation is frequent.

2. MONTLIVALTIA PAINSWICKI, *Duncan.* Pl. I, fig. 12.

The corallum is rather flabelliform, compressed, especially inferiorly, has a narrow but elongated base, with the remains of former adhesion, and an elliptical and deep calice.

The epitheca is very strong, transversely ribbed, and folded, moreover, inferiorly; there is a projection on either side of the base.

The calicular margin is broad and rounded.

The septa are numerous, unequal, not exsert, crowded, and some are attached to others near the central space.

There are six systems of septa and five cycles, with some orders of the sixth in each.

Height of corallum $\frac{7}{10}$ths inch. Length of calice $\frac{9}{10}$ths inch.

Locality. Oolite-marl, Painswick.

In the Collection of Dr. Holl, F.G.S.

3. MONTLIVALTIA MORRISI, *Duncan.* Pl. II, fig. 13.

The corallum is turbinate, the base is slender and conical, and the calicular margin is deformed, and more or less oval. The corallum expands above.

The calice is deep; its margin is rounded, rather sharp, and there is no columella.

The septa are stout, numerous, unequal, long, and curved. The larger septa unite deep in the fossa in a kind of whorl.

There are six systems and five cycles, with part of the sixth.

The corallum is often deformed by arising close to others.

Height of corallum $\frac{9}{10}$ths inch. Breadth of calice $\frac{12}{10}$ths inch.

Locality. Inferior Oolite.

In the Collection of the Royal School of Mines.

Genus—THECOSMILIA.

1. THECOSMILIA WRIGHTI, *Duncan.* Pl. V, figs. 1—5.

The corallum is large, massive, and irregular in shape.

The corallites are cylindrical and increase very slightly in their calices during their growth. They do not remain long united after fissiparity and budding, and they form an aggregate of rather short tubes which are not united by a common epitheca.

The epitheca of each corallite is dense and marked with lateral lines, but it is usually worn off here and there so as to show the costæ which are delicate, straight, numerous, and subequal.

The calices are usually slightly elliptical and the epitheca reaches to them. They are not of greater diameter than the corallites.

The septa are few in number and probably do not attain the full complement of the fourth cycle. The primary septa are the largest, but in some calices the secondary equal them in size.

The columella is rudimentary.

Length of calices $\frac{1}{2}$ inch (largest). Height of corallite 2 inches.

Locality. Crickley. Inferior Oolite.

In the Collection of Dr. Wright, F.G.S., Cheltenham.

2. Thecosmilia gregaria, *M^cCoy*, sp. Pl. VI, figs. 1—4.

This common species appears to vary greatly in some districts, and Dr. Wright, of Cheltenham, has a series which appears to gradate towards and into the genus *Symphyllia.* The figures explain this tendency, but the calices of fig. 1 are rather too much levelled internally. Fig. 2 represents the calices on the outside of the corallum.

Locality. Crickley.

In the Collection of Dr. Wright, F.G.S., Cheltenham.

Genus—Latimæandra, *Ed. & H.*

1. Latimæandra Flemingi. *Ed. & H.* Pl. V, figs. 6, 7.

A fine specimen of this Lower Oolite form is delineated in plate V. The magnified view (fig. 7) shows a calice in which gemmation has taken place very remotely from the centre. Many portions of the corallum do not present serial calices, and if such fragments were found separate they would necessarily be associated with the genus *Isastræa.* The *Latimæandræ* may be regarded as modified *Isastræa;* but most probably they descended from *Thecosmiliæ.*

Genus—Symphyllia, *Ed. & H.*

1. Symphyllia Etheridgei, *Duncan.* Pl. VI, figs. 5—8.

The corallum is nodular in shape; the base is uneven, and the sides and upper surface are irregular, convex, and gibbous. The remnants of a basal epitheca exist and the costæ of the calices end in a wall with which the costæ of the base are continuous (fig. 8).

The calices are irregular in shape and size, and often form short series. The intercalicular spaces are broad, and are marked by the costæ which are continuous with the septa.

The septa are numerous, very unequal, and crowded. The larger reach to the columellary space, and the small are almost rudimentary.

In small calices the fifth cycle is incomplete.

The columella is small and not always visible.

The dissepiments are close and join the septa so as to resemble synapticulæ.

Height of corallum $1\frac{3}{4}$ inch.

Breadth of corallum $2\frac{3}{4}$ inch.

Breadth of calices $\frac{4}{10}$ths to $\frac{6}{10}$ths inch.

Locality. Crickley. Inferior Oolite.

In the Collection of Dr. Wright, F.G.S., Cheltenham.

This is the earliest representative of the genus *Symphyllia,* and its derivation from a *Thecosmilia* does not admit of much doubt.

Family—FUNGIDÆ.

Genus—Thamnastræa.

1. Thamnastræa Walcotti, *Duncan.* Pl. IV, figs. 5—10.

The corallum is moderate in size and of a flat conical shape.

The apex of the cone is truncated and forms the inferior part or peduncle of the corallum which was adherent.

The base of the cone is inferior and is flat, and there is a tendency to inequality and curving of the margins.

The epitheca is well developed, rigid, and marked with transverse lines; where abraded it permits the subequal moniliform costæ to be seen and their connecting synapticulæ.

The calices are large, flat, shallow, and tolerably well defined, and are separated by much cœnenchyma covered with costæ.

The columella is distinct and formed by one pimple-shaped mass.

The septa are in very unequal systems, and there are three incomplete cycles. They are short, rather moniliform, perforated on their free margins, marked with lateral synapticulæ, and end in larger or shorter costæ, which are continuous with the septa of neighbouring calices.

The endotheca is fully developed, and is partly in the form of synapticulæ and partly of dome-shaped dissepiments.

Height of corallum $\frac{9}{10}$ths inch.

Breadth of calicular surface $2\frac{1}{2}$ inches.

Breadth of calices $\frac{3}{10}$ths inch.

Locality East Coker. Inferior Oolite.

In the Collection of W. Mansel, Esq., F.G.S.

2. Thamnastræa Manseli, *Duncan*. Pl. IV, figs. 11—14.

The corallum is small and conical, with a rounded apex, which is inferior, and a circular flat but slightly gibbous upper or calicular surface.

The epitheca is distinct and is marked with transverse lines, and where abraded permits the costæ to be seen.

The costæ are numerous, alternately large and small, slightly apart, and are connected by numerous synapticulæ.

The calices are numerous, small, nearly circular, shallow, and are separated by distinct nodular elevations of cœnenchyma.

The septa are distinct, rather moniliform, unequal, and more or less continuous with those of the neighbouring calices. They are broader externally than within the calice, and the larger unite more or less to form a false columella.

The costæ on the calicular surface are wavy and moniliform.

There are six systems of septa and usually some orders of the fourth cycle in addition to the complete but very irregularly disposed third cycle.

The endotheca is abundant and assumes the synapticular form.

Height of corallum $\frac{7}{10}$ths inch.

Breadth of calicular surfaces $1\frac{3}{10}$ths inch.

Breadth of calices about $\frac{1}{10}$th inch.

Locality. East Coker. Inferior Oolite.

In the Collection of W. Mansel, Esq., F.G.S.

Genus nov.—GONIOSERIS.

The corallum is simple and free.

The base is polygonal in outline and the projecting angles are formed by groups of costæ terminating in septa. Between the angles the margin is concave externally. The centre of the base is concave.

The costæ are numerous and they cover the base. Many converge at each angle along a line leading from the large septum to the centre.

The upper surface of the corallum is convex, and is divided by masses of septa which are continuous with the angles of the base, and which, after projecting there, become exsert and pass to the axial space where they meet.

There is a large, prominent, primary septum in each mass.

The calicular wall is invisible. The synapticulæ are broad and numerous.

This extraordinary genus is represented by two forms in the Inferior Oolite. Probably the normal number of projecting angles is six, but in one specimen there are five, and a careful examination of it tends to prove that there was no abortion of a septum, but that the quinary arrangement was initiated from the first.

The type is *Gonioseris angulata* nobis. Probably the small specimen delineated in the same plate is a young form of it. Plate VII, figs. 10—11. The third specimen I have called *Gonioseris Leckenbyi* after the discoverer of these fossils.

1. GONIOSERIS ANGULATA, *Duncan*. Pl. VII, figs. 1—5.

The base is hexagonal, and the projecting angles are connected by marginal concavities. The space between the central concavity of the base and the margin is broad and slightly convex.

The costæ are of two kinds—those which pass from the concave margins to the concavity of the base, and those which pass from the margin near the angles to a line directed from the angle to the base. All the costæ are thin, slightly crenulate, alternately large and small; and they are all continuous with the septa. Each septal mass, which forms one of the six angles, consists of a large primary septum and several small septa associated on either side. The mass projects upwards and outwards from the base, and then curves inwards and slightly upwards to the axial space. The spaces between the six masses are convex from within outwards and concave from side to side.

There are six large primary septa; and the others are subequal, long, thin, crenulate, and uniting.

There is no columella, but the large septa and many of the small appear to unite over the axial space.

The synapticulæ are not numerous, and are delicate.

Height of corallum $\frac{6}{10}$ths inch.

Extreme length $1\frac{1}{2}$ inch.

Locality. Millepore bed, Cloughton Wyke, near Scarborough.

In the Collection of John Leckenby, Esq., F.G.S.

2. Gonioseris Leckenbyi, *Duncan.* Pl. VII, figs. 6—9.

The corallum is pentagonal.

The costæ are thick.

The concavity of the base is angular in outline.

The septal masses at the angles are formed by small septa, which converge towards the large costæ.

Height of corallum $\frac{1}{10}$ths inch.

Length $1\frac{7}{10}$ths inch.

Locality. Millepore bed, Cloughton Wyke, near Scarborough.

In the Collection of John Leckenby, Esq., F.G.S.

Genus nov.—Dimorphoseris.

The corallum is compound, turbinate, and adherent.

The epitheca is dense and faintly striated, but in no way incised or plicated.

The calicular surface is slightly concave and circular in outline.

There is a large central primary calice, and one or more concentric rows of calices at some distance from the primary.

The septa are continuous and moniliform.

There is no columella.

The secondary calices increase by fissiparous division.

1. Dimorphoseris oolitica, *Duncan.* Pl. IV, figs. 1—4.

The corallum is turbinate, and has a small peduncle and a large and slightly concave calicular surface.

The central calice is large, and about twenty-four septa enter into its composition, but there are many others just outside.

The fossa is shallow.

The septa are ornamented with elongated, bead-shaped projections, and their costal prolongations are very long, and are also ornamented in the same manner.

Some of the external costæ on the calicular surface bifurcate, and even divide into three portions. Usually the costæ are subequal and the synapticulæ are very numerous and distinct.

Height of corallum 1 inch.

Breadth of calicular surface $1\frac{3}{4}$ inch.

Locality. East Coker. Inferior Oolite.

In the Collection of W. Mansel, Esq., F.G.S.

Genus—Cyclolites.

1. Cyclolites Lyceti, *Duncan.* Pl. III, figs. 7—9.

The corallum is small, pedunculate, depressed, and nearly flat, and the calicular margin is everted and elliptical.

The epitheca is strongly marked, and is in folds.

The calicular fossa is in the centre of the calicular surface.

The septa are very numerous, alternately large and small, and are delicately ornamented with moniliform projections.

The calice is slightly convex.

Height of the corallum $\frac{4}{10}$ths inch.

Length of the calice $1\frac{2}{10}$ths inch.

Locality. Inferior Oolite.

In the Collection of Dr. Holl, F.G.S.

2. Cyclolites Beanii, *Duncan.* Pl. III, figs. 10, 11.

The corallum is turbinate and greatly expanded, and slightly concave above. It is slightly flat at the base where it adhered.

The epitheca is stout, and in transverse folds.

The calicular margin is nearly circular.

The septa are very numerous, and number about 220. They are unequal, long, and moniliform, here and there.

The synapticulæ are very numerous.

Height of corallum $\frac{1}{2}$ inch.

Breadth of calice $1\frac{1}{2}$ inch.

Locality. Lower Ragstone, Dorset.
In the Collection of Dr. Holl, F.G.S.

Genus—Podoseris.

1. Podoseris constricta, *Duncan.* Pl. III, figs. 5, 6.

The corallum is fungiform and constricted beneath the rounded calicular surface.

The base is small and presents the concave surface of a former adhesion to a foreign body.

The epitheca is delicate.

The calice is convex.

The septa are delicate, narrow, long, slightly unequal, and there are five cycles of them and part of the sixth.

The costæ are distinct and equal inferiorly where they are linear.

The synapticulæ are rare.

Height of corallum $\frac{6}{10}$ths inch.

Breadth of calice $\frac{4}{10}$ths inch.

Locality. Lower Ragstone, Dorset.

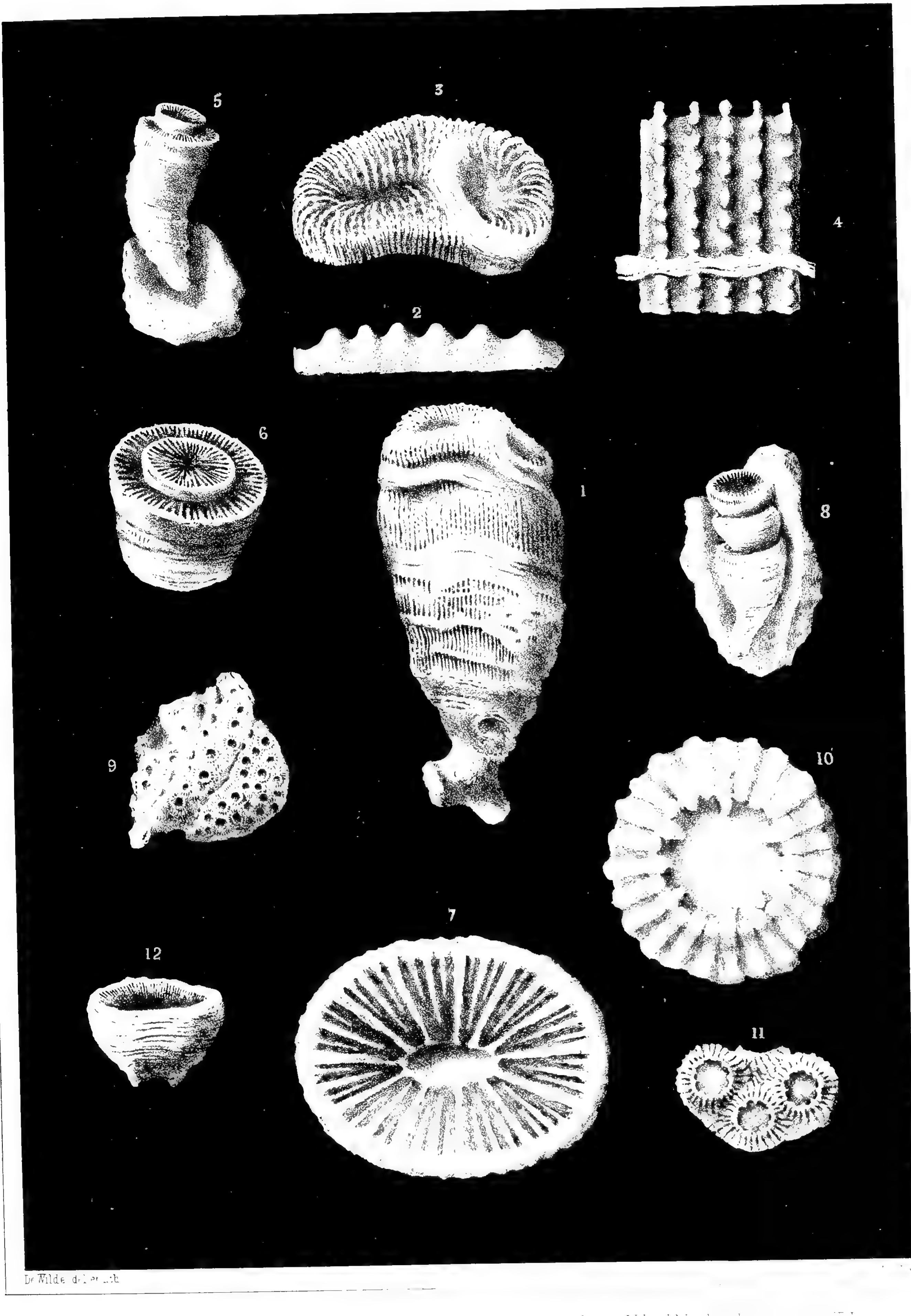
In the Collection of Dr. Holl, F.G.S.

PLATE I.

CORALS FROM THE GREAT OOLITE AND FROM THE INFERIOR OOLITE.

FIG.

1. *Thecosmilia obtusa*, d'Orb. The corallum. (Great Oolite.) (P. 14.)
2. The upper margin of a septum, magnified.
3. The calicular surface, magnified.
4. Costæ, magnified, and epitheca.
5. *Montlivaltia Holli*, Duncan. (Inferior Oolite.) (Page 16.)
6. The calicular surface, magnified.
7. The calice, magnified.
8. A corallum with calicular gemmation.
9. *Cyathophora insignis*, Duncan. (Great Oolite.) (Page 14.)
10. A calice, magnified.
11. Three calices, slightly magnified.
12. *Montlivaltia Painswicki*, Duncan. (Inferior Oolite.) (Page 17.)



De Wilde del. et lith.

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PLATE II.

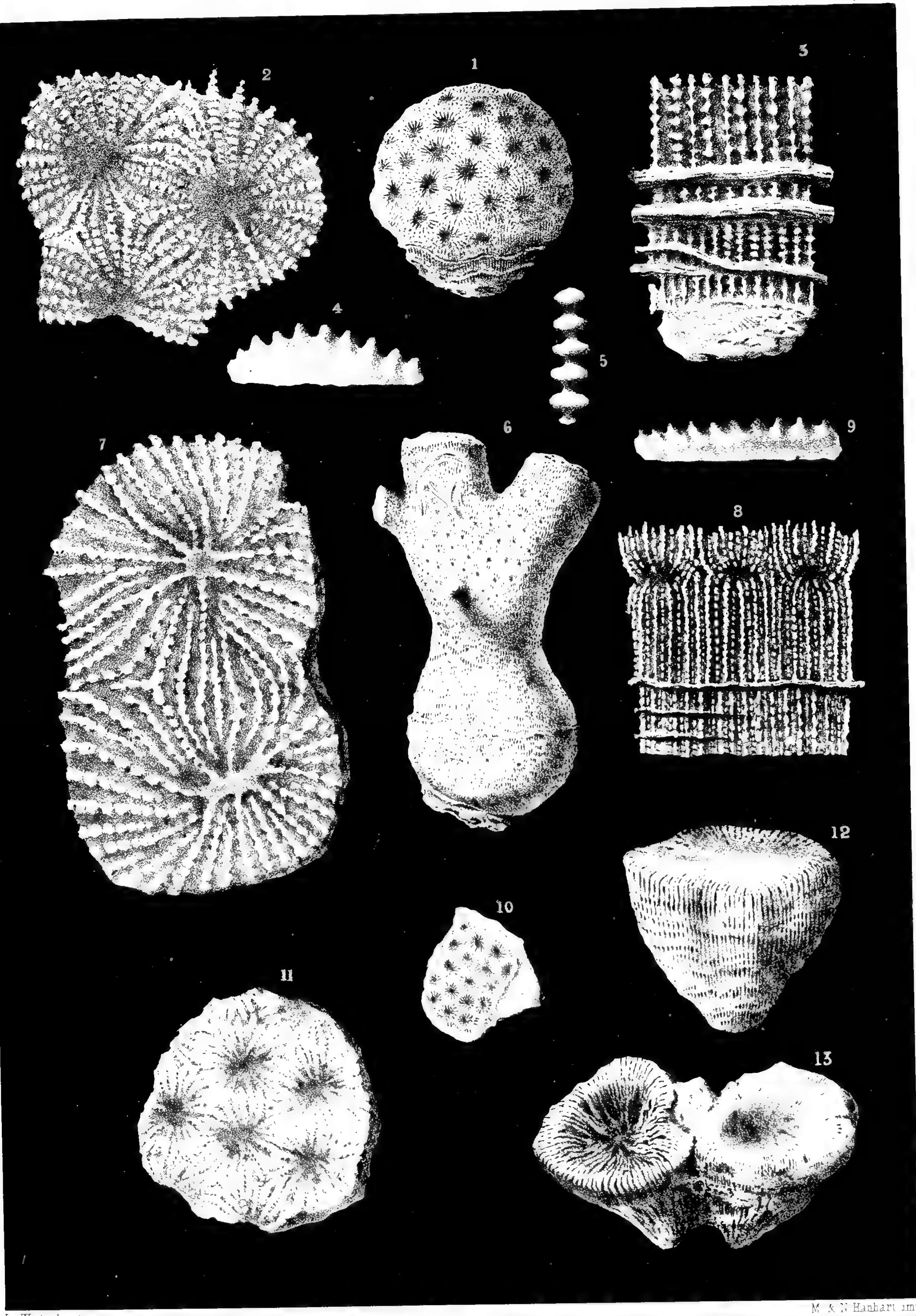
FIG.

1. *Thamnastræa Browni,* Duncan. (Great Oolite). (Page 16.)
2. The calices, magnified.
3. The costæ and epitheca, magnified.
4. A septum, magnified.
5. A costa, magnified.
6. *Thamnastræa Waltoni,* Ed. & H. (Inferior Oolite.)

7., 8., 9. Details, magnified.

10., 11. *Isastræa gibbosa*, Duncan, and magnified view. (Page 15.)

12. *Montlivaltia trochoides,* Ed. & H. (Inferior Oolite.)
13. *Montlivaltia Morrisi,* Duncan. (Inferior Oolite.) (Page 17.)



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CORALS FROM THE GREAT OOLITE, AND FROM THE INFERIOR OOLITE

PLATE III.

Fig.

1.
2.
3.
4. } *Cladophyllia Babeanna*, Ed. & H. Corallum and details. (Page 3.)

5. *Podoseris constricta*, Duncan. (Inferior Oolite.) (Page 24.)
6. Corallum, magnified.
7.
8. } *Cyclolites Lyceti*, Duncan. (Inferior Oolite.) (Page 23.)
9. The costæ, magnified.
10. *Cyclolites Beanii*, Duncan. (Inferior Oolite.) (Page 23.)
11. The septa and synapticulæ, magnified.
12.
13.
14. } A *Montlivaltia* with distinct costæ. (Inferior Oolite.)
15. *Cyathophora tuberosa*, Duncan. (Great Oolite.) (Page 15.)
16. A calice, magnified.
17. Calices, magnified.
18. Side view of calice, magnified.

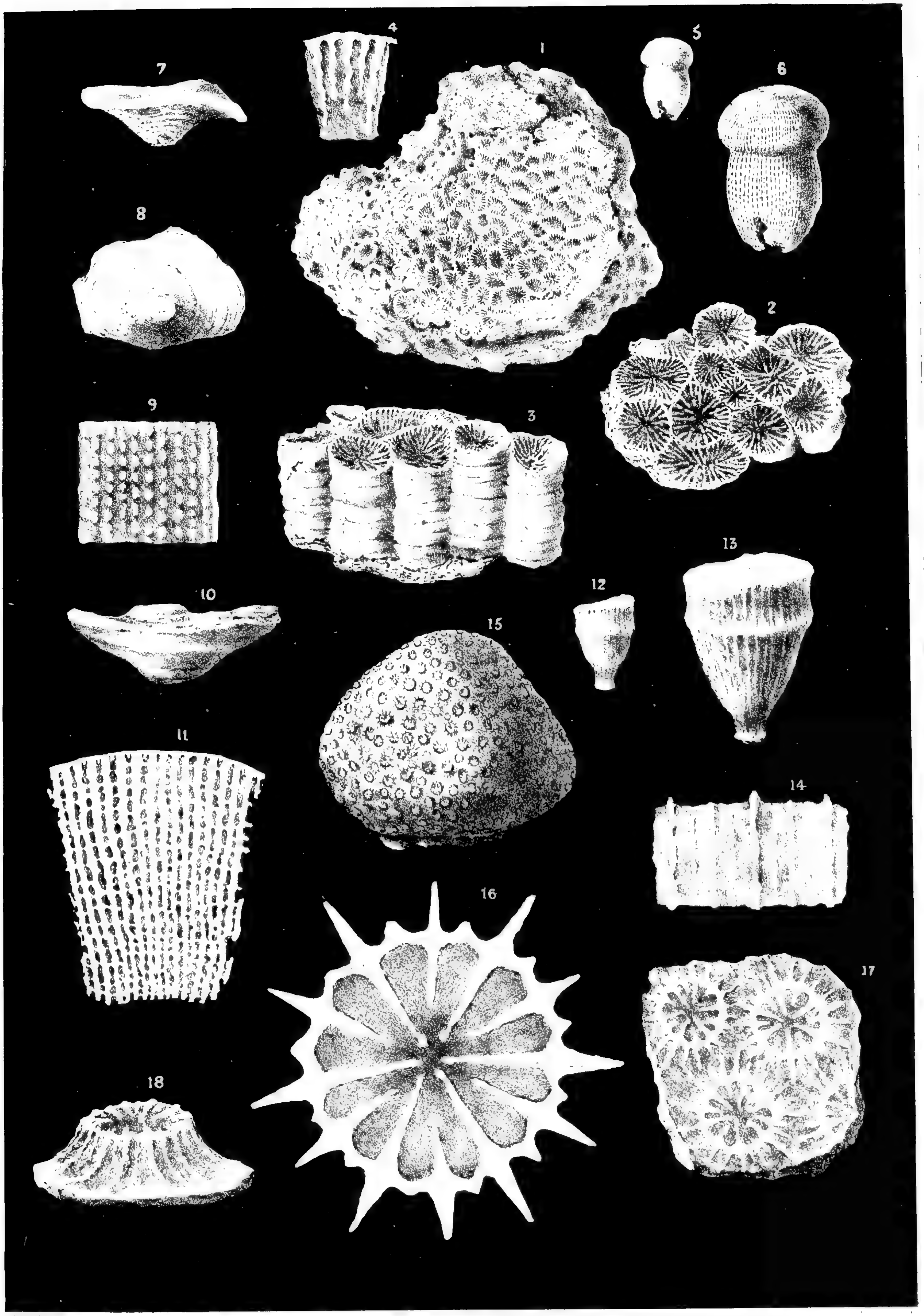

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PLATE IV.

FIG.

1. *Dimorphoseris oolitica,* Duncan. (Inferior Oolite.) (Page 22.)
2. Calicular surface.
3. A calice, magnified.
4. Synopticulæ, magnified.

5.–10. Corallum and details of *Thamnastræa Walcotti,* Duncan. (Inferior Oolite.) (P. 19.)

11.–14. *Thamnastræa Manseli,* Duncan. (Inferior Oolite.) (Page 20.)

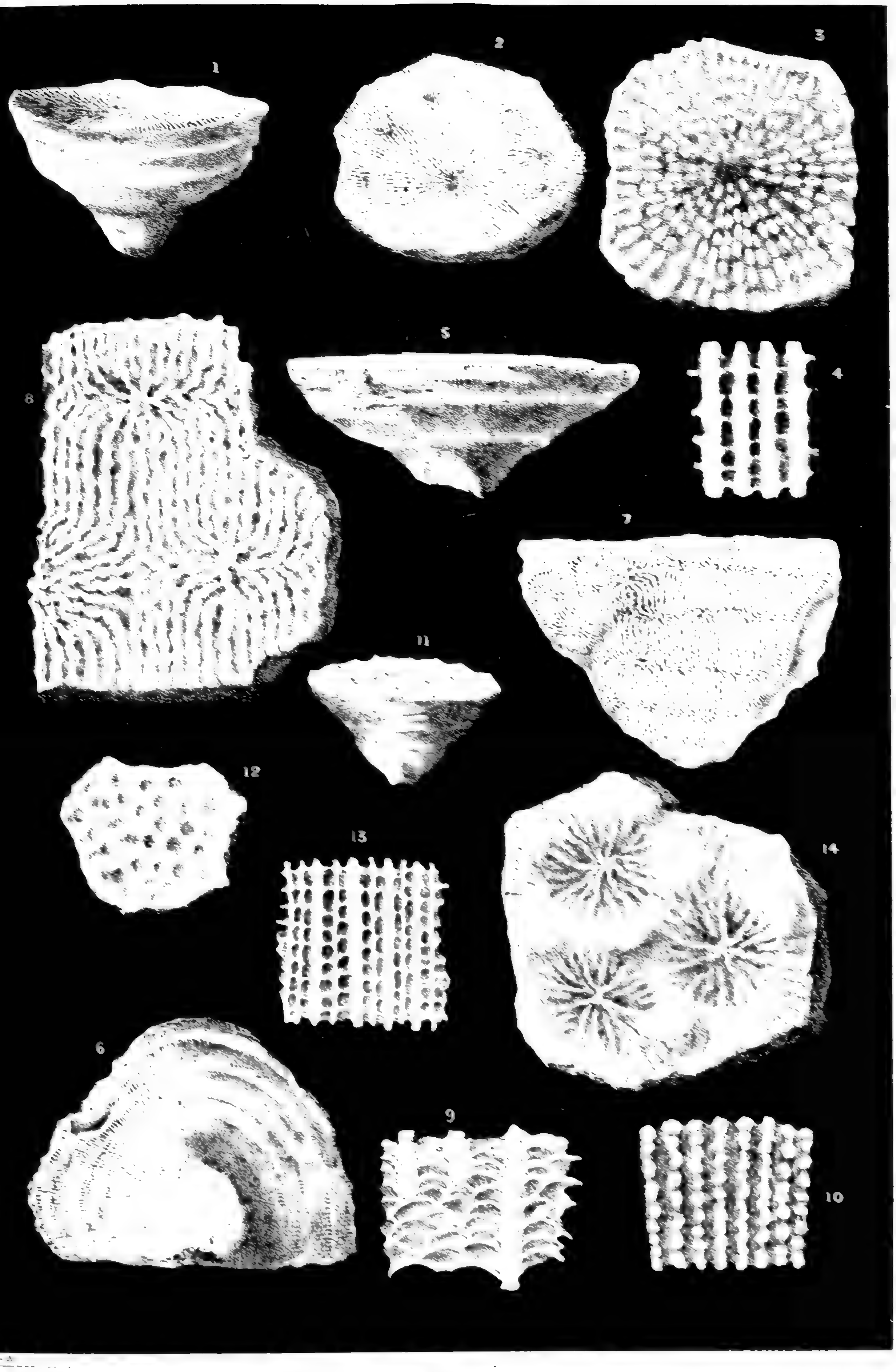
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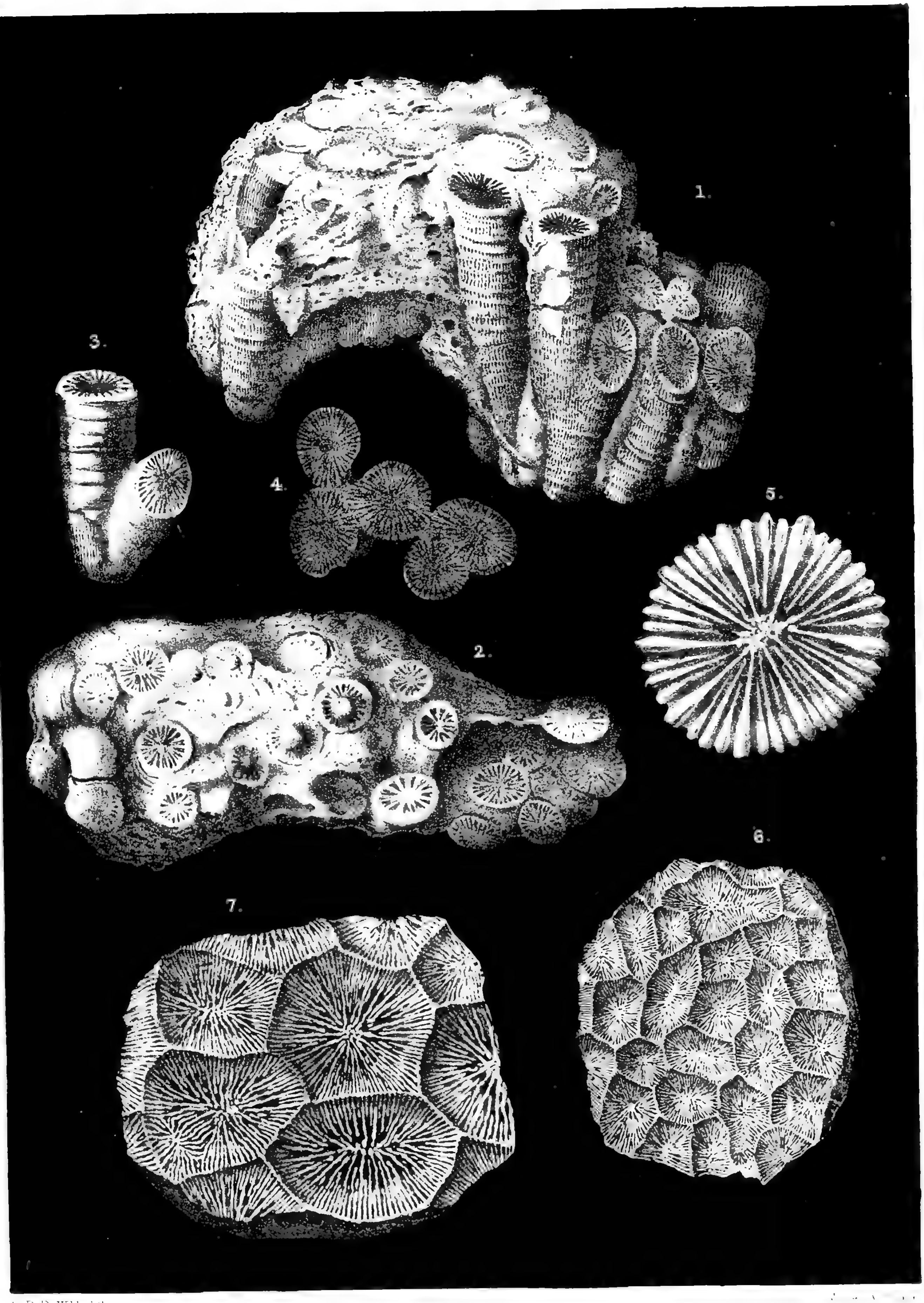
PLATE V.

Fig.

1\.
2\. The corallum and details of *Thecosmilia Wrighti*, Duncan. (Inferior Oolite.)
3\. (Page 17).
4\.

5\. A calice, magnified.

6\.
7\. Views of *Latimæandra Flemingi*, Ed. & H. (Page 18.)



G. R. DeWilde lith.

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PLATE VI.

FIG.

1. *Thecosmilia gregaria*, M'Coy. Variety. (Page 18.)

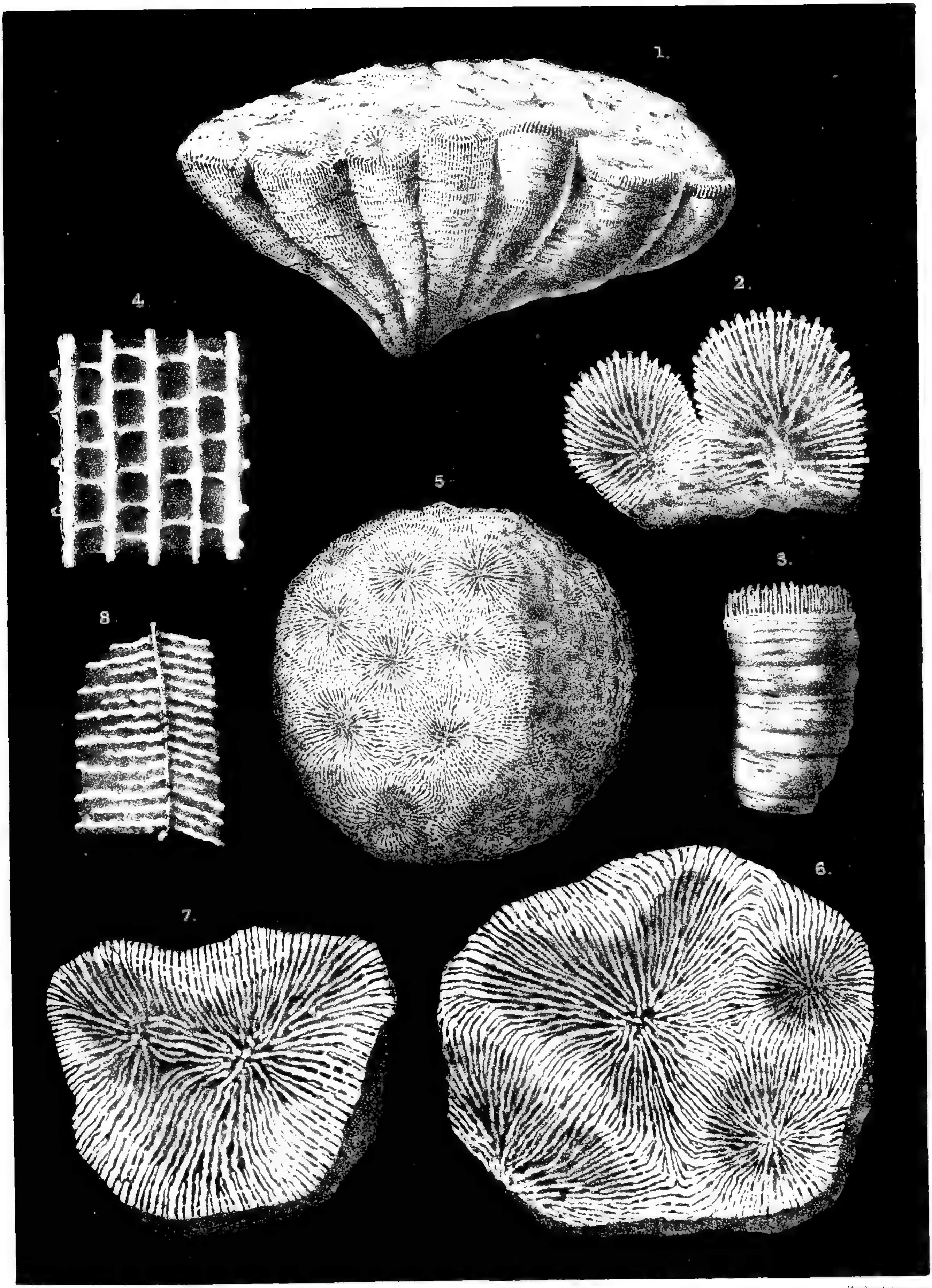
2. }
3. } Parts of corallum, magnified slightly.

4. Costæ and exotheca, magnified.

5. The corallum of *Symphyllia Etheridgei*, Duncan. (Page 19.)

6. }
7. } Calices, magnified.

8. Costæ, magnified.



G. R. De Wilde lith. W. West & Co. imp.

CORALS FROM THE INFERIOR OOLITE.

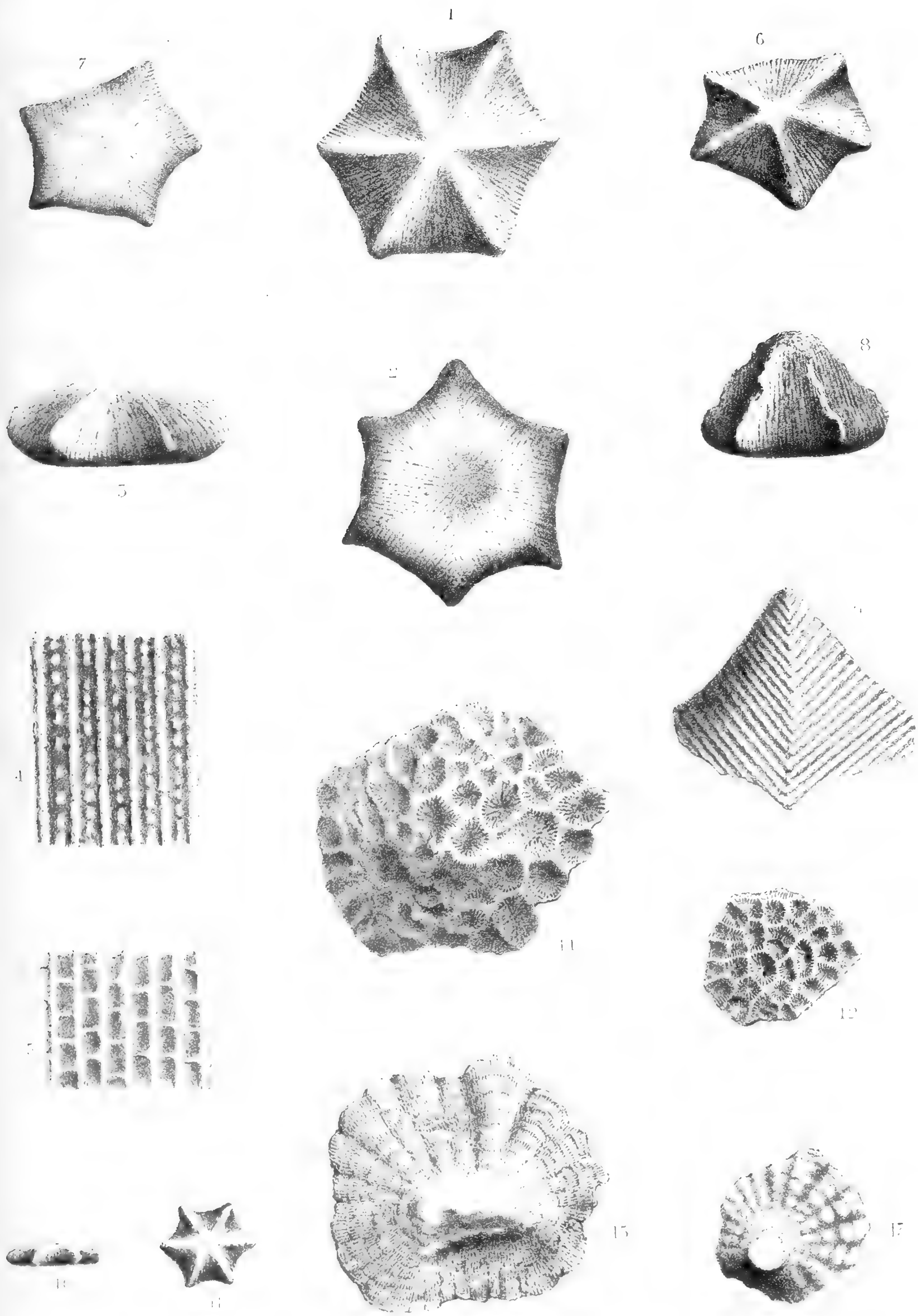
PLATE VII.

Fig.

1. *Gonioseris angulata*, Duncan. (Page 21.)
2. Under side—the base.
3. Side view.
4. Costæ.
5. Synapticulæ.
6. *Gonioseris Leckenbyi,* Duncan. (Page 22.)
7. Base.
8. Side view.
9. Costæ at the angle of the base.

10., 11. Small specimen of young *Gonioseris.*

12., 13., 14., 15. Symphyllian form of a *Thecosmilian.* (Page 9.)



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CORALS FROM THE SUPERIOR OOLITE

INDEX

TO THE

BRITISH TERTIARY CORALS

DESCRIBED IN THE MONOGRAPH

BY

H. MILNE EDWARDS,

PROFESSOR AT THE MUSEUM OF NATURAL HISTORY, PARIS, ETC.,

AND

JULES HAIME,

AND IN THE SUPPLEMENTARY MONOGRAPH

BY

P. MARTIN DUNCAN, M.B. LOND., F.R.S., F.G.S., &c.,

PROFESSOR OF GEOLOGY TO KING'S COLLEGE, LONDON.

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INDEX TO THE TERTIARY CORALS.*

* The words "Edw. and Haime" preceding the numerals, refer to the Pages in the Monograph of British Fossil Corals by MM. Milne Edwards and Jules Haime; and the word "Duncan" to the Pages in the Supplementary Monograph by Professor Duncan.

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Pages 73—145, Plates XII—XXX, by H. Milne Edwards and Jules Haime (in the volume for the year 1851), were published *June*, 1851.

Pages 1—26, Plates I—IX, of the Supplementary Monograph, Part II, by P. Martin Duncan (in the volume for the year 1868), were published *February*, 1869.

Pages 27—46, Plates X—XV, of Part II, by P. Martin Duncan (in the volume for the year 1869), were published *January*, 1870.

Pages 1—24, Plates I—VII, of Part III, by P. Martin Duncan (in the volume for the year 1872), were published *October*, 1872.

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INDEX TO THE SECONDARY CORALS.*

*_** *The synonyms are printed in italics.*

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ON THE

BRITISH FOSSIL

ECHINODERMATA

FROM

THE CRETACEOUS FORMATIONS.

BY

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

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J. E. ADLARD, BARTHOLOMEW CLOSE.

Peltastes Wiltshirei, *Wright*, nov. sp. Pl. XL, fig. 1 *a—h*.

Diagnosis.—Test subglobose, elevated at the upper surface, flat at the base; ambulacra narrow, straight, two rows of marginal mammillated granules; poriferous zones narrow, and slightly flexed; inter-ambulacra wide, two rows of large tubercles, five in each; apical disc very broad, margin deeply cut out; ovarial plates largely incised; vent elevated; periprocte prominent, projecting outwards and backwards.

Dimensions.—Altitude, six tenths of an inch; latitude, eight tenths of an inch.

Description.—We owe the discovery of this beautiful *Peltastes* to the long, careful, and patient study of my excellent friend, the Rev. T. Wiltshire, F.G.S., on the red chalk of England, to whose valuable collection it belongs. The test is subglobose, much elevated on the upper surface, and covered with a very large apical disc; the base is flat, and the sides are tumid. The ambulacral areas, very narrow and straight, are occupied by two rows of small oblong mammillated marginal granules, about nineteen in each row, separated by a narrow band of fine, close-set granulations, which extends from the base to the summit of the area; the poriferous zones are narrow and slightly flexed, and the small pores are arranged in oblique pairs, of which there are thirty-eight in each zone. Fig. 1 *f* exhibits one entire ambulacrum, with its poriferous zones, magnified four diameters.

The inter-ambulacral areas are wide and largely developed (fig. 1 *a, d, e*); the ovarial and ocular plates of the apical disc cover up much of the upper portion (fig. 1 *b, d, e*); there are ten primary tubercles in each area, of which four are very large, two small, and four smaller; they are all surrounded by wide areolas (fig. 1 *d, e*), and around their margins a few large granules are sparsely disposed, about five around the largest plates, three at the central, and two at the zonal side of the plate, as shown in fig. 1 *h*. The base is flat (fig. 1 *c*), about two fifths the diameter of the disc, the mouth-opening is nearly one half the diameter of the test, and the peristome is divided into ten nearly equal lobes by deep incisions; the numerous small tubercles at the base of the areas, and the larger size of the marginal ambulacral granules, impart to this region of the test a highly ornamented appearance (fig. 1 *c*).

The apical disc (fig. 1 *b* and *g*) is a large and complicated structure; the suranal plate lies in front of the vent, and is notched with sections of four elliptical impressions; the ovarial plates are large and cut in a like manner into similar patterns, the two adjoining plates contributing each one half of the ellipse, so that the sculptured pattern on the entire disc is made up of separate pieces like mosaic; the oviductal holes are in the middle of the plates and on the right antero-lateral; the madreporiform tubercle appears like a laceration on the inner side of the oviductal hole—this has unfortunately escaped the eye of our artist, as it looks more like a portion of decayed plate than a veritable natural structure. The ocular plates are likewise large, and have five or six notches round their border, which in like manner join similar notches on the ovarial plates and complete the elliptical pattern of the sculpture of the disc; the outer border of each ocular plate forms a crescent around the summit of the ambulacra, and the terminal portions of the ovarial plates form an elegant five-leafed petal extending down the middle of the inter-ambulacra; the outer margin of the disc is therefore very deeply incised between the ovarial and ocular plates, and produces a structure which will be better understood by an examination of fig. 1 *g*, magnified four diameters, than by any verbal description. The vent is large and the periprocte bluntly diagonal, angular at the sides, and less convex before than behind (fig. 1 *g*); when viewed in profile, as in fig. 1 *a* and *d*, the apical disc is conspicuously prominent, and the elevated periprocte is seen to be very excentral and projected far backwards.

Affinities and Differences.—This beautiful species in its general characters resembles *Salenia Austeni*, Forbes; but a careful comparison of the tests of both species discloses important differences; the ambulacra in *P. Wiltshirei* are narrower, with only two rows of oblong marginal granules throughout, whilst *S. Austeni* has four rows in its wider ambulacra. The inter-ambulacral areas in *P. Wiltshirei* are wider, and the primary tubercles therein fewer and larger than in *S. Austeni*. The apical disc of *P. Wiltshirei* is much larger; the marginal incisions are deeper, the lines of sculpture wider, and the periprocte is in the axis of the suranal plate.

This species resembles *P. Bunburyi*, Forb., in the general structure of the test, and of the apical disc; the inter-ambulacral areas in *P. Wiltshirei* are wider, the tubercles are larger and more regular, the apical disc covers a wider surface of the test than in *P. Bunburyi*, and is deeply sculptured after a different pattern, both around the margin and along the sutures of the plates.

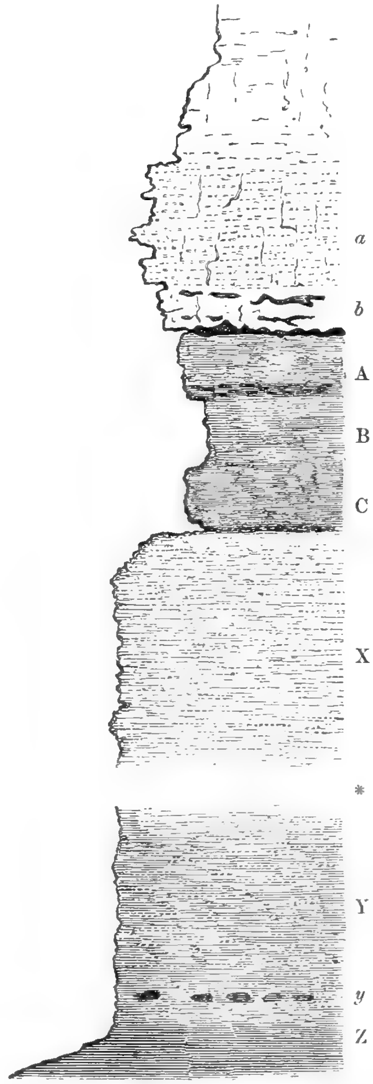
Locality and Stratigraphical Position.—This *Peltastes* is a very rare Urchin in the Red Chalk of Hunstanton Cliff, Norfolk, where it was found by the Rev. T. Wiltshire, F.G.S., who has contributed a valuable paper on this stratum to the 'Quarterly Journal of the Geological Society,'[1] and from which I have made the following quotations, as the true position of the Red Chalk is well defined in that communication. I am indebted to the kindness of the Council of the Geological Society for the use of the annexed woodcut illustrating the stratigraphy of this locality.

Hunstanton Cliff "is marked by three parallel coloured bands, slightly inclined, and cropping out in succession on the surface soil, of which bands the uppermost is white, the next bright red, and the lowest yellow, each division being sharply defined, without any intermingling of tints at the line of contact. . . . The highest stratum, the white, consists of a hard calcareous substance, compact in texture, and much shattered and fissured, originally deposited in such a manner that its materials were arranged in definite layers, two of which (*a b*), those forming the base, are represented in the annexed section drawn to scale. The first of these (*a*), in thickness about 2 feet 6 inches, is noticeable for the presence of an enormous quantity of fragments of *Inocerami* dispersed throughout its

[1] 'Quart. Journ. Geol. Soc.,' vol. xxv, p. 185, 1869.

whole extent, and which under the influence of weathering impart to this portion of the cliff a jagged and rough appearance. Its characteristic fossils are spines of *Cidaris vesiculosa, Holaster planus, Vermicularia umbonata, Terebratulina gracilis, Terebratula semiglobosa,* and *Plicatula inflata.* The band *b*, in thickness about 1 foot 2 inches, is conspicuous for a meandering and many-branched Sponge (*Syphonia paradoxica*), specimens of which are visible in the cliff only in short lengths, but on the fallen blocks washed by the sea are seen to extend continuously and horizontally over many square feet of surface. The underside of *b* departs from the general arrangement in the other courses; for its base, instead of forming a flat or approximately flat floor, is broken up into a series of irregularly rounded ridges and hollows, which undulate perpendicularly within the limits of a few inches, and are represented in the section. The fossils from this bed (*b*) are not so many (numerically speaking) as those in *a*. The chief forms are *Siphonia paradoxica, Terebratula biplicata, Terebratula semiglobosa*, var. *undata, Kingena lima, Avicula gryphæoides,* and *Inoceramus latus.*

Section of Hunstanton Cliff.



"Next in succession, in descending order, is the red stratum, locally called the 'Red Chalk,' marked by an abundance of organic remains, some of which, as *Bourgueticrinus rugosus* and *Terebratula capillata*, are, in England, special to this deposit. Lithologically it is unlike the beds above it, from the fact of its abounding in great numbers of rolled and subangular pebbles of quartz, slate, &c., which for the most part are of small size and insignificant, though occasionally assuming larger dimensions. In appearance it is divisible into three almost equal portions, of which the first (A) has towards its base a large quantity of fragments of *Inocerami*, the second and thickest division (B) is rich in *Belemnites*, and the third and lowest (C) yields many *Terebratulæ*. The bands A and B are exceedingly hard and stony, and sufficiently tabular in character to have offered a plane of resistance to former upheaving forces, and to have afforded great support to the overlying white beds; thus, although the whole cliff was evidently, in ancient geological times, much disturbed, the perpendicular fissures which rise out of the yellow bands

* A thickness of upwards of 30 feet is here omitted for convenience.

(Y, X) cease just before reaching the layer B, affect the red beds to the right and left of the points of application, and then start upwards through the white stratum in new positions and in greater number. The colouring matter in A is less equally distributed than in B and C, and seems to have been accumulated as an envelope around irregular spheroidal masses; in B the tint is of a lighter, and in C of a darker shade than in the highest division. The middle bed (B) is in substance the hardest and most homogeneous of the three; the last (C) is the least compact. Viewed in the cliff, A wears a mottled aspect, B a nodular facies, and C a plain surface. Towards the base of the bottom bed (C) the hard limestone character of the Red Chalk is lost, and the stratum degenerates into a somewhat sandy incoherent mass, hardly differing from the underlying yellow division, except in colour. On account of the less compact nature of the last of the three red beds, fossils are more easily procured from it, have their surfaces in better condition, and are more readily seen when of small size. Resting on the top of A and filling the undulations on the under side of the lowest white bed (*b*) is a bright red argillaceous substance, very friable, without sand, apparently destitute of organic remains, and never exceeding two or three inches in thickness.

"The fossils in the three red beds are for the most part similar, and suggest the inference that all three bands may be considered as forming a single division, and composing one geological stratum. In the case where certain fossils have been seen only in the lowest part, their absence elsewhere may be accounted for on the ground that the upper bed (A) is less numerically abundant in organic remains than are those below, and that the middle bed (B) is so exceedingly hard and compact as to diminish the chance of discovering fossils. *Avicula gryphæoides* and *Spongia paradoxica* would seem, however, to be special to the upper part of A, the highest of the three red beds. The dip of these beds in the cliff is about 2° to the north; sections inland, taken at right angles, give the same number of degrees to the east.

"Underlying the Red Chalk is a coarse sandy deposit (X, Y of the Section) termed in the district 'Carstone,' of a yellow tint, loose in composition, and full of small pebbles, which are subangular and polished. The upper part (X), for about 8 feet, consists of much sand, and is succeeded by a dark brown stratum (Y), in which, at the beginning, the pebbles are of larger size, and in which, afterwards, the sandy particles are so loosely held together as to present a strong contrast to the massive nature of the white and red beds above. Covered by the Carstone and adjoining it is a bed of clay marked Z in the section.

"Throughout the space of more than thirty feet below the base of the Red Chalk no fossils have been hitherto found at Hunstanton in the Carstone; but beyond that distance, and just above the clay (Z), there is a line of nodules (*y*), in which are numerous specimens of *Ammonites Deshayesi*, and occasionally of *A. Cornuelianus;* close to these nodules are others of ironstone, very similar to the masses found in the Lower Greensand of Blackgang and Shanklin, in the Isle of Wight, containing casts of fossils.

"From this part of the Carstone I have obtained *Perna Mulleti*, *Ancyloceras gigas*, *Pleurotomaria gigantea*—fossils which, viewed in connection with the presence of *Ammonites Deshayesi*, &c., correlate the portion of the Carstone immediately above the clay (Z) with the base of the English Lower Greensand.

"By a reference to the section it will be seen that the Hunstanton Red Chalk is, in position, lower than the Chalk-marl (*a*), and higher than the Lower Greensand (X, Y); the fossils also, it will be observed, recorded in the list as common to the bed, present a mixture of what are generally considered Lower Chalk, Upper Greensand, and Gault forms. The mingling together of these species, no less than the peculiar aspect of the stratum, has long caused the Red Chalk to be a fertile field for discussion in reference to its proper position in the geological scale, various writers offering various opinions, Mr. C. B. Rose[1] inclining to its being the equivalent of the Gault, Mr. H. Seeley[2] to its being Upper Greensand, and Mr. Judd[3] to its combining both formations. If, however, the very fine section of the Gault at Folkstone (where the succession of the beds and their fossils can be examined *in sitû*) be taken as typical of the English Gault, then it will become evident that the 'Red Chalk' is the representative of the upper division of that formation."

Genus—Goniophorus, *Agassiz*, 1838.

Goniophorus, *Desor*. Goniophorus, *Cotteau*.

Test small, circular, elevated above, and flat beneath. Interambulacral areas wide, two rows of large tubercles with well-developed areolæ, crenulated bosses and imperforate mammelons; pores small, simple, unigeminal. Ambulacral areas very narrow, and having the poriferous zones slightly undulated.

Mouth-opening small, peristome decagonal, with nearly equal sized oral lobes.

Apical disc smooth, prominent, regularly pentagonal, and moderately large, composed of five ovarial and five ocular plates, and one suranal placed before the vent, which is excentral, in the axis of the body, and placed a little backwards, as in the genus *Peltastes*. The disc is destitute of sutural impressions so characteristic of many Salenidæ, and is ornamented with prominent carinæ, which assume regular geometrical figures, altogether independent of the form of the ovarial plates or their connecting sutures; in fact, it is

[1] "On the Geology of West Norfolk," 'Phil. Mag.,' 1835, vol. vii, p. 180.

[2] "Notice of Opinions on the Stratigraphical Position of the Red Limestone," 'Ann. Mag. Nat. Hist.,' 1861, vol. vii, p. 240.

[3] "Strata which form the base of the Lincolnshire Wolds," 'Quart. Journ. Geol. Soc.,' vol. xxii, p. 249, 1867.

the carinated structure, superadded to the surface of the disc, which forms one of the most distinctive characters of this group.

The genus *Goniophorus* resembles *Peltastes* in the arrangement of the elements of the apical disc and the relative position of the periprocte to the axis of the body. It is distinguished from it, however, in the absence of sutural impressions, and the presence of prominent ribs, that divide the surface of the pentagonal disc into a number of triangular areas (Pl. XXXVI, figs. 1 and 2).

M. Cotteau[1] has added another character, which he considers of more importance than the preceding; and observes, "The structure of the ambulacra presents a difference much more important, and the existence of poriferous impressions at the base of some of its granules form a type certainly exceptional, which ought to have a place apart in the Family Salenidæ. This character has not hitherto been noticed in any other Echinid."

Goniophorus lunulatus, *Agassiz*, 1838. Pl. XXXVI, fig. 1 *a—d*, fig. 2 *a—d*.

Goniophorus lunulatus,		*Agassiz.* Monogr. des Salénies, p. 30, pl. v, figs. 17—24, 1838.
—	apiculatus,	*Agassiz.* Ibid., p. 32, pl. v, figs. 25—32, 1838.
—	—	*Agassiz.* Catal. Ectyp. Foss., p. ii, 1840.
—	favosus,	*Agassiz*, MS. Morris's Catal. of British Fossils, p. 52, 1843.
—	lunulatus,	*Morris.* Catalogue of British Fossils, p. 52, 1843.
—	—	*Agassiz* et *Desor.* Catal. raison. des Échinides, Ann. des Sc. Nat., 3e série, t. vi, p. 343, 1846.
—	apiculatus,	*Agassiz* et *Desor.* Ibid.
—	—	*Bronn.* Index Palæontol., p. 548, 1849.
—	favosus,	*Bronn.* Ibid.
—	lunulatus,	*Bronn.* Ibid.
—	—	*D'Orbigny.* Prod. de Pal. strat., t. ii, p. 179, 1850.
—	apiculatus,	*D'Orbigny.* Ibid.
—	favosus,	*D'Archiac.* Hist. des Progr. de la Géol., t. iv, p. 51, 1851.
—	lunulatus,	*Bronn.* Lethæa geogn., t. ii, p. 184, pl. xxix, fig. 6, 1852.
Salenia lunulata,		*Morris.* Catal. of Brit. Foss., 2 ed., p. 89, 1854.
Goniophorus apiculatus,		*Desor.* Synopsis des Échinides Foss., p. 14, pl. xx, fig. 12, 1856.
—	lunulatus,	*Pictet.* Traité de Paléontol., t. iv, p. 248, 1857.
—	apiculatus,	*Pictet.* Ibid., pl. xcvii, fig. 3, 1857.
—	lunulatus,	*Cotteau.* Paléontol. Française, t. vii, pl. 1029, figs. 8—19, 1864.

[1] 'Paléontologie Française,' t. vii, p. 126, Terrain crétacé.

Diagnosis.—Test small, globular, upper surface elevated, summit depressed, base flat, sides rounded; ambulacra narrow, slightly flexed, filled with two rows of granules; inter-ambulacra wide, two rows, six in each, of well-developed tubercles; apical disc small, angular, and pentagonal; diagonal ridges of shell marking the surface of the plates; base narrow, concave; mouth-opening small, peristome decagonal with equal lobes.

Dimensions.—A. The largest specimen, fig. 1 *a*, altitude half an inch; latitude six tenths of an inch.

B. Altitude, three lines; latitude, five lines.

C. Altitude, two and a half lines; latitude, three and a half lines.

Description.—This beautiful little Urchin, the sole representative of the genus *Goniophorus*, was at one time not uncommon in the Upper Greensand, near Warminster, and it is curious that no second species of the remarkable group to which it belongs has up to the present time been discovered; the two other forms which appear in the table of synonyms (*G. apiculatus*, *G. favosus*) being only usual varieties of the original type, so beautifully and accurately figured by M. Nicolet in Professor Agassiz's 'Monographies d'Échinodermes,' where it was for the first time described.

The test is small and nearly globular, the upper surface much elevated, the summit a little depressed, the sides inflated, and the base narrow and flat. The ambulacral areas are very contracted, and slightly flexed (fig. 2 *b*), the two rows of granules are set so closely together that they alternate on the area; the poriferous zones are nearly as wide as the ambulacra, the pores are oblique, and the pairs remote from each other, twenty-four in the zone. The inter-ambulacral areas are well developed (fig. 2 *a*); in the specimen, fig. 1 *a*, there are six primary tubercles in each row, the four above the ambitus are much larger than those on the lower part of the area, and the areola of each tubercle is surrounded by a complete circle of small mammillated tubercles (fig. 1 *a*, *d*, and fig. 2 *a*, *c*); the miliary zone separating the two series is narrow and zig-zag, and only a little enlarged at the upper surface (fig. 1 *d*, fig. 2 *a*).

The base is narrow and concave, and the small mouth-opening, one third the diameter of the test, lies in a central depression; the peristome is divided by feeble incisions into ten equal-sized lobes (fig. 1 *c*).

The apical disc (fig. 1 *b*, *d*) forms a regular pentagon, ornamented with prominent ridges; an external carina bounds the outline of the disc, an oval carina encircles the vent, and two others extend from the anterior part of the periprocte to the two anterior sides of the discal pentagon (fig. 2 *d*), and two others unite these with the sides of the vent (fig. 1 *b*); these ridges of ornamentation have nothing whatever to do with the sutures of the disc, which are very delicate, and only seen in some rare specimens; these sutures in *Goniophorus* are destitute of the incisions, punctuations, and impressions which form so remarkable a feature in the test of *Peltastes*.

The suranal plate lies before the periprocte, having the two anterior carinæ passing from the periprocte to the anterior border extended over its surface; the two antero-lateral ovarials have a rhomboidal figure, the postero-laterals an irregular shape, occasioned by the lateral extension of the vent, and the single plate is still longer and narrower by reason of the space occupied by the same aperture; the oviductal holes occupy the centres of the sides of the pentagon near the point touched by the diagonal carinæ that cross the ovarial plates. The ocular plates form small triangular bodies, the apices of which touch the summits of the ambulacra (fig. 2 *b*); in neither of the fine specimens from Mr. Cunningham's collection, nor in those from the School of Mines, which were selected as the best extant for figuring, could the sutures of the ovarial and ocular plates be seen. I have only discovered them now, April, 1871, long after the drawings were executed, in an otherwise indifferent specimen of my own, collected many years ago, and I have been able therefrom to trace out these sutural lines satisfactorily, and complete my description of the apical disc of this most curious and beautiful *Salenia*. The vent is transversely oblong, inclining to an angular figure, and surrounded by a ridge of the test, which well defines its boundary, and forms a prominent periprocte at the same time. The carinæ of the disc cross the sutures of the plates in all directions, especially those anterior to the periprocte, and convert its surface into a series of seven triangles when all the ridges are preserved entire.

Affinities and Differences.—This Urchin is so entirely different from other SALENIDÆ in the structure of its apical disc that it forms a type quite distinct from all the others; the calcareous processes or carinæ on the surface of the ovarial and ocular plates have nothing whatever to do with the sutural lines which unite the elements of the discal apparatus, whereas in *Peltastes* and *Salenia* the figures on the disc are always developed in the line of the sutures.

Locality and Stratigraphical Position.—This Urchin has been collected from the Upper Greensand near Warminster; on the Continent it is a very rare fossil. The original specimen was found in the Étage Cénomanien, at Cap la Hève, near Havre, Seine Inférieure; others from the same stratum at Vaches Noires, Calvados, and Vimoutiers, Orne; in all these localities it is reported as being very rare.

History.—First described and figured by Professor Agassiz in his 'Monographie sur les Salénies.' In this work he described two forms as distinct species, *G. lunulatus* and *G. apiculatus*, which I consider as varieties only of the same Urchin. Professor Agassiz afterwards gave the MS. name *G. favosus* to a form of this group which he saw in the collection of Mr. Bunbury, of London, and the name found its way into Professor Morris's 'Catalogue of British Fossils,' 1st Edition; this variety exhibits only a slight deviation from the type form, so that the singular genus *Goniophorus* is at present represented by the beautiful little Urchin now under consideration. Seeing that so many examples of SALENIDÆ have been collected from the Upper Greensand of England, and the Cenomanian stage of France, during the last forty years, it is remarkable that no true second species has been found. It has often occurred to me that this is one of many problems of a like nature that the disciples of Darwin might attempt to solve. The geological record of the Cretaceous rocks where the SALENIDÆ abound is not so imperfect as many assert, and connecting forms, if such ever really existed, ought to be found somewhere in beds that are so often searched and so diligently worked for the Palæontological treasures they contain. Notwithstanding all this investigation, *Goniophorus lunulatus* still remains an isolated genus represented by a single species among the SALENIDÆ.

Genus—SALENIA, *Gray,* 1835.

SALENIA, *Agassiz,* 1838. SALENIA, *Desor,* 1858. SALENIA, *Cotteau,* 1864.

Test small, circular, moderately elevated, sides inflated, more or less convex above and flat beneath; poriferous zones narrow, pores unigeminal, simple in the zones, and crowded near the peristome; ambulacral areas narrow, gently flexuous, with two or four rows of close-set homogeneous mammillated granules. Inter-ambulacral areas wide, with two rows of large crenulated imperforate tubercles.

Mouth-opening nearly two thirds the diameter of the test; peristome divided into ten unequal lobes by feeble incisions; vent circular, periprocte elevated, excentral, and posterior, placed at the right side of the axial line of the body; apical disc shield-shaped, covering a large portion of the dorsal surface; plates prominent, with a deeply undulated border; the ovarials and suranal large and pentagonal, the oculars wide and cordate; the sutures punctuated or incised, and the surface of the plates smooth in *S. petalifera,* sometimes granulated, in *S. granulosa,* or striated with geometrical lines forming various figures, as in *S. Clarkii* and *S. Austeni.*

The right antero-lateral ovarial plate exhibits a slight laceration, in which the madreporiform body is sometimes seen in well-preserved specimens; often it is invisible.

The spines are known only in a few species; in some they are long, slender, and aciculate; in others they are stronger, with spatulate terminations (Pl. XXXVIII, fig. 2); some rarer specimens have their stems flexed, and others have the extremities bent to right angles with the stem (Pl. XXXVIII, fig. 3; Pl. XLII, figs. 1, 2, 3, 4, 5).

The genus *Salenia* is distinguished from *Heterosalenia* and *Pseudosalenia* by its imperforate tubercles, and from *Peltastes,* which it very much resembles, by the position of the vent. In *Salenia* the periprocte opens excentrically on the right side of a line passing through the axis of the body, whilst in *Peltastes* the periprocte lies in the centre of such an axial prolongation.

A.—*Species from the Upper Greensand.*

SALENIA PETALIFERA, *Desmarest*, sp., 1825. Pl. XXXIII; Pl. XLII, fig. 3.

ECHINITE, from Wiltshire,		*Parkinson.* Organic Remains, vol. iii, pl. i, fig. 12, 1811.
ECHINUS,		*W. Smith.* Strata identified by Organized Fossils, p. 12, Greensand, fig. ii, 1816.
—	AREOLATUS,	*König.* Icones foss. sectiles, fig. 100, 1820.
—	PETALIFERUS,	*Desmarest.* Oursin; Dict. Sc. Nat., t. xxxvii, p. 101, 1825.
—	—	*De Blainville.* Zoophytes, Ibid., t. lx, p. 210, 1830.
—	—	*Desmoulins.* Études sur les Échinides, p. 302, 1837.
SALENIA	PETALIFERA,	*Agassiz.* Monogr. des Salénies, p. 9, pl. i, figs. 17—24, 1838.
—	—	*Agassiz.* Catal. Ectyp. foss., p. 11, 1840.
—	—	*Dujardin.* In Lamarck's Animaux sans Vert., 2e éd., t. iii, p. 394, 1840.
—	—	*Morris.* Catalogue of British Fossils, p. 58, 1843.
—	PERSONATA,	*Agassiz* et *Desor.* Catal. rais. des Échinides, Ann. Sc. Nat., 3e série, t. vi, p. 341, 1846.
—	—	*Forbes.* Mem. of Geol. Surv., Decade I, pl. v, 1849.
—	PETALIFERA,	*Bronn.* Index Palæontologicus, p. 1107, 1849.
—	PERSONATA,	*d'Orbigny.* Prodrome de Pal. strat., t. ii, p. 179, 1850.
—	—	*d'Orbigny.* Cours élément. de Pal., t. ii, p. 126, fig. 277, 1851.
—	PETALIFERA,	*Bronn.* Lethæa Geog. Kreide-Geb., pl. xxix, fig. 15, 1852.
—	PERSONATA,	*John Müller.* Ueber den Bau der Echinodermen, p. 7, pl. i, fig. 15, 1854.
—	PETALIFERA,	*Forbes.* In Morris's Catal. of Brit. Foss., p. 89, 1854.
—	—	*Desor.* Synopsis des Échinides foss., p. 149, pl. xx, figs. 1—3, 1856.
—	PERSONATA,	*Pictet.* Traité de Paléontologie, t. iv, p. 247, pl. xcvii, fig. 1, 1857.
—	PETALIFERA,	*Cotteau.* Paléontologie Française, Terrain crétacé, tom. vii, p. 144, pl. 1034, 1864.

Diagnosis.—Test circular, depressed, upper surface convex, sides inflated, base narrow, concave; ambulacra wide, prominent, flexed, two complete rows of large marginal, and two incomplete rows of small central granules. Inter-ambulacra three times the width of ambulacra, two rows of tubercles, six in each, large above the ambitus, small below; miliary zone wide, sparsely granulated; apical disc smooth, large, margin undulated, sutures marked with punctuations; vent circular, periprocte thin and prominent.

Dimensions.—Altitude, four tenths of an inch; latitude, seven tenths of an inch.

Description.—This beautiful Urchin, so long known to collectors of Upper Greensand fossils, has a subglobose body, depressed above, flat below, and with inflated sides; the ambulacral areas, gently flexed, stand out more prominently than the inter-ambulacrals; they have two complete rows of larger granules on the margins of the area, and two incomplete rows of smaller ones within (fig. 1 *c, d,* and fig. 2 *b*); the poriferous zones are very narrow, depressed, and much flexed, and the pores, which are unigeminal throughout (fig. 1 *d*), are arranged in oblique pairs, separated by a prominent tubercle on the septum (fig. 2 *b*). The inter-ambulacral spaces are three times as wide as the ambulacral, with two rows of tubercles, having six in each row, those above the ambitus are large and well developed (fig. 1 *b, d*), those below are small, and decrease much in size as they approach the peristome (fig. 2 *a*); the base acquires an ornamented appearance from the number of small primary tubercles that adorn it (fig. 2 *a*). Each tubercle is surrounded by a wide areola, around which a more or less complete circle of large granules is regularly arranged (fig. 1 *d*), and most of these granules are mammillated; the miliary zone is wide below, and increases in diameter above; throughout it is covered with small granules nearly of the same size (fig. 1 *c* and *d*). At the base of the area the primary tubercles and granules are disposed as in fig. 3, where a portion of the area is magnified six times; and a profile of one tubercle is given in fig. 4, magnified four times.

The base is flat, and concave towards the centre, the mouth-opening, one third the diameter of the test, is sunk in a depression; the peristome is deeply incised, and divided into ten nearly equal-sized lobes (fig. 2 *a*, fig. 4 *b*).

The apical disc forms a very regular structure in this species; the antero-lateral and postero-lateral ovarial plates have a rhomboidal figure, and the single or suranal plate is smaller in consequence of the position of the vent; the oviductal holes are perforated near the centre of the plates; and the madreporiform body is seen as a slight laceration on the surface of the right antero-lateral in some well-preserved specimens only. The ocular plates are much smaller, and transversely or subtriangularly oblong, their inner sides forming the prominent portions of the triangle, and their frontal margins the bases. The suranal plate occupies the centre of the disc before the vent; it is nearly as large, and of the same form as one of the ovarials, and the lines of the sutures present many punctuations. At the angles of junction of every three plates is a deep punctuation, and another in the line of union between every two plates. Thus there are nine punctuations around the borders of the three anterior ovarials, six around each of the posterior ovarials, and three around the oculars (fig. 1 *e, b*). The pits at the junction of three plates are triangular, and those at the junction of two circular; they are never prolonged as linear notches into the substance of the plates, as in *Peltastes clathratus* and *P. Bunburyi.* The vent is subcircular, excentral, and inclines to the right side; the periprocte is elevated and prominent, and bordered by a rim formed of the elevated margins of the suranal, right postero-lateral, and single ovarial plates. There is considerable variation in the size of the punctuations and the width of the lines of suture; but these variations have all their connecting links, and fall within the general description given of the punctuations on the sutural lines of the discal elements.

Affinities and Differences.—*Salenia petalifera* forms an excellent type of the true *Salenia,* and a leading fossil of the beds in which it is contained. I cannot appreciate the differences which some naturalists point out between this species and *S. scutigera,* Münster; and as I have never seen a true type of that species, I must reserve my opinion until I can make a comparison between them. After many careful examinations of Herr Hohe's figure in the 'Petrefacta,' and knowing the extreme accuracy and truthfulness of that excellent artist's admirable drawing, I am inclined to think that *Cidarites scutiger,* Münster, is only a smaller form of *S. petalifera,* Desm.; but as most competent authorities have ruled it otherwise, I have not put *S. scutigera* in my list of synonyms.

S. petalifera resembles *S. Austeni,* Forb.; the latter, however, has a more elevated test with a smaller apical disc, and more prominent periprocte. It very much resembles *Salenia gibba,* from the same stratum of Upper Greensand, which may be only a variety of *S. petalifera:* a closer comparison between these two allied forms will be found in the description of *S. gibba.*

Locality and Stratigraphical Position.—*Salenia petalifera* was at one time an abundant fossil in the Upper Greensand of Longleat, Wilts; but has now become more rare. It is collected from the Grey Chalk near Folkestone, where some very fine examples are sometimes obtained. I have long noticed that nearly all the Upper Greensand Echinidæ are found in the Grey Chalk, and that the specimens from the latter stratum are in general larger and more fully developed, as if they had been better nourished, than those collected from the arenaceous beds of the Upper Greensand of Wilts and other localities.

History.—This Urchin has long been considered to be a leading English fossil of the Upper Greensand; and Parkinson, 1811, Smith, 1816, König, 1820, have all given good figures of this Echinite.

Foreign Distribution.—In the Craie Chloritée de Cap-la-Hève, and other parts of France, in Bavaria and Minorca, and in the "Hils-Conglomerat" of North Germany.

SALENIA LORIOLII, *Wright,* nov. sp. Pl. XXXV, fig. 1 *a—d.*

Diagnosis.—Test small, circular, depressed; upper and under surfaces flattened; ambulacra straight, narrow, two rows of marginal homogeneous granules; interambulacra wide, four or five tubercles in each row; decreasing gradually in size from above downwards; apical disc large, border slightly undulated, surface flat, smooth; ovarial plates without sutural lines or punctuations in the middle of the disc, and with ten round apertures near the outer border; mouth-opening large, peristome deeply incised, lobes unequal.

Dimensions.—Altitude, two lines; latitude, four lines.

Description.—This small Urchin exhibits a form of apical disc very unusual among the

Salenidæ. The test is depressed on the upper and under surfaces, and the sides are inflated between. The poriferous zones are narrow, and the pores unigeminal throughout. The ambulacral areas are straight and narrow, with twelve pairs of marginal, close-set, homogeneous granules, and a few granulations between them at the widest part thereof (fig. 1 *d*). The inter-ambulacral areas are wide, and filled with two rows of large tubercles, four in each row; those in the upper part of the area are the largest, and they gradually diminish in size from above downwards; the bosses of the tubercles are very prominent, and their summits sharply crenulated; the mammillon likewise is large (fig. 1 *d*). Two rows of large granules occupy the miliary zone, and describe a zig-zag ornamentation on each side of the mesial suture, and two granules occupy the angles of each of the plates at their zonal side, so that the test of this small species has a highly ornamented appearance (fig. 1 *c*, *d*).

The apical disc is large, solid, and remarkable for the absence from its ovarial plates of sutural lines or punctuations; its border is thickened, and recurved, and near this marginal bourrelet are ten wide equidistant punctures (fig. 1 *a*); the vent is round, the periprocte annulated, not much elevated, and slightly excentral (fig. 1 *a*, *c*).

The mouth-opening is very large, one half the diameter of the test; the peristome is deeply incised, and the oral lobes are slightly unequal (fig. 1 *b*).

Affinities and Differences.—*Salenia Loriolii* resembles *Salenia minima* in the closely united sutures of its apical disc, but differs from it in the larger development of its tubercles and wideness of its mouth-opening. It differs from *Salenia Desori*, associated with it in the same "terrain" in which it is found, in possessing larger tubercles, a smooth disc without punctuations, and a much larger mouth-opening. A comparison of the capital figures of these two *Saleniæ* on the same plate places their affinities and differences better before the student than any verbal description.

Locality and Stratigraphical Position.—This rare specimen belongs to the British Museum, and was collected from the Upper Greensand near Warminster.

I have dedicated this Urchin to my friend Monsieur P. de Loriol, of Geneva, one of the learned authors of the 'Échinologie Helvétique,' and of several other important works on the Geology and Palæontology of Switzerland.

Salenia Desori, *Wright*, nov. sp. Pl. XXXV fig. 2 *a*—*f*.

Diagnosis.—Test small, circular, depressed, upper surface convex; ambulacra straight, narrow, with two rows of mammillated granules; inter-ambulacra wide, four or five moderate-sized tubercles in each row; pores unigeminal throughout; apical disc prominent, with large punctuations along the sutural lines; mouth-opening moderate; peristome deeply incised; lobes nearly equal.

Dimensions.—Latitude, four and a half lines; altitude, two and a half lines.

Description.—This pretty little *Salenia* was collected with *S. Loriolii* in the Upper

Greensand of Wiltshire. The test is small and circular; the upper surface convex, and the base flat; the sides are inflated, and the disc conspicuous and prominent.

The ambulacral areas are straight, with two rows of prominent homogeneous granules on their margins, and oblique rows of small granulations, three in each, between every pair of marginal granules (fig. 2 *f*, 2 *c*). The pores are unigeminal, the pairs slightly oblique, and the zones narrow and straight.

The inter-ambulacral areas are wide, and the two rows of primary tubercles are placed close to the pores, so that the miliary zone is wide and filled with granules of different sizes (fig. 2 *c*); the tubercles are of moderate dimensions, and gradually decrease from above downwards. Four of the five sides of each plate are encircled with a row of mammillated granules (fig. 2 *f*).

The apical disc is large, solid, and prominent, the border gently undulated, and the sutural lines soldered up; in lieu thereof, there are three large punctuations between the junctions of the three anterior ovarial and sur-anal plates, and between all the ocular plates and ovarials; the oviductal holes are large; the vent is round; the periprocte thickened, prominent, and slightly excentral (fig. 2 *a*, 2 *d*).

The mouth-opening is nearly half the diameter of the test; the peristome is deeply incised, and the lobes are nearly equal (fig. 2 *b*).

Affinities and Differences.—Salenia Desori resembles *S. gibba.* It has, however, fewer granules in the ambulacra, the inter-ambulacra are more regularly developed, the apical disc is without sutures, and the mouth-opening is larger in proportion to the diameter of the test.

Locality and Stratigraphical Position.—This rare Urchin was collected from the Upper Greensand near Warminster. I have dedicated it to my friend Professor E. Desor, of Neuchatel, one of the learned authors of the 'Catalogue raisonné des Échinides' and 'Échinologie Helvetique,' and author of the 'Synopsis des Échinides fossiles' and many other valuable works on natural science.

Salenia gibba, *Agassiz.* Pl. XXXIV, fig. 4 *a, b, c, d, e.*

Salenia gibba, *Agassiz.* Monogr. des Salénies, p. 13, pl. ii, figs. 9—16, 1838.
— — *Agassiz* et *Desor.* Catalog. rais. des Échinides, Ann. Sc. Nat., 3e série, t. vi, p. 341, 1846.
— — *Bronn.* Index Palæontologicus, p. 1107, 1847.
— — *d'Orbigny.* Prod. de Pal. strat., t. ii, p. 180, 1850.
— — *Morris.* Catalogue of British Fossils, 2nd ed., p. 89, 1856.
— — *Pictet.* Traité de Paléontologie, t. iv, p. 248, 1857.
— — *Cotteau.* Paléontologie Française, Terrain crétacé, tom. vii, p. 151, pl. 1035, figs. 13—20, 1865.

Diagnosis.—Test small, circular, upper surface inflated, gibbous, under surface flat, sides rounded; ambulacra narrow, flexed, two rows of marginal, closely set, mammillated granules, with intermediate granulation; poriferous zones flexed; pores small, oblique, unigeminal; inter-ambulacra wide, tubercles large and prominent above, four or five in a row. Apical disc thick, gibbous, subconical; sutural impressions deep, punctuations large, vent circular, periprocte elevated.

Dimensions.—Specimen *a.* Altitude, two lines; latitude, four lines.
„ *b.* Altitude, five lines; latitude, six lines.

Description.—The type specimens of this species figured by Professor Agassiz and M. Cotteau, from the Cenomanian of France, have a more elevated gibbous test than any of the specimens referred to *Salenia gibba* that I have seen from the Upper Greensand of England. The shell is small and circular, the upper surface elevated, the under surface flat, and the sides inflated. The ambulacral areas are narrow, and flexed in their upper third; they have two rows of mammillated marginal granules set close together, from eighteen to twenty in a series (fig. 4 *e*), and the surface of the space between the granules is covered with a microscopic granulation. The poriferous zones are depressed, and follow the flexures of the areas; the pores are small, round, and unigeminal, and disposed in oblique pairs, the two pores forming a pair being separated by a septal granule (fig. 4 *e*).

The inter-ambulacral areas are wide, and the tubercles, of which there are four or five in a series, are large, prominent, and distant at the upper surface, and small, granuliform, and closely set together below (fig. 4 *b* and *e*); the miliary zone is narrow and sinuous, and provided with unequal granules; some of these are large and mammillated, and disposed around the primary tubercles in incomplete circles; others are smaller, and fill the lower portion of the zone with a sparse granulation.

The apical disc is thick, irregularly round and prominent (fig. 4 *c, d*), and the plates are unequal. The sutures are open and incised, and the punctures deep; in some specimens figured by M. Cotteau the disc is thick, gibbous, and subconical, and the impressions are wide and deep; the surface of the ovarial plates has small attenuated elevations, which converge at the centre of the plates. The ocular plates are sub-triangular, and appear to be perforated in the middle; the sur-anal plate is large and thick, and the oviductal lobes pierce the centre of the plates (fig. 4 *d*). The vent is sub-circular, and the periprocte prominent, with an annular projecting border.

The mouth-opening is small, rather more than one third the diameter of the test (fig. 4 *b*). The peristome is slightly incised, and the oral lobes are nearly equal.

Affinities and Differences.—In his 'Synopsis des Échinides fossiles,' my friend Professor Desor considers *S. gibba* as simply a variety of *S. scutigera;* it appears, however, to have a more inflated gibbous form, with more flexuous ambulacra, a thicker apical disc, more unequal in outline, and marked with larger and deeper perforations; and the mouth-opening is likewise proportionally smaller.

The structure of the apical disc allies *S. gibba* to *S. Bourgeoisi;* the test of the latter is much less inflated, the apical disc thinner and more depressed, the ambulacra are straighter, and the mouth-opening wider.

Locality and Stratigraphical Position.—The specimen I have figured belongs to the British Museum, and was collected from the Upper Greensand near Longleat, Wilts, where it is extremely rare. This species appears to be equally scarce in France; as it was obtained from the Cenomanian = Upper Greensand, in the "Ile d'Aix" (Charente-Inférieure). From this locality the type specimens in the Musée de Paris and others in private collections were collected.

B.—*Species from the Grey Chalk.*

Salenia Austeni, *Forbes.* Pl. XXXVII, figs. 1, 2.

Salenia Austeni, *Forbes*, MS. Woodward, Mem. Geol. Surv., Decade V, App., 1856.
— — *Forbes.* In Morris's Catalogue of British Fossils, p. 89, 1854.

Diagnosis.—Test tumid, more or less elevated; ambulacra prominent, slightly flexed, two complete rows of remote marginal granules and two incomplete rows of smaller granules within; inter-ambulacra with two rows of tubercles, five in each, decreasing in size from above the ambitus to the peristome. Miliary zone wide, sparsely covered with granules. Apical disc small, thick, prominent; sutures marked by regular punctuations; vent elevated, periprocte projecting, having a sharply crenulated border.

Dimensions.—Altitude, five tenths of an inch; latitude, seven tenths of an inch.

Description.—This beautiful *Salenia* has in general a tumid body, with a narrow base, inflated at the sides, and convex on the upper surface, the vent being very excentric, elevated, and prominent; in some examples, however, the upper surface is more or less depressed, and approaches the form of *S. petalifera.*

The ambulacral areas are narrow, nearly straight, and very prominent; they have two complete rows of remote marginal granules, twenty-four in each (fig. 1 *d*), and two incomplete rows of smaller central granules, which occupy two thirds of the area (fig. 1 *f*). The poriferous zones are narrow and slightly flexed; the pores are very small, oblique, and unigeminal, ten pairs occupying the height of a single plate (fig. 1 *f* and *g*).

The inter-ambulacral areas are wide, and regularly developed (fig. 1 *a*), with two rows of primary tubercles, gradually diminishing in size from the upper to the lower part of the area, those near the disc being large, and those near the peristome small. Fig. 1 *e* shows an entire area magnified four diameters; the tubercles are seated near the poriferous zones; each is surrounded by a wide, areolar space, and around the margin thereof three parts of a circle of six to eight large round granules are placed (fig. 1 *d, e, g*).

The miliary zone is wide throughout, and sparsely covered with small granules, especially near the discal region (fig. 1 *d, e*). The base is concave (fig. 1 *b*), and highly ornamented by the numerous small close-set tubercles of the inter-ambulacra, the large granules of the ambulacra, and the width of the miliary zones. The mouth-opening is large, more than one third the diameter of the test; the peristome is deeply incised, and forms ten nearly equal-sized lobes (fig. 1 *b*).

The apical disc is small and thick, and rises above the test (fig. 1 *c* and *d*). The two antero-lateral and the left postero-lateral plates have a rhomboidal figure, and are nearly the same size. The right postero-lateral, the single plate, and the suranal are small in consequence of the encroachment of the vent; the posterior border of the suranal is thickened and elevated (fig. 1 *c, d, i*), and rises to form the anterior wall of the periprocte; the sutures between the three anterior ovarial plates are each marked by six deep punctuations, which define their line of junction; and the sutures, uniting the ocular with the ovarial plates, have each three deep punctuations (fig. 1 *c* and fig. 1 *i*). The test I have figured has not the perforations in the ovarial sutures as distinctly marked as the test which now lies before me for description, so that this character varies in different specimens. The vent is round and elevated, and placed near the posterior part of the disc (fig. 1 *c*). The periprocte projects upward and backward (fig. 1 *a* and *d*), and forms a crenulated rim around the aperture (fig. 1 *a*, fig. 1 *d*, and fig. 1 *i*).

Affinities and Differences.—In a large majority of specimens the general form of the body in *S. Austeni* differs from *S. petalifera* in being more globose and elevated. The apical disc is smaller in diameter, and thicker in substance. The vent is likewise more elevated, the periprocte more produced, and its margin sharply crenulated. In the structure of the areas, such as the character of the granules in the ambulacra, and the tubercles in the inter-ambulacra, there is a close resemblance between these portions of the test in both species.

Locality and Stratigraphical Position.—*S. Austeni* is the most abundant species in the Lower or Grey Chalk, near Folkestone; from this locality and stratum it has been collected by my kind friend, the Rev. T. Wiltshire, F.G.S., to whom I am indebted for several fine specimens given to help me in my work.

History.—Named by the late Professor Edward Forbes, but not described by him. A brief diagnosis of the species was given by my late friend Dr. Woodward, in the Appendix to the Fifth Decade of the 'Memoirs of the Geological Survey.' It is now figured and described in detail for the first time.

SALENIA CLARKII, *Forbes*. Pl. XXXVIII, fig. 1; Pl. XXXIX, fig. 1; Pl. XLII, figs. 1, 2, 5.

SALENIA CLARKII, *Forbes*. In Morris's Catalogue of British Fossils, p. 89, 1856.
— — *Woodward*. Mem. Geol. Surv., Decade V, App., p. 5, 1856.

Diagnosis.—Test globose, elevated, flattened on the upper and under surfaces;

ambulacra narrow, two complete rows of marginal granules, and a few small central; inter-ambulacra wide, two rows of primary tubercles large in the upper part, small below; apical disc half the diameter of the test, plates roughened with raised points; each ovarial plate with five furrows leading to the large sutural pores. Spines slender, cylindrical, finely striated and granulated, the longest exceeding $1\frac{3}{4}$ inches in length, and less than one line in diameter; frequently forked at their extremities, and sometimes bent and otherwise distorted.

Dimensions.—Height, nine twentieths of an inch; latitude, thirteen twentieths of an inch.

Description.—This very distinct form of *Salenia* has an elevated body, depressed and flattened on the upper and under surfaces; the ambulacral areas are narrow and straight (fig. 1 *d*,) with two complete rows of marginal granules, about twenty in each; within these are two incomplete rows of small irregular granules, having a microscopic granulation scattered around their base. Fig. 1 *g* shows an ambulacral area magnified four times, and exhibits the increase in volume of the marginal granules near the base of the area. The poriferous zones are narrow; the pores form oblique pairs with a thick septum between, and having a small granular elevation on the surface: fig. 1 *h* shows this structure magnified six diameters, as well as the minute granulation on the surface of the plates, and the comparative sizes of the marginal and central granules in the area. The number of pores opposite each large plate is eight or nine pairs.

The inter-ambulacral areas are wide above and narrow below; there are six primary tubercles in each of the two rows, and of these the four above the ambitus are much the largest; those on the under side are much smaller and set closely together; all the tubercles have wide areolar spaces, which are encircled for three parts of their circumference with a series of large, remote, well-developed granules. Fig. 1 *f* shows an entire inter-ambulacral space magnified four diameters, and fig. 1 *h* a single plate with its primary tubercle, areolar space, and circle of marginal granules, with the poriferous zones and ambulacra, magnified six diameters. The miliary zone (fig. 1 *f*) is wider below the ambitus, and is here filled with an abundant granulation (fig. 1 *c*, fig. 1 *f*); above the ambitus, the large size of the tubercles diminishes the width of the zone, and the tubercles here are fewer and larger (fig. 1 *f*, fig. 1 *b*, and fig. 1 *d*).

The apical disc is one half the diameter of the test, and the surface of the plates is roughened with many raised points (fig. 1 *b*); each ovarial plate has five furrows leading to the sutural pores, which have an arrangement similar to the punctuations on the disc in *S. petalifera;* a semicircle of seven punctures indicates the sutures by which the sur-anal is united to the three anterior ovarials; one large and two smaller punctures mark the line of union between the ocular and ovarial plates. In fig. 1 *e* the apical disc is magnified four diameters; and the sutural punctuations are very correctly delineated in this drawing.

The spines of *Salenia Clarkii* are very well preserved with the test in the unique specimen belonging to the Museum of the Royal School of Mines, and which I have figured in Pl. XXVIII, fig. 2 *a*. The spines are slender, cylindrical, finely striated, and granulated; the longest exceed $1\frac{3}{4}$ inches in length, and are less than the twelfth of an inch in diameter; some of the spines are bent, as in figures 3 and 4, some are spatulate (fig. 2 *b*), and others are forked (fig. 2 *c*) at their extremities. The base of the spine around the milled ring has fine longitudinal lines extending a short distance up the stem, which is likewise covered by finer microscopic lines (fig. 2 *d*, and figs. 3 and 4) extending along the stem.

Affinities and Differences.—This species very much resembles *S. gibba;* but, according to Dr. Woodward, it is entirely distinct from the mould of Professor Agassiz's original example of that species.

Locality and Stratigraphical Position.—*Salenia Clarkii* is very rare in the Grey Chalk near Folkestone; from this "terrain" the specimens in the Royal School of Mines and the British Museum were obtained.

History.—First named by the late Professor Edward Forbes, in his additions to the Echinodermata in the 2nd edition of Professor Morris's Catalogue of British Fossils. A diagnosis of the species was subsequently drawn up by Dr. Woodward, in his Appendix to Decade V, Memoirs of the Geological Survey, illustrative of Organic Remains. It is now figured in detail from specimens contained in the Cabinet of the Rev. T. Wiltshire, F.G.S., and in both our National Collections.

B.—*Species from the Lower White Chalk.*

SALENIA GRANULOSA, *Forbes*. Pl. XLI, figs. 2, 3; Pl. XLIII, fig. 1 *a—h*.

SALENIA SCUTIGERA, *Forbes*. In Dixon's Geol. Foss. Sussex, pl. 340, pl. xxv, fig. 24, 1850.
— HELIOPHORA, *Sorignet*. Oursins de l'Eure, p. 20, 1850.
— GRANULOSA, *Forbes*. In Morris's Catalogue of Brit. Foss., p. 89, 1854.
— — *Woodward*. Mem. of Geol. Surv., Dec. V, 1856.
— INCRUSTATA, *Cotteau*, in Desor's Synops. des Éch. foss., p. 152, 1856.
— GRANULOSA, *Pictet*. Traité de Paléontologie, t. iv, p. 218, 1857.
— — *Cotteau*. Paléontologie Française, Terrain Crétacé, tom. vii, p. 167, pl. 1039, figs. 6—21, 1860.

Diagnosis.—Test small, circular, depressed, upper surface convex, under surface flat; ambulacra narrow, slightly flexed, with two rows of marginal mammillated granules; inter-ambulacra wide, much covered by a prolongation of the ovarial plates, tubercles small, surrounded by areolas; apical disc very large, covering like an incrustation nearly the entire upper surface; the flat ovarial plates have flexuous lines of granular processes diverging from their centres, and the convex oculars have similar lines extending over them from their inner side; the sutures smooth, and without impressions.

Dimensions.—Specimen *a.* Altitude, four lines; latitude, five lines.

„ *b.* Altitude, four and a half lines; latitude, six and a half lines.

Description.—This beautiful species was first noticed by M. l'Abbé Sorignet, in his description of 'l'Oursins de l'Eure,' and referred by him to *Hyposalenia heliophora* from the Upper Chalk (Danian) of Ciply, which M. Desor[1] described as "distinguished by its very much ornamented disc, each ovarial and ocular plate being the centre of a system of fine ridges, that radiate in all directions." This species was not figured by Sorignet; and I have not yet seen a French specimen to compare with our Urchin from the lower white gritty Chalk of Dover, where it has hitherto only been found.

The test is small and circular, the upper surface convex, the lower flat, and the sides rounded and moderately inflated (Pl. XLI, fig. 2 *c;* Pl. XLIII, fig. 1 *d*). The ambulacral areas are narrow, straight, or slightly flexed, with two marginal rows of round prominent granules, twelve to thirteen in each; those near the base are large and mammillated (Pl. XLI, fig. 1 *e*); those at the ambitus smaller, and on the upper part very small and closely placed together; the intermediate space being filled with an unequal microscopic granulation, which extends horizontally between the marginal granules.

The poriferous zones are narrow, the pores unigeminal, and set in oblique pairs, separated from each other by a small granuliform elevation of the septum; there are about eight pairs of holes opposite one of the large inter-ambulacral plates (Pl. XLI, fig. 2 *f;* Pl. XLIII, fig. 1 *h,* in which I have given accurate figures of this part of the test, magnified six times).

The inter-ambulacral areas are wide (Pl. XLI, fig. 2 *d*), and covered over in their upper third by a lateral extension of the ovarial plates; there are three or four tubercles in each row, which rise a little above the ambitus; only one or two of these tubercles in each series are well developed, surrounded by a circular areola, and having a large boss and prominent mammillon (Pl. XLIII, fig. 1 *h;* Pl. XLI, fig. 2 *f*). The miliary zone is narrow, and its granules unequal in size and structure; the larger are distinctly mammillated, and disposed in a regular crescentic form around the areolæ; where the latter abut against the poriferous zones the granules are absent (fig. 1 *h*, fig. 1 *g*); the other granules are small and irregularly disposed, filling up the space with a fine granulation (fig. 1 *h*).

The mouth-opening is very small (Pl. XLI, fig. 2 *b;* Pl. XLIII, fig. 1 *c*), in excess of one third the diameter of the test; the peristome is divided into ten equal lobes by well-marked incisions.

The apical disc is very large and pentagonal, occupying a great part of the upper surface (Pl. XLIII, fig. 1 *b*, *d*, *e*). It is convex above, and so thin and closely adherent to the shell at the borders that it appears to blend with the plates of the test; the ovarial plates are large, and of an irregular form; their surface is sculptured with small unequal punctuated lines, which appear to radiate outwards from the oviductal holes situate near

[1] 'Synopsis des Échinides fossiles,' p. 148.

the centre of the plate; the ridges on the plates resemble numbers of prominent granulations projecting outwards, which impart a granulose aspect to the surface of the disc, and is very well represented in Pl. XLI, fig. 3, and Pl. XLIII, fig. 1 *e;* a process of each plate extends into the inter-ambulacra, the ornamentation of which differs from that in the middle of the plate; the punctuated lines are widest and more flexed, and this incrusting process appears to blend with the granulations on the test; the sur-anal plate is elevated, and forms the anterior border of the periprocte; the ocular plates are heart-shaped, and more prominent than the ovarials; they are likewise covered with punctuated flexuous ridges, but the lines are more tortuous, and the style of ornamentation is different (Pl. XLIII, fig. 1 *e*) from that on the ovarials.

The spines are not preserved in any of the Dover specimens that have passed through my hands. M. Cotteau, however, describes them as elongate or aciculate, cylindrical, or a little compressed, provided with fine longitudinal sub-granular striæ; their greatest diameter is near the neck of the spine, and they regularly diminish to the upper extremity, which is pointed. The collarette is short or absent, the milled ring very prominent and strongly striated, and the rim of the articular cavity crenulated.

Affinities and Differences.—*Salenia granulosa,* Forb., strongly resembles *Hyposalenia heliophora,* Desor, from the Chalk of Maestricht; it is distinguished from it, however, according to M. Cotteau, by being smaller in size, and having its upper surface more conical, its ambulacra furnished below the ambitus with smaller granules, and in possessing fewer primary tubercles in the inter-ambulacra; the apical disc is thinner and distinctly circumscribed, the flexuous ridges on the ovarial and ocular plates are more irregular and more granular, and the periprocte is situated to the right of the axis.

Locality and Stratigraphical Position.—This fine species is found in the hard gritty whitish beds of the Lower Chalk at Dover, where it is associated with *Cyphosoma simplex,* Forb., and numerous *Polyzoa.* All the specimens I have examined were obtained from this one locality, where it is rather rare.

M. Cotteau states that it is a common species in the Étage Sénonien of Vernonnet, Giverny, Petit-Andely, Penterville (Eure), and the environs of Beauvais (Oise).

History.—M. l'Abbé Sorignet first described in 1850 this *Salenia* in his interesting memoir 'l'Oursins de l'Eure,' and identified it as the *Hyposalenia heliophora,* Desor. In the same year the late Professor Forbes, in Dixon's 'Geology of Sussex,' gave a figure of this Urchin, which he referred to *Salenia scutigera,* Gray; subsequently, in the second edition of Morris's 'Catalogue of British Fossils,' 1854, Forbes separated it from that species under the MS. name *S. granulosa.* In 1856 M. Cotteau, in M. Desor's 'Synopsis des Échinides fossiles,' named the specimens collected and identified as *Hyposalenia heliophora* by M. Sorignet, *Salenia incrustata,* Cott.; he gave the following diagnosis of this form :—" Small Urchins, well characterized by their very large apical disc, thin, and little in relief, and incrusting in some manner the whole of the upper surface of the test. The ovarial plates present a series of small points disposed like rays around many centres;

the disc is so intimately soldered to the test that it is sometimes difficult at first sight to recognize its limits." A comparison of the English with the French specimens showed them to be specifically identical, and thus M. Sorignet was the discoverer, but Forbes the namer, of this well defined species.

c.—*Species from the Upper White Chalk.*

Salenia geometrica, *Agassiz*, 1838. Pl. XLIII, fig. 2 *a—g*, fig. 3 *a, b*.

Salenia geometrica, *Agassiz.* Mongr. Échinodermes, pl. i, figs. 25—32, p. 11, 1838.
Cidaris ? vesiculosus, *Portlock.* Report on the Geology of Londonderry, pl. xviii, fig. 5, p. 358, 1843.
Salenia scutigera ? *Forbes.* In Dixon's Geology of Sussex, pl. xxv, fig. 23, 1850.
— Portlockii, *Forbes.* In Morris's Cat. of Brit. Foss., 2nd ed., p. 89, 1854.
— — *Woodward.* Mem. of the Geol. Surv., Decade V, Append., p. 5, 1856.
— geometrica, *Cotteau* et *Triger.* Échinides du Départ. de la Sarthe, pl. xlvi, figs. 1—7, 1860.
— scutigera, *Cotteau*, pars. Paléontologie Française, Terrain Crétacé, tom. vii, p. 154, pl. 1036, 1864.

Diagnosis.—Test sub-globose, elevated, convex above, contracted and concave beneath; ambulacra narrow, slightly flexuous, marginal granules separated by two rows of granulets; inter-ambulacra wide, plates slightly radiate; two rows of tubercles, seven to eight in each, the ambital large, the basal small; miliary zone with large sparse granules and minute granulations; apical disc moderate, of a regular geometrical figure, flattened, two thirds the diameter of test; sutures punctuated; plates nearly equal in size; mouth-opening small, one third the diameter of test.

Dimensions.—*a.* Altitude, eight lines; latitude, nine lines (Mr. Searles Wood's specimen).
b. Altitude, eleven lines; latitude, one inch (Mr. King's specimen).

Description.—The species to which this Urchin has been referred is considered by Professor Desor and M. Cotteau to be the *Salenia scutigera*, Gray; as I am doubtful about the identity of Dr. Gray's form, I have retained the name given by Professor Agassiz, seeing that he has published good figures and a clear description of this species in his beautiful Monograph on the Salénies. *S. geometrica* is the largest species of the genus at present known. The test is elevated and sub-globose, slightly flattened at the upper and under surfaces. The ambulacral areas are narrow and slightly flexed, with two marginal rows of close-set granules, fourteen to sixteen in each, and separated by a double row of minute granulation extending down the middle of the area (Pl. XLIII, fig. 2 *c, g, f*). The poriferous zones are narrow and slightly flexed, the pores unigeminal and oblique (fig. 2 *f*), and the septa between the pores support prominent granuliform elevations (fig. 2 *g*).

The inter-ambulacral areas are very wide throughout (fig. 2 *c*, *e*, and fig. 3 *a*, *b*); they are formed of two series of deep plates, seven in each, that support large prominent tubercles (fig. 2 *e*, *g*, fig. 3 *a*). The four ambital tubercles are the largest; they have well-defined areolas, prominent bosses, and moderate-sized mammelons. A series of mammillated granules surround the areola, except where it abuts against the zones (fig. 2 *e* and *g*). The miliary zone is wide, and filled with numerous small granulations (fig. 2 *e*) in addition to the larger granules that encircle the tubercles.

The apical disc, two thirds the diameter of the test, has a regular geometrical figure, hence the origin of the specific name (fig. 2 *a*, *b*); it is circular, slightly convex, and a little elevated at the vent. The ovarial plates have an irregular hexagonal shape, their outer sides are elongated and contracted, and the rounded external border lies within the circle described by the ocular plates, which have an irregular triangular figure, the largest side being turned outwards and slightly undulated (fig. 2 *d*); the sutures are fine, distinct, and regularly interrupted by small punctuated angular impressions; the oviductal holes open in the middle of the plates, and the orbits lie under the central projecting process (fig. 2 *d*); the surface of all the plates is quite smooth. The vent is slightly elevated, and the periprocte surrounded by a thick annulus (fig. 2 *b*, *d*); this aperture, nearly circular, occupies the posterior half of the sur-anal and the anterior halves of the two posterior ovarial plates.

The mouth-opening is one third the diameter of the test (fig. 3 *b*); and the peristome is divided into ten unequal lobes.

Affinities and Differences.—*Salenia geometrica* resembles *S. scutigera;* by some authors it is considered to be a large variety of the latter. M. Cotteau, in his beautiful Monograph on the 'Échinides du Département de la Sarthe,' figured and described this Urchin under the name *Salenia geometrica*, Ag., but in his later and most valuable contribution to the 'Paléontologie Française' has united it with *Salenia scutigera;* he says, however,[1] as to the *Salenia geometrica*, "la question est plus délicate et plus difficile à résoudre. Au premier abord, cette espèce se distingue certainement du *Salenia scutigera* par plusieurs caractères importants: sa taille est beaucoup plus considérable, car sa hauteur dépasse souvent 13 millimètres, et son diamètre 17 millimètres; sa face supérieure est plus élevée et plus sensiblement déprimée au sommet; ses tubercules inter-ambulacraires sont plus nombreux, et la zone miliare qui les sépare plus large, plus droite et plus granuleuse; ses ambulacres sont plus longs et plus flexueux, et l'appareil apicial, relativement moins grand et moins épais, affecte une forme plus pentagonale. Ces différences se reproduisent chez un certain nombre d'individus avec une constance qui n'est pas sans leur donner de la valeur; aussi, dans nos 'Échinides de la Sarthe,' n'avons-nous pas hésité à maintenir la *S. geometrica* comme une espèce parfaitement distincte.

[1] 'Paléontologie Française, Ter. Crétacé,' tom. vii, p. 157.

"Les nombreux matériaux que nous avons sous les yeux, et que nous venons de comparer, nous engagent aujourd'hui à revenir sur cette opinion. Associés aux types les mieux caractérisés il se rencontre des exemplaires chez lesquels les differences que nous venons d'énumérer s'effacent plus ou moins, et qui tendent à se rapprocher, par des passages insensibles, du véritable *S. scutigera.* Les uns, tout en conservant leur grande taille, sont moins renflés, garnis de tubercules moins abondants, et présentent un appareil apicial plus développé, plus épuis et arrondi au pourtour; les autres, plus petits, ont un appareil apicial qui cesse peu à peu d'être pentagonal, et tend, en s'agrandissant à s'arrondir sur les bords. Ils appartiennent encore à la variété *geometrica;* cependant ils offrent une grande ressemblance avec les exemplaires Cénomaniens; quelquefois même il est difficile de les en séparer.

"Woodward, d'après Forbes, decrit sous le nom de *S. Portlockii* une espèce d'assez grande taille, élevée, sub-globuleuse, à ambulacres étroits et sinueux, à disque apicial médiocrement développé; ses caractères la rapprochent beaucoup du *S. scutigera,* var. *geometrica.* Peut-être devrait-elle y être réunie."

Locality and Stratigraphical Position.—This fine large species occurs in the Upper Chalk of the North of Ireland, where it was collected by the officers of the Geological Survey, and figured in Colonel Portlock's 'Report on the Geology of the County of Londonderry.' It is found very rarely in the upper beds of white Chalk at Norwich and in Sussex, and flint moulds are not uncommon in the Gravel of Norfolk. The specimens figured belong to the British Museum. Mr. Searles Wood possesses a good example, and Mr. John King, of Norwich, has a large one which measures eleven lines in height and as much in diameter. There is also a fine specimen in the Hunterian Collection, Museum of the College of Surgeons (Woodward).

Salenia magnifica, *Wright,* nov. sp. Pl. XLIV, fig. 1, *a—l.*

Diagnosis.—Test spheroidal, much elevated; ambulacra nearly straight, two marginal rows of large mammillated and two internal rows of smaller granules; poriferous zones narrow, pores very oblique and unigeminal; inter-ambulacra wide, two rows of tubercles, seven in each, the ambital and dorsal very large, the basal very small; miliary zone wide, and sparsely covered with granulations; apical disc large, plates smooth, sutures punctuated, vent large, oblong; periprocte hexagonal, elevated, and projecting; mouth-opening small, oblong.

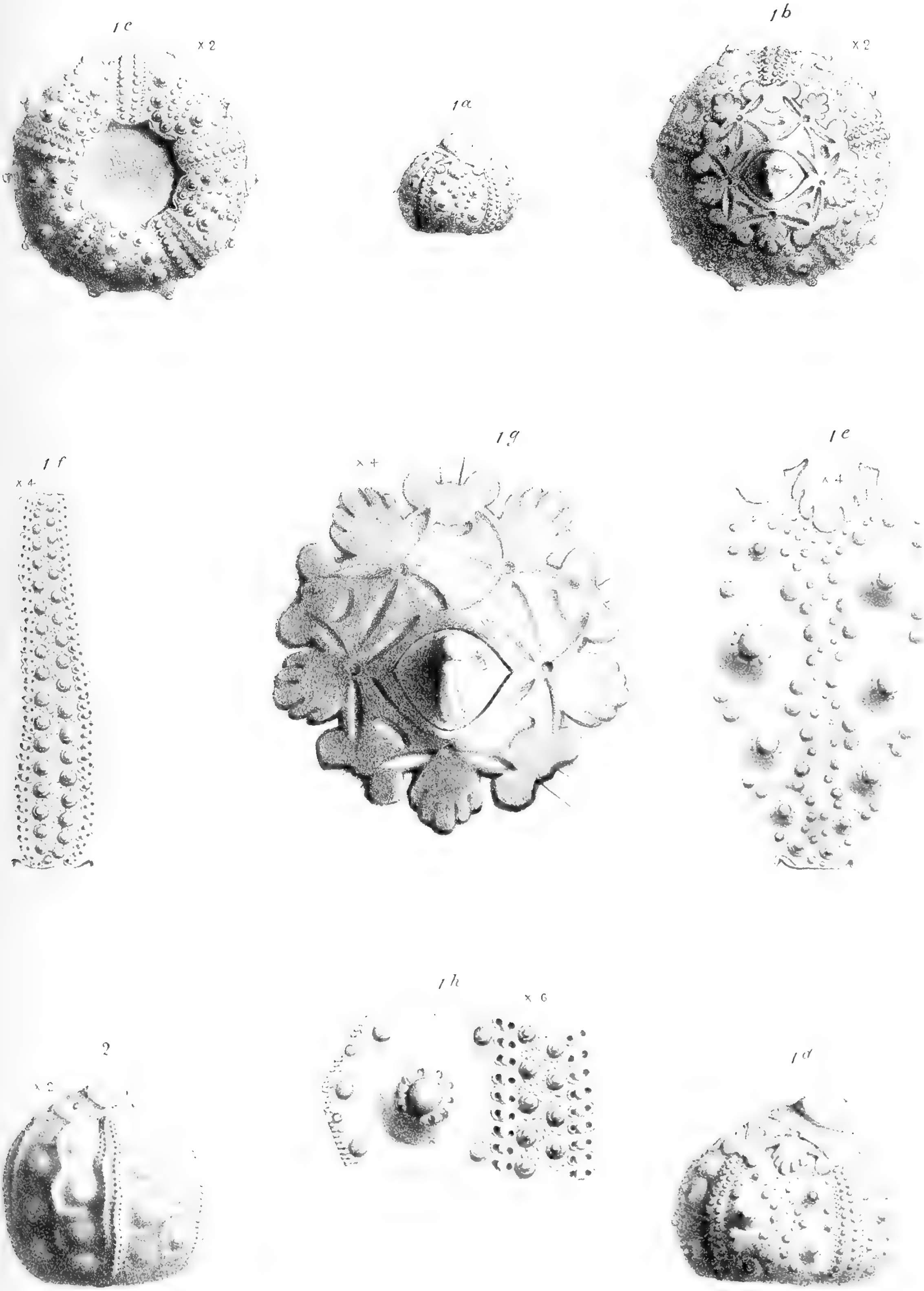
Dimensions.—Altitude, nine lines; latitude, ten and a half lines.

Description.—This magnificent *Salenia* from the White Chalk belongs to the British Museum, and to the illustration of its finely preserved details I have devoted Pl. XLIV. The test is spheroidal and much elevated, its altitude exceeding its diameter by one and a half lines; the ambulacral areas are narrow and slightly flexed, with two marginal rows of large

PLATE XL.

From the Red Chalk.

Fig. 1 *a*.	PELTASTES WILTSHIREI, *Wright*.	Test, natural size. Cabinet of the Rev. T. Wiltshire, F.G.S. (P. 161.)
b.	,, ,,	Upper surface, magnified two diameters.
c.	,, ,,	Under surface, do. do.
d.	,, ,,	Lateral view, do. do.
e.	,, ,,	Inter-ambulacral area, magnified four times.
f.	,, ,,	Ambulacral area, do. do.
g.	,, ,,	Apical disc, do. do.
h.	,, ,,	Single plate and portion of ambulacra, magnified six times.
Fig. 2.	,, ,,	Mould magnified two diameters.



C.R.Bone del et lith

M & N Hanhart imp

PLATE XLI.

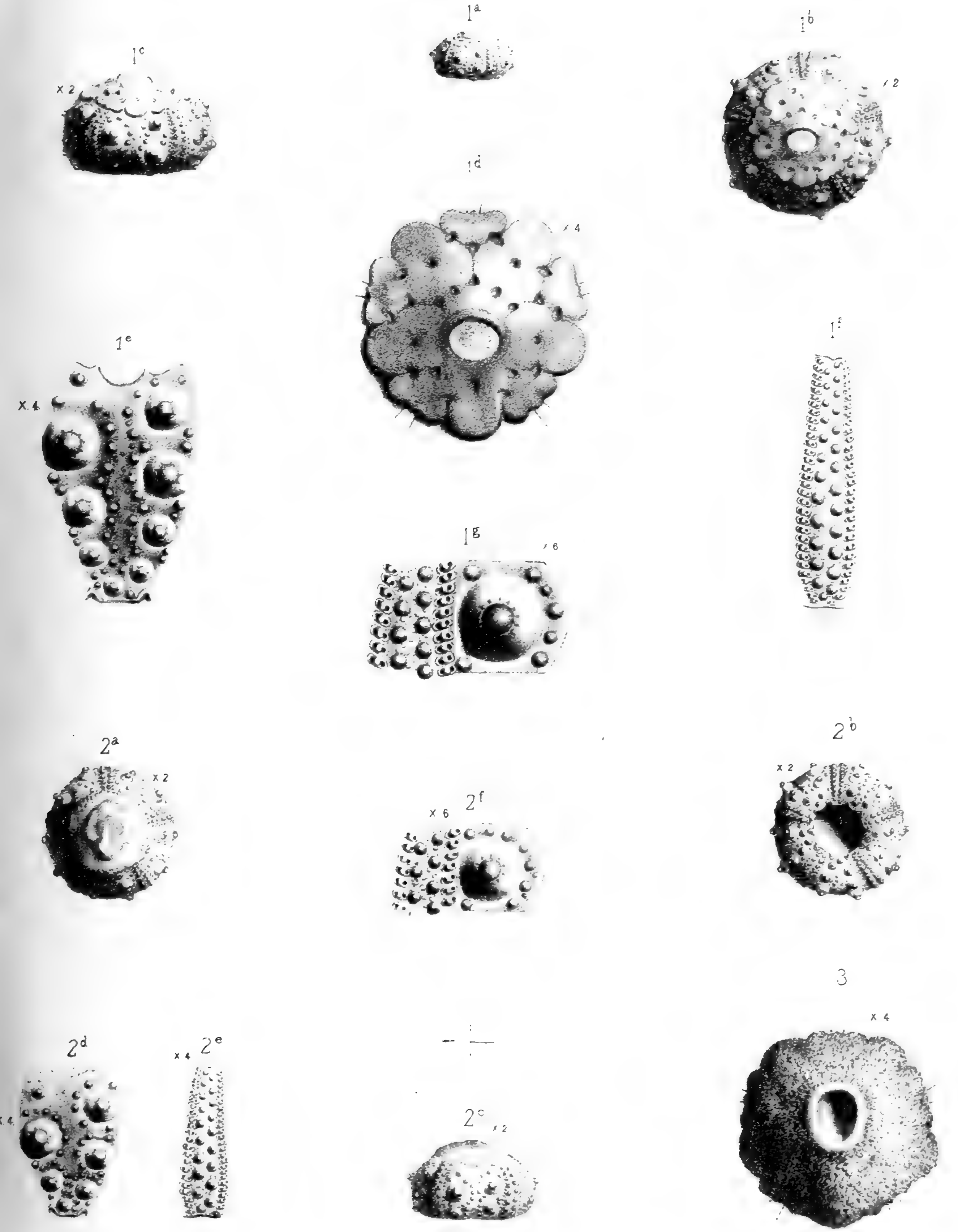
From the Red Chalk.

Fig. 1 *a.*	PELTASTES STELLULATUS, *Agassiz.*	Test, natural size. Rev. T. Wiltshire, F.G.S. (P. 153.)
b.	,, ,,	Upper surface, magnified two diameters.
c.	,, ,,	Lateral view, do. do.
d.	,, ,,	Apical disc, do. four times.
e.	,, ,,	Inter-ambulacra, do. do.
f.	,, ,,	Ambulacra, do. do.
g.	,, ,,	Single plate and portion of ambulacra, magnified six times.

From the Lower White Chalk.

Fig. 2 *a.*	SALENIA GRANULOSA, *Forbes.*	Upper surface, magnified two diameters. The British Museum. (P. 179.)
b.	,, ,,	Under surface, magnified two diameters.
c.	,, ,,	Lateral view, do. do.
d.	,, ,,	Inter-ambulacral area, magnified four times.
e.	,, ,,	Ambulacral do. do. do.
f.	,, ,,	Single plate and portion of ambulacra, magnified six times.
Fig. 3.	,, ,,	Apical disc, magnified four diameters. The Rev. T. Wiltshire, F.G.S.

Pl. XLI



C.R.Bone del et lith.

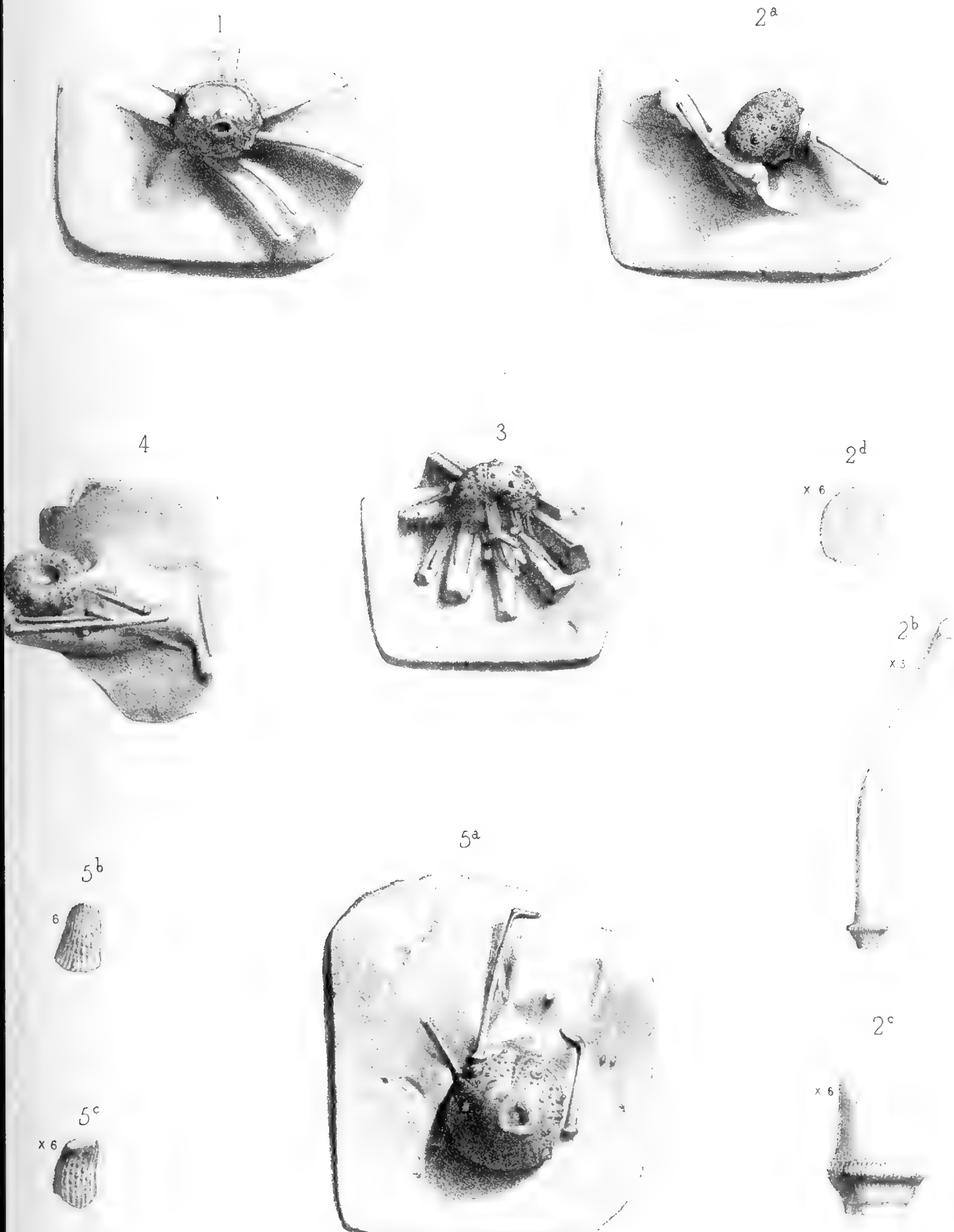
M & N Hanhart imp.

PLATE XLII.

Tests with Spines attached.

Fig. 1.	SALENIA CLARKII, *Forbes*,		with bent spines attached and *in sitû*. Rev. T. Wiltshire, F.G.S. (P. 177).
2 *a*.	,,	CLARKII, *Forbes*.	Test, with bent spines. Rev. T. Wiltshire, F.G.S.
b.	,,	,,	Spine bent near the middle, magnified three times.
c.	,,	,,	Base, showing lines and milled ring, magnified six times.
d.	,,	,,	Section of a spine, magnified six times.
3.	,,	PETALIFERA ? *Desm*.	Test, with spines, natural size. British Museum. (P. 170).
4.	,,	,,	Do. do. do. Rev. T. Wiltshire, F.G.S.
5 *a*.	,,	CLARKII, *Forbes*.	Do. do. do. Royal School of Mines.
b.	,,	,,	Portion of spine, magnified six times.
c.	,,	,,	Do. do. do.

Pl. XLII



C R Bone del et lith   M & N Hanhart imp.

PLATE XLIII.

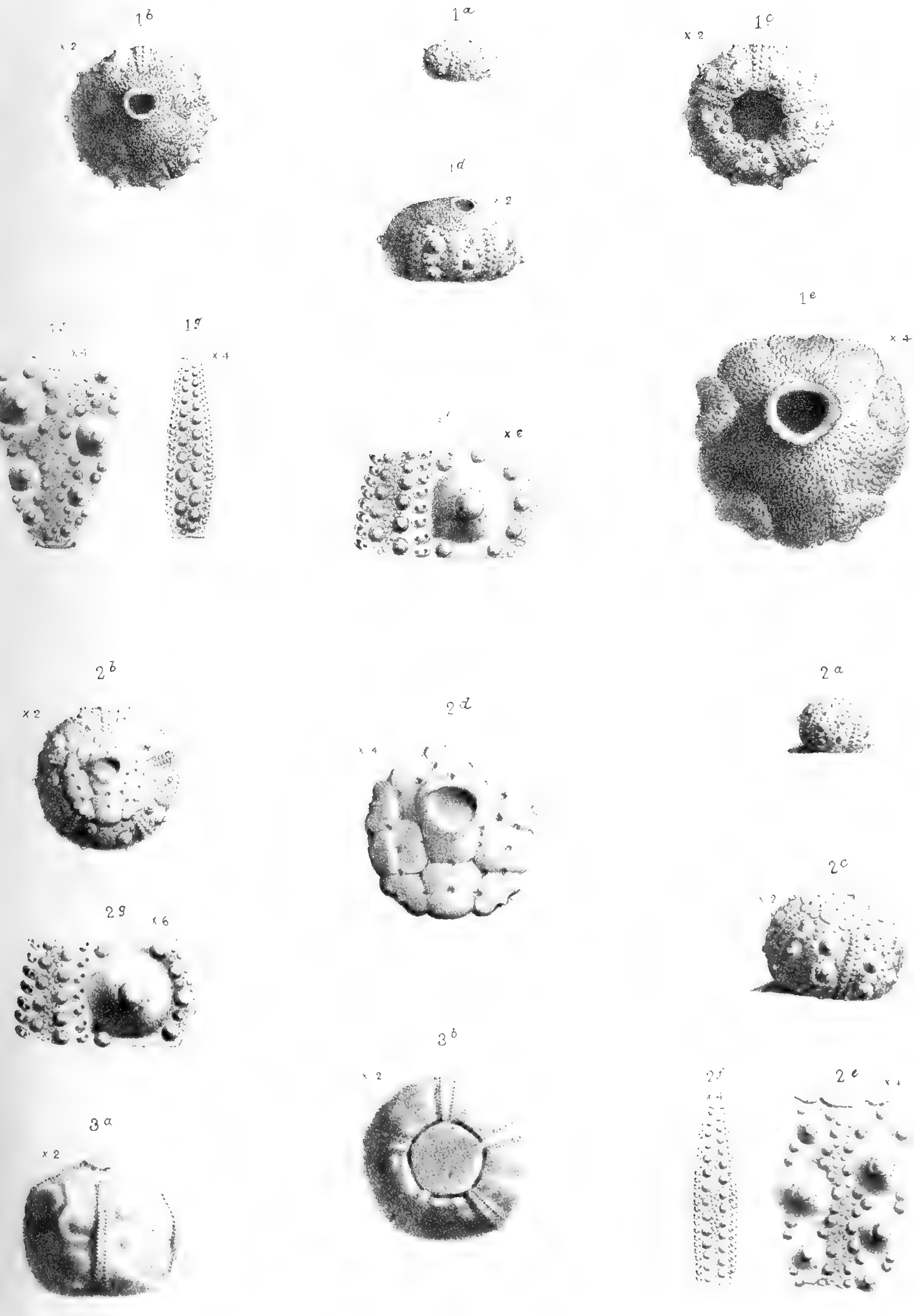
From the Lower White Chalk.

Fig. 1 *a*.	SALENIA GRANULOSA, *Forbes*.	Test, natural size. Dr. Bowerbank's Collection, now in the British Museum. (P. 179.)
b.	,, ,,	Upper surface, magnified two diameters.
c.	,, ,,	Under surface, do. do.
d.	,, ,,	Lateral view, do. do.
e.	,, ,,	Apical disc, do. four diameters.
f.	,, ,,	Inter-ambulacral area, magnified four times.
g.	,, ,,	Ambulacral area, do.
h.	,, ,,	Single plate and portion of ambulacra, magnified six times.

From the Upper White Chalk.

Fig. 2 *a*.	SALENIA GEOMETRICA, *Agassiz*.	Test, natural size. British Museum. (P. 182.)
b.	,, ,,	Upper surface, magnified two diameters.
c.	,, ,,	Lateral view, magnified two diameters.
d.	,, ,,	Apical disc, do. four do.
e.	,, ,,	Inter-ambulacral area, magnified four diameters.
f.	,, ,,	Ambulacral area, do. do. do.
g.	,, ,,	Single plate and portion of ambulacra, magnified six times.
3 *a*.	,, ,,	Mould, *in silex*, a lateral view, natural size. British Museum.
b.	,, ,,	Under surface of the same mould, natural size.

Pl. XLIII.



C. Rone. del. et lith.

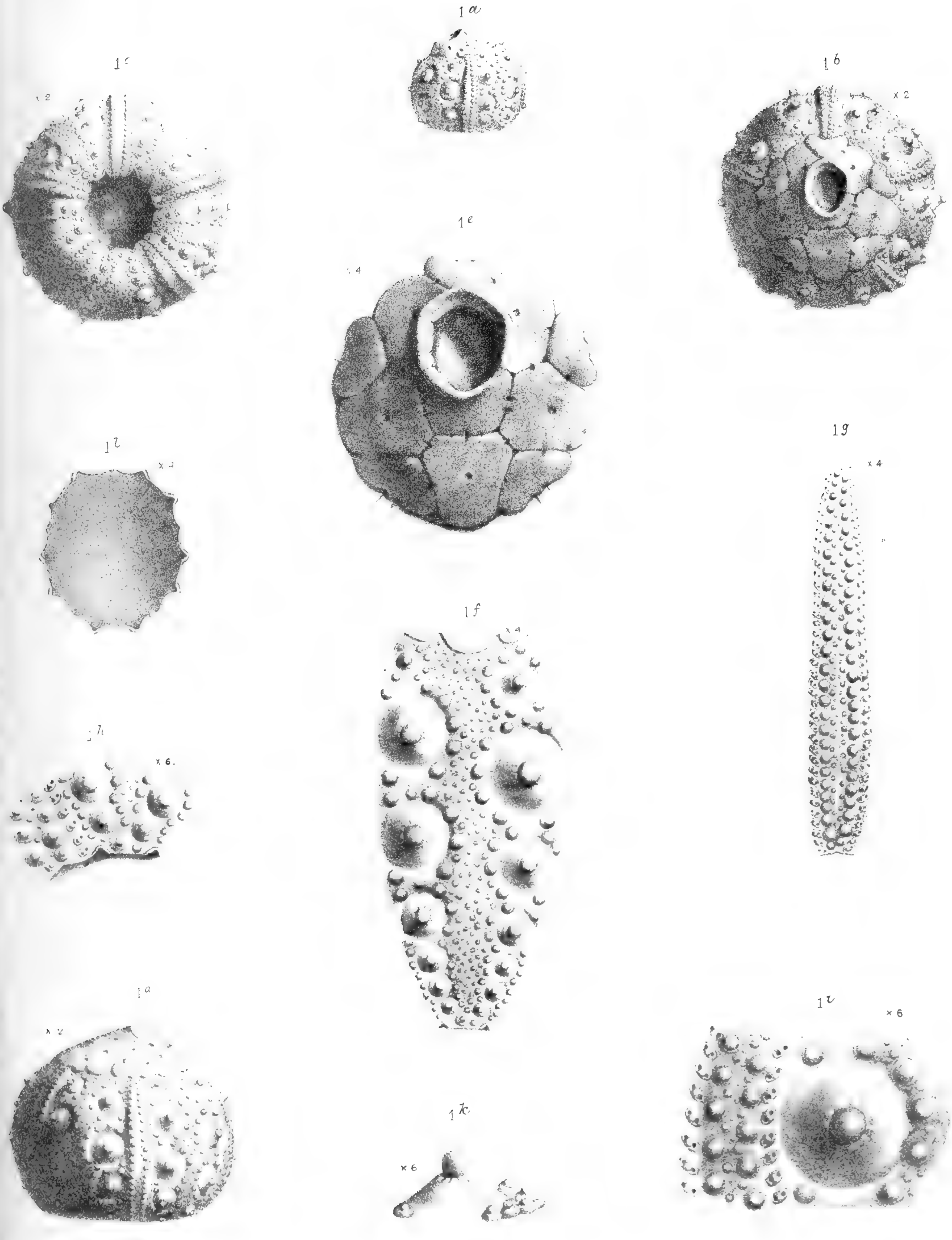
M & N Hanhart imp.

PLATE XLIV.

From the Upper White Chalk.

Fig. 1 *a*.	SALENIA MAGNIFICA, *Wright*.	Test, natural size. British Museum. (P. 184.)
b,	,, ,,	Upper surface of test, magnified two diameters.
c.	,, ,,	Under surface, do. do.
d.	,, ,,	Lateral view, do. do.
e.	,, ,,	Apical disc, do. four do.
f.	,, ,,	Inter-ambulacral area, do. do.
g.	,, ,,	Ambulacral do. do. do.
h.	,, ,,	Portion of the base of ambulacral and inter-ambulacral areas, magnified six times.
i.	,, ,,	Single plate and portion of ambulacra, magnified six diameters.
k.	,, ,,	Lateral view of a primary tubercle, magnified six times.
l.	,, ,,	Oblong mouth-opening and peristome, magnified four times.

Pl. XLIV.



C.R Bone del et lith.

M & N Hanhart imp.

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MDCCCLXXII.

A MONOGRAPH

OF THE

BRITISH FOSSIL CRUSTACEA,

BELONGING TO THE

ORDER MEROSTOMATA.

PART IV.

[STYLONURUS, EURYPTERUS, AND HEMIASPIS.]

PAGES 121—180; PLATES XXI—XXX.

BY

HENRY WOODWARD, F.G.S., F.Z.S.,

OF THE BRITISH MUSEUM.

LONDON:
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A MONOGRAPH

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BRITISH FOSSIL CRUSTACEA

OF THE

ORDER MEROSTOMATA.

PART IV.

Genus 3.—STYLONURUS, *Page.* 1856.

To the acuteness and discrimination of Professor Page, F.G.S., we are indebted for the earliest indication of two very well-marked genera of Palæozoic Crustacea of the order Eurypterida, namely, *Slimonia* and *Stylonurus*.[1] *Slimonia* has already been figured and described in the preceding part of this Monograph (pp. 105—120), and *Stylonurus* in the 'Geological Magazine' (1864, vol. i, p. 197), and in the 'Quarterly Journal of the Geological Society' (1865, vol. xxi, p. 482).

During a visit to Scotland early in 1864, I spent a week with my friend Mr. James Powrie, F.G.S., at Reswallie, which enabled me to examine the localities in Forfarshire, whence the Devonian species of *Pterygoti, Stylonuri,* &c., have been obtained. Upon that occasion, and also upon a subsequent visit in 1867, I had the great advantage of studying, not only Mr. Powrie's fine collection of palæozoic fossils, but also the collections of Lady Kinnaird, at Rossie Priory, of the University of St. Andrew's, the Watt Institution, Dundee, the Natural History Museums of Arbroath and Montrose, the Andersonian and Hunterian Museums in the University of Glasgow, and the Museum of Science and Art, Edinburgh; besides the private collections of James Armstrong, Esq., and others, in both Edinburgh and Glasgow, containing many fine examples of these palæozoic

[1] See Page's 'Advanced Text-Book of Geology,' 1856, p. 135, figs. 2 and 3, and subsequent editions. Mr. Page, however, has published no descriptions of these fossils, and his woodcut, figures, and explanations appended thereto are only partially correct.

Crustacea. During my last visit to Scotland, in August, 1871, the only additional materials for my Monograph which I then obtained consisted of the specimens of *Eurypterus Scouleri* from my friend Mr. Powrie's collection.

The most important characters by which the genus *Stylonurus* is distinguished are the peculiar form of the carapace, the great length of the telson or terminal joint (in *S. Powriei* one third the length of the entire animal), and the substitution of two pairs of long, slender, oar-like jaw-feet, instead of the single pair of broad, short, natatory organs more usually met with in this group.

Species 1.—STYLONURUS POWRIEI:—H. Woodw. Pl. XXI, fig. 1 (and fig. 2 ?).

STYLONURUS, *Page*. British Assoc. Report, Glasgow, 1855, p. 89.
— POWRIENSIS, *Page*. Advanced Text-Book of Geology, 1856, p. 135, fig. 2.
— POWRIEI, *Page*. Op. cit., 2nd edit., 1859, p. 181, fig. 3.
— — *H. Woodw.* Brit. Assoc. Report, Bath, 1864, p. 73.
— — *H. Woodw.* Quart. Journ. Geol. Soc., 1865, vol. xxi, p. 482, pl. xii, fig. 1.

Stylonurus Powriei was obtained from the Old Red Sandstone of the Turin Hill range, near Pitscandly, in Forfarshire, by Mr. James Powrie, F.G.S., of Reswallie, after whom it has been named.

The impression and counterpart of *S. Powriei* being only on sandstone, and, in all probability, the interior side of the upper surface, do not afford such good material for description as the specimens of the other species to be hereafter mentioned.

Dimensions.—The Carapace measures 2 inches 3 lines across at its posterior border, and 2 inches 7 lines in its greatest breadth, and 2 inches in length. It is bordered in front by a deep groove, $\frac{1}{8}$th of an inch from the external margin, which gradually unites with it half-way up the sides, which rapidly contract for $\frac{1}{4}$th of their length before reaching the posterior angle.

The Eyes are placed $\frac{3}{4}$ths of an inch apart, on either side of a median furrow, which, passing forward, divides into two semicircular arches, and is lost in a series of minute tuberculations. On either side of the median line are two small oblong tubercles, placed between and slightly in front of the eyes. The eyes themselves can hardly be said to be preserved in this specimen, but their position is clearly indicated.

Only two pairs of long appendages in *S. Powriei* are known. The basal joints of these were, no doubt, furnished with palpi, as in *Pterygotus*, *Eurypterus*, and *Slimonia*. They appear to have been eight-jointed, the first joints being broad and flat, precisely like that of *Stylonurus Logani;* the second, a short articulation not clearly seen; the third, about 1 inch in length, and having a keel down the centre; the fourth, 10 lines in length, also keeled; the fifth and sixth, 7 lines; the seventh and eighth, 6 lines each. The third and fourth joints seem to have been about 5 lines in width, and the others slightly narrower to the eighth, which terminates in a fine slender point, slightly incurved. The two pairs of limbs on either side appear to have been about equal both in length and breadth.

The Body-segments, twelve in number, increase gradually in breadth to the fourth, when they as gradually decrease to the eighth, whilst the four remaining segments rapidly decrease in breadth and increase in length.

Dimensions.—Thoracic segments:—First, 2 inches three lines broad, 3 lines long; second, 2 inches 5 lines broad, 5 lines long; third, 2 inches 5 lines broad, 5 lines long; fourth, $2\frac{1}{2}$ inches broad, $\frac{3}{4}$ths of an inch long; fifth, 2 inches 3 lines broad, 5 lines long; sixth, 2 inches 5 lines long; seventh (or first abdominal), 5 lines (about) long, 1 inch 7 lines broad (about); eighth (or second abdominal), 5 lines long, $1\frac{1}{2}$ inch broad; ninth (or third abdominal), 9 lines long, 17 lines broad; tenth (or fourth abdominal), 5 lines long, 14 lines broad; eleventh (or fifth abdominal), 6 lines long, 10 lines broad; twelfth (or sixth abdominal), 5 lines long, 9 lines broad, forming a semicircular curve into which the proximal end of the tail is inserted.

The Telson, or tail-spine, is 3 inches 10 lines in length, nearly 3 lines broad through its entire length, having a deep groove down its centre $\frac{1}{16}$th of an inch in width. Two zigzag lines of plicæ pass down from the head, on either side of the thoracic segments, about $\frac{3}{4}$ths of an inch from their lateral margins. These markings appear to be due to compression, and, as they are also noticeable in the Lanarkshire specimen, are probably lines along which muscular attachment within was strongest.

The Thoracic segments are slightly spinose along their posterior margins. *S. Powriei* had, probably, epimeral pieces to its abdominal segments; but being, as before stated, a cast, these pieces would not be shown attached, but remain upon the exterior slab, as is the case both in *Pterygotus Anglicus* in the Arbroath Museum, and *Stylonurus Scoticus* described herewith.

On Pl. XXI, fig. 2, is represented two detached parts of the long swimming appendages of *Stylonurus*, which, from their size, belonged to an individual larger than *S. Powriei* (fig. 1). The specimen shows that the joints were strongly keeled down the centre, and slightly serrated along the inner border.

Formation.—Pl. XXI, fig. 1, Old Red Sandstone; fig. 2, Upper Silurian.

Locality.—Fig. 1, Turin Hill range, Pitscandly, Forfarshire; fig. 2, Lesmahagow, Lanarkshire.

From the collection of James Powrie, Esq., F.G.S., Reswallie.

Species 2.—STYLONURUS MEGALOPS:—Salter, sp. 1859. Pl. XXI, fig. 3, 3 *a*.

EURYPTERUS MEGALOPS, *Salter*. Quart. Journ. Geol. Soc., 1859, vol. xv, p. 233, pl. x, figs. 9 and 10 (*not* figs. 11—14, which are referable to another species).
STYLONURUS — *H. Woodw.* Op. cit., 1865, vol. xxi, p. 486.

In a communication made by me to the Geological Society of London in June, 1865, I stated that, from an examination of *Eurypterus megalops*, Salter, from Ludlow, I was led to conclude that this was also a "*Stylonurus*."[1]

Under this name Mr. Salter had associated several detached body-segments, which, however, presented no character by which they might definitely be placed with the head-shield, upon which my conclusion was based.

"The head (writes Mr. Salter) in the largest specimens known is $1\frac{1}{4}$ inch wide (and this would give fully the length here assigned to the body [namely, 7 or 8 inches long]; it is wider than long, semicircular, granuloso-plicate, and with the hinder margin tuberculate.

"The great reniform eyes are nearly one third as long as the head, and (including the swollen base on which they are set, and the large circular eye-lobe which covers them) fully one third, measured from within the eye-lobes; they are about their own diameter apart, and placed much more than half-way, but not quite two thirds, up the head. The anterior margin of the head (carapace) is rounded, or very slightly angular, and margined all round the front."

Locality.—Base of Old Red Sandstone, Ludlow Railway.

Species 3.—STYLONURUS SYMONDSII:—Salter, sp. 1857. Pl. XXI, fig. 4.

EURYPTERUS SYMONDSII, *Salter*. Edin. New Phil. Journ., new series, 1857, vol. vi, p. 257.
— — *Salter*. In Murchison's Siluria, 3rd edition, 1859, p. 274, woodcut, Fossils (68).
— — *Salter*. Quart. Journ. Geol. Soc., 1859, vol. xv, p. 230, pl. x, fig. 1.
STYLONURUS — *H. Woodw.* Quart. Journ. Geol. Soc., 1865, vol. xxi, p. 486, pl. xiii, fig. 4.
— — *Murchison's* Siluria, 4th edition, 1867, p. 246, Fossils (69).

This very curious form, which was described by Mr. Salter, in 1859,[2] under the name

[1] 'Quart. Journ. Geol. Soc.,' 1865, vol. xxi, p. 486.
[2] Id., 1859, vol. xv, p. 230.

of *Eurypterus Symondsii,* was obtained from the middle beds of the Old Red Sandstone (" Cornstones") of Rowlestone, south of the Hay, Brecknockshire. Only the carapace has as yet been obtained, but its square form, and the indications of the bases of the great sub-central eyes, leave me in no doubt in referring it to *Stylonurus.*

It was named *Symondsii* in honour of the Rev. W. S. Symonds, F.G.S., of Pendock Rectory, near Tewkesbury, by whom it was first brought under Mr. Salter's notice, and by whose interest the original specimen is now preserved in the Museum of Practical Geology, Jermyn Street. A cast of the same may also be seen in the British Museum.

The specimen, of which we have only the exterior cast of a head, perfectly representing the surface, however, is impressed on a slab of brownish-gray micaceous grit, from the Upper Cornstones of Rowlestone, Brecknockshire, and was obtained by the Rev. Mr. Wenman. It is $2\frac{4}{10}$ inches long, and $2\frac{6}{10}$ inches broad at the wide anterior part, the greatest breadth being at the anterior third; the hinder edge is only 2 inches wide. The front margin is arched, and somewhat truncate in front, and gibbous at the sides, and from about halfway up the head it is double, or has an inner raised ridge 2 lines distant from the edge. This ridge is continuous all round with the somewhat elevated border of the sides, in such a way that the carapace appears complete, without the addition of the anterior border.

Exclusive of this border, which is concave, and somewhat bent downwards, the surface of the head is but very gently convex, and is covered, except along the posterior margin, by elevations and furrows, which give it a very rugged and lobed aspect. A deep Y-shaped vertical furrow, forked upwards at an angle of 30°, divides the space between the eyes, and occupies the middle third of the head;[1] the space between the branches is very convex.

A shallower depression takes its origin above the eyes, and radiates outward to the front margin; a pair of shorter furrows run obliquely outwards behind those organs; another deep oblique depression occurs further back, at half an inch from the hinder border, and outside it a strong triangular lobe is marked out, partly by this furrow and partly by a submarginal one, which occupies about one third the length of the head. Between these strong lateral lobes, and on the same level, a central tubercle, flanked by two depressions, occurs immediately behind the deep Y-shaped furrow first noticed. Lastly, there is a short and shallow pair of furrows in the central front portion of the head.

The posterior border is quite plain for a breadth of half an inch, and free from ridges or furrows of any kind. The posterior angles are slightly obtuse and not at all produced, the hinder edge is sinuous, and without the raised border which runs round all the rest of the margin. The eyes are large, rounded, and circumscribed by a sunken space; they are placed more than half-way up the head, and as wide apart as they are distant from the

[1] In *E. Scouleri* there is a ridge, forked *downwards,* between the eyes.

outer margin. As they are abraded in this unique specimen, their shape and convexity cannot be ascertained; they appear to have been large and rounded.

In a communication made by me to the Geological Society in June, 1865,[1] I pointed out that there was now good evidence, from the specimens of other species, discovered, since Mr. Salter described it, by Mr. James Powrie, F.G.S., in Forfarshire, and Mr. Robert Slimon, in Lanarkshire, that the remarkable crustacean carapace, referred by Mr. Salter to *Eurypterus,* was a true *Stylonurus,* agreeing most closely with *S. Logani* and *S. Powriei* in form. I accordingly referred it to that genus in the paper above quoted, and I see no reason for doubting the correctness of its allocation.

Formation and Locality.—Old Red Sandstone, Rowlestone, Brecknockshire. No other specimen has since been obtained.

Species 4.—STYLONURUS ENSIFORMIS :—H. Woodw. Pl. XXI, fig. 5.

STYLONURUS ENSIFORMIS, *H. Woodw.* Geol. Mag., 1864, vol. i, p. 198, Woodcut, p. 199.

A tail-spine of *Stylonurus,* nearly 4 inches long (probably longer when perfect), $\frac{3}{4}$ths of an inch in width, and deeply channelled through its entire length, from $\frac{2}{8}$ths at its widest part, and $\frac{1}{8}$th of an inch at its extremity, was found in the Old Red Sandstone at one of the Turin Hill quarries in Forfarshire.

This spine is so peculiar in its form, and so distinct from any other specimen as yet met with, that I have ventured to name it *Stylonurus ensiformis.* The specimen is in the collection of Mr. James Powrie, F.G.S., of Reswallie.

Formation and Locality.—Old Red Sandstone, Turin Hill Quarries, Forfarshire.

Species 5.—STYLONURUS SCOTICUS :—H. Woodw. Pls. XXII and XXIII.

STYLONURUS SCOTICUS, *H. Woodw.* Brit. Assoc. Reports, Bath, 1864, p. 73.
— — *H. Woodw.* Quart. Journ. Geol. Soc., 1865, vol. xxi, p. 484, pl. xiii, figs. 2 and 3.

Although not so large as *Pterygotus Anglicus,* this species is, perhaps, the most

[1] 'Quart. Journ. Geol. Soc.,' vol. xxi, p. 486.

remarkable of all the Palæozoic Crustacea. It was found in an Old Red Sandstone quarry in Montroman Muir, near the Forfar and Montrose Pike, by James Powrie, Esq., of Reswallie.

It is represented by a separate carapace (Pl. XXII), the relievo side of which is in Lady Kinnaird's cabinet, and the intaglio in the British Museum collection, and by an almost entire example (Pl. XXIII) which Mr. Powrie has been so fortunate as to obtain, and which is preserved in his museum at Reswallie. The latter is lying on a slab of Old Red Sandstone, at full length, with its dorsal aspect exposed, and the last five body-segments detached entire, so as to show both the ventral and the dorsal surfaces. The impression of the upper surface of the same on a separate slab exhibits in the most perfect manner the epimeral portions of each of the last four segments, and also the remarkable spatulate telson, 9 inches in length.

The entire specimen is 3 feet 4 inches in length. The margin of the carapace is much injured, but fortunately the separate carapace is well-nigh perfect, so that we are at no loss to ascertain its contour. The posterior margin of the head is at its narrowest point $9\frac{1}{2}$ inches in breadth and (about) 8 inches in length.

There is an oblong median ridge in the centre of the carapace, terminating in a smooth rounded prominence 3 inches from the posterior margin, and extending forward about 2 inches. On either side of this central line are two smaller oblong prominences, rising more in advance of the central ridge ($4\frac{1}{4}$ inches from the posterior margin, and about $\frac{3}{4}$ths of an inch in length), broader in front than behind, and curving away from the median line, from which they are distant $\frac{1}{2}$ an inch on the other side. The central ridge and lateral prominences are carried forward in a V-shaped elevation, which spreads out laterally as it advances, the whole of the front and antero-lateral portion being coarsely tuberculated, a single irregular row running down the median ridge.

The Eyes are situated parallel to the median ridge, and take their rise exactly 1 inch on either side. They are almost identical in form with those of *Phacops* and *Asaphus* among the Trilobites, being arranged in a semilunar or horseshoe shape around a raised prominence. The cornea of the eye measures 22 lines, and is disposed outwards and forwards, the centre being directed towards the latero-anterior angles. The eyes are elevated about 5 lines above the surface of the carapace; probably they may have been even higher, but are somewhat compressed.

Very minute scale-like markings are seen on the lateral and posterior margins of the carapace and body-segments.

The margin of the head is double around the frontal and latero-anterior portion, as in *S. Powriei* and *S. Logani*, &c.

Thoracic Segments.—The first segment is $1\frac{1}{16}$ of an inch in length and 10 inches in breadth; the lateral portion is rounded and curved upwards; the surface is minutely scale-marked.

The second segment is 17 lines in length and 10 inches in breadth. A series of long tubercles borders the posterior margin, and the surface is covered with minute scale-markings. The lateral portion is rounded and slightly expanded.

The third segment is 2 inches wide and $10\frac{1}{2}$ broad. Three principal prominent tubercles and several smaller ones mark the posterior margin, pointing backwards.

The epimeral portion of all the thoracic segments is widely rounded, and a broad margin of each segment overlaps the succeeding one.

The fourth segment exposes 1 inch and 10 lines of its length.

The tubercles upon this and the third segment are the most strongly marked of any. It is 11 inches in breadth. The fifth segment (thoracic) is $1\frac{3}{4}$ inch in length, and 9 inches broad. The sixth segment is 19 lines in length and (about) 8 inches in breadth. The seventh (or first abdominal) is 2 inches in length and from 5 to 6 inches in breadth. (Here the specimen is fractured across, and the margins of this segment are wanting.) Each of the abdominal segments has large epimeral pieces, which have been well preserved upon the surface of the overlying slab.

The eighth (or second abdominal) is 14 lines in length and 5 inches in breadth, including the epimeral portion, which is clearly shown. The ninth (or third abdominal) is $2\frac{1}{2}$ inches long and $4\frac{3}{4}$ in breadth. The tenth (or fourth abdominal) is $2\frac{1}{8}$ inches in length and $4\frac{1}{2}$ inches broad, including the epimeral portion. The eleventh (or fifth abdominal) is $2\frac{3}{4}$ inches long and 3 inches 10 lines in breadth, including the epimeral portion. The twelfth (or sixth abdominal) is $2\frac{1}{4}$ inches in length and $3\frac{3}{4}$ inches in width. From this segment two elongated epimeral pieces are developed, measuring $4\frac{1}{2}$ inches in length by about 5 lines in width, and terminating in a broad rounded point.

The Telson ($9\frac{1}{4}$ inches in length) is somewhat broad at the point of attachment, and becomes slightly narrower in the first quarter, gradually widening to $1\frac{1}{2}$ inch.

The central depression is $\frac{3}{4}$ inch in width. The termination is rounded, and the border does not appear to have been ornamented. Of the appendages, there remains only the joint of a swimming-limb attached to the left margin of the carapace, measuring 4 inches in length by 2 in breadth, and having a row of tubercles upon the centre.

In a letter dated 9th February, 1865, Mr. Powrie wrote to me as follows:

"Mr. Salter has expressed his conviction that *Stylonurus Powriei* and *S. Scoticus* are specifically the same—the larger one a full-grown male, and the smaller a young female, the longer and narrower body, shorter tail, and epimeral appendages being all characteristics of the male; in other respects the resemblance is most marked."

Were we to accept this opinion, that *S. Powriei* and *S. Scoticus* are identical, then the method of determining the sexes in the British and American species of *Eurypterus, Pterygotus,* and *Slimonia,* hitherto adopted, namely, by the two forms of thoracic plates, must be abandoned. Moreover, if we are to be guided by more general characters than those of the sexual plates, we must expect the antennæ to be modified in the male, as in the recent *Limulus;* in which case the two or three forms of plates in *Slimonia acuminata* would indicate two or three species of females, while the several forms in *Pterygotus bilobus* would probably indicate the males with their chelate antennæ. But to establish this position, most palæontologists would require evidence as conclusive as that obtained by Mr. Binney in the case of *Stigmaria* and *Sigillaria*.[1]

Formation and Locality.—Old Red Sandstone, Forfar.

Species 6.—STYLONURUS LOGANI:—H. Woodward. Pl. XXIV, fig. 1.

STYLONURUS, *Page*. Brit. Assoc. Rep. Glasgow, 1855, p. 89.
— SPINIPES, *Page*. Advanced Text-Book, 2nd edition, 1859, p. 181, fig. 1 (*no description*).
— LOGANI, *H. Woodward*. Geol. Mag., 1864, vol. i, p. 197, pl. x, fig. 1.

Since Mr. Page figured *Stylonurus Powriei* in 1856, then the only species known, much better specimens have been found, not only by Mr. Powrie, of Reswallie, in Forfarshire, but also by Mr. Robert Slimon, of Lesmahago, in Lanarkshire. A specimen of another species of this genus, from the last-named locality, furnishes us with most valuable details as to the minute structure of this remarkable generic form.

Only one specimen of this species from Lesmahagow, Lanarkshire, is known, the intaglio half of which is in the Museum of Practical Geology, Jermyn Street, and the relievo half in the collection of Mr. James Powrie, of Reswallie. It is from the former half that our present figure is taken[2] (Pl. XXIV, fig. 1).

The specimen exhibits the carapace and the body-rings as far as the tenth segment united, and one of the long slender swimming-feet *in sitû* on the left side, whilst on the right are seen the bases and portions of two other long appendages. Lying upon the slab, in various positions around the head, are four spiny eight-jointed palpi, or foot-jaws, one of which still retains its attachment to the carapace, although twisted and bent from its natural position.

Upon referring to the figure of *Stylonurus Powriei* in Page's 'Advanced Text-book' (3rd edit., p. 190, fig. 1), it will be seen that it has *two pairs* of long slender swimming-feet upon either side of the head. In the species here figured, from Logan Water, there is also evidence of a second pair of long limbs, making, with the spiny palpi, four pairs of appendages; the fifth and absent pair being, no doubt, the antennæ, which, as in *Slimonia* and in *Eurypterus*, were probably much smaller (*ante*, p. 109, Fig. 31, *et infra*, p. 142, Fig. 44). The form of the carapace in *Stylonurus* is well marked, and very different from any other genus in this singular family.

In the Logan Water shales, although the finest and most delicate markings are often

[1] See Dr. Hooker's Memoir on "Vegetation of the Carboniferous Period;" 'Mem. Geol. Surv.,' 1848, 8vo, vol. ii, part ii, pp. 417, 432, &c.

[2] We figured Mr. Powrie's specimen in the 'Geological Magazine,' 1864, vol. i, pl. x, fig. 1.

preserved, yet the specimens are so compressed as to give scarcely any idea of their original contour, except by comparison with those from the Old Red Sandstone of Forfarshire and elsewhere.

The Eyes are situated upon the surface of the carapace, somewhat near the anterior angles. They were reniform, and raised upon round prominent bosses, but these are now squeezed flat to the surface of the head.

The Carapace is quadrate, with the anterior angles rounded; the sides present a slightly waving outline, contracting towards the posterior angles. The margin is double, having an inner ridge, which circumvents the sides and front and terminates in a rounded elevation at the posterior angles. An inner border-line also passes up each side and around the front of each eye, reminding us of the cheek-sutures in the Trilobites.

No sculpturing is noticeable upon the surface of the carapace, but (as is the case with all the Logan Water specimens) impressions of portions of the organs are seen, the position of which is beneath the surface of the head.

The basal joints of several of the palpi are visible; and, underlying the 1st and 2nd thoracic segments, may be discerned the median appendage of the thoracic plate.

The Body is extremely slender, as compared with *Pterygotus*, and the segments in this species (as in *St. Powriei*) had very small epimeral portions. The 11th and 12th segments, which are not preserved, were doubtless still narrower; and the telson was probably a long styliform appendage, as in *St. Powriei.*

Dimensions of *Swimming-foot:*—Basal joint, 6 lines in length and 5 broad; 2nd joint, 2 lines long, 4 broad; 3rd, 1 inch long, 2 lines broad; 4th, 10 lines long, 2 lines broad; 5th and 6th, each 8 lines long and 2 lines broad; 7th, 6 lines long, 1 line broad; 8th, 5 lines long, 1 line wide, terminating in a fine point.

Carapace:—Greatest anterior breadth, 1 inch 3 lines; greatest length, 1 inch 2 lines; width between the eyes, 5 lines; breadth of inner raised margin, 1 line.

Thoracic segments:—1st segment, 2 lines long and 1 inch and 1 line wide; 2nd and 3rd, 3 lines long and 1 inch wide; 4th, 4 lines long and 1 inch 1 line wide; 5th, 3 lines long by 1 inch wide; 6th, 2 lines long and 11 lines wide. The posterior margin of each segment is ornamented by a row of minute spines along the border.

Abdominal segments:—7th segment, 2 lines long by 10 lines wide; 8th, 3 lines long by 9 lines wide; 9th, 3 lines long by 8 lines wide; 10th, 3 lines long;—here the specimen is broken, and the 11th and 12th segments and telson are wanting.

The form of the carapace and the position of the eyes are two very well-marked features in this genus; these, and the two pairs of long slender oar-like feet, sufficiently separate them from the rest of the family, but even the long tail-spine is peculiar.

From the extreme rarity of its occurrence in a formation where other genera are so numerously represented, I am strongly inclined to believe this form to have been a *larval* condition probably of some other genus of the same group.

I have named it after my friend Sir William Logan, F.R.S., the late Director of the

Geological Survey of Canada, whose great services to geological science, as well as his kindly disposition to all, will long cause him to be remembered and esteemed.

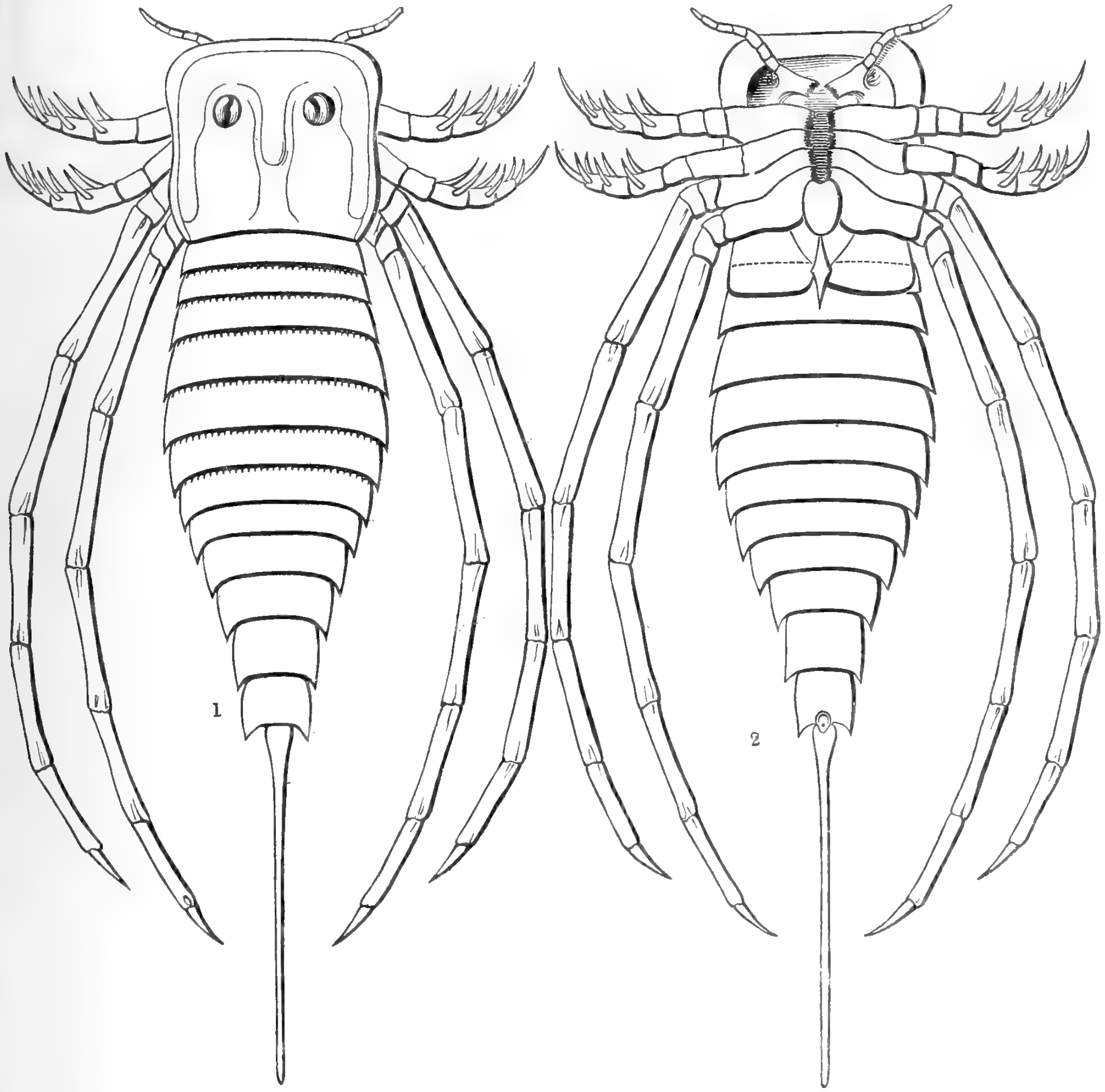


FIG. 39.—*Stylonurus Logani*, H. Woodward (restored).
About natural size. From the Upper Silurian, Lesmahagow, Lanarkshire.
1. Dorsal view. 2. Ventral aspect.
(Only the 10 anterior body-segments are preserved; the hinder part and the telson are added from the evidence afforded by the specimen of *Stylonurus Powriei* from the Devonian. See Pl. XXI, fig. 1.)

Formation.—Upper Silurian.

Locality.—Logan Water, Lesmahagow, Lanarkshire.

The original specimens are in the collection of James Powrie, Esq., F.G.S., of Reswallie, Forfar, and in the Museum of Practical Geology, Jermyn Street.

Genus 4.—Eurypterus, *Dekay*, 1825.

The first notice of the discovery of *Eurypterus* was made in America in 1825 by Dr. J. E. Dekay, who described and figured the only species then known, the *Eurypterus remipes*, and referred it to the class Crustacea, and to the order *Branchiopoda*.

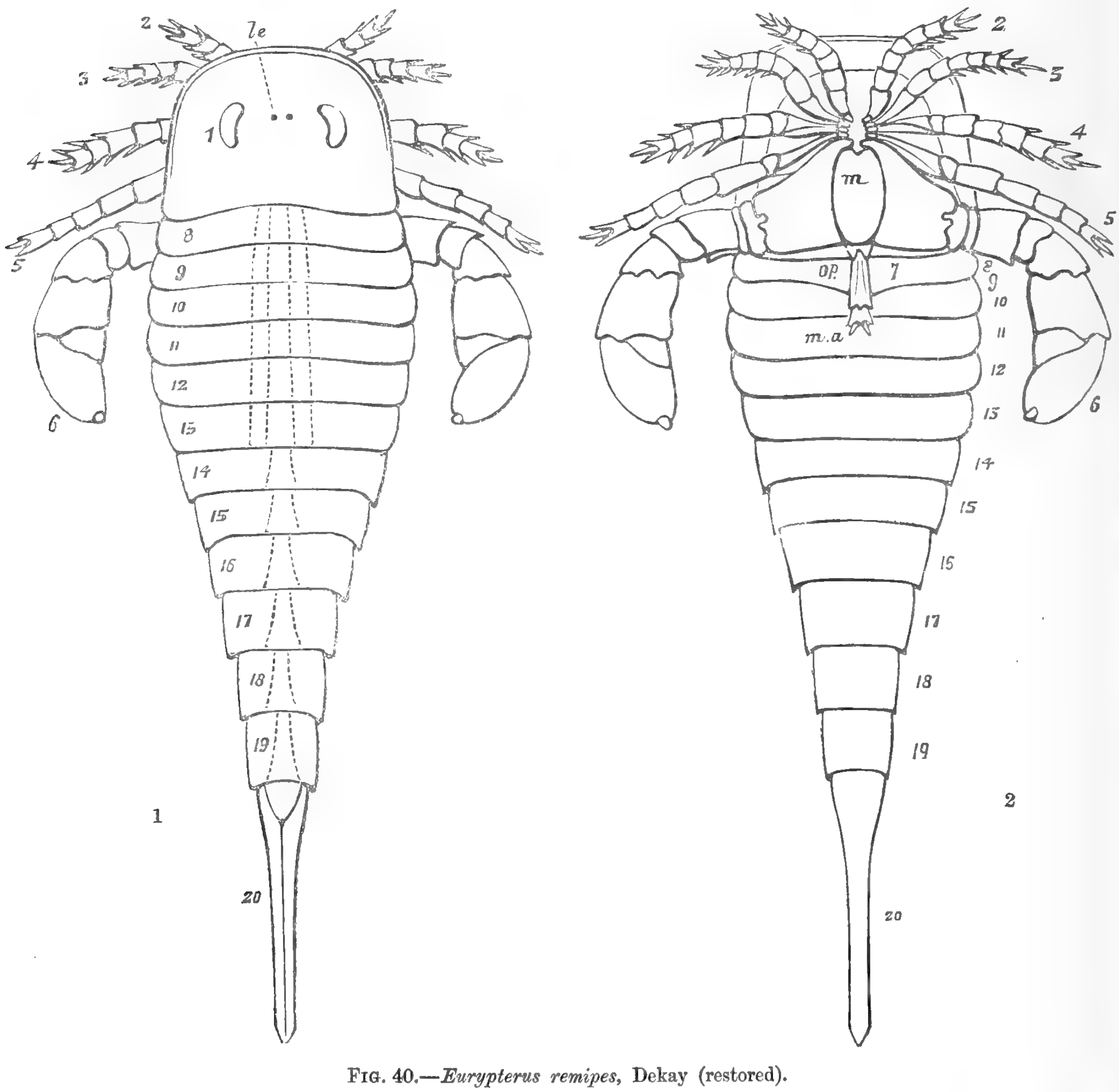


Fig. 40.—*Eurypterus remipes*, Dekay (restored).

From the Waterlime group (Uppermost Silurian), Waterville, Westmoreland, Oneida County, and at Wheelock's Hill, Litchfield, Herkimer County, New York.

Copied from Hall's 'Palæontology of New York,' 1859, vol. iii, part i, text p. 403*, figs. 6 and 7, and part ii, plate 84A, figs. 1 and 2. "The parts represented are not in any respects imaginary, but have all been seen in different individuals or parts of individuals, and are known to have the relations here expressed." (Explanation of plate 84A by Prof. James Hall.)

1. Dorsal view. 2. Ventral aspect.

The remains of a British species of *Eurypterus*, which probably measured nearly two feet in length, were discovered in the Freshwater Limestone of Carboniferous age, at Burdie House, near Edinburgh, and recorded by Dr. John Scouler, of Glasgow, in 'Cheek's Edinburgh Journal' (vol. iii), 1831, under the generic name of *Eidothea.*

In 1836, Dr. S. Hibbert figured four specimens of this Burdie House Crustacean, and referred them to *Eurypterus,* under the name of *E. Scouleri.*[1]

Dr. Harlan, Mr. Conrad, Mr. Vanuxem, and Prof. James Hall, in America; Fischer de Waldheim, Edward von Eichwald, and Dr. J. Nieszkowski, in Russia; Prof. Reuss, Dr. Jordan, and H. von Meyer, in Germany; and Mr. J. W. Salter, in England, have all contributed to the bibliography of this genus.

Both the Russian and American species of *Eurypterus* are well preserved, and have been carefully figured.

But the most instructive and elaborate description and figures of this genus are to be found in the 'Palæontology of New York' (vol. iii, 1859), by Prof. James Hall, of Albany.

The figures on the preceding page are copied from his work, and convey the clearest idea of the details of the organs and form of the body-segments in this genus which have yet been produced. They will prove of the greatest service in elucidating the less perfect and often very fragmentary remains which occur in our own rocks.

As elsewhere shown in the Tables of the Geographical and Geological Distribution of the Merostomata (see Part I, pp. 11—19), there is in this, as in all other fossil genera, the same relative distribution in time and space.

Thus we find *Eurypterus* represented in time from the Lower Ludlow (*U. Silurian*) to the Lower Carboniferous—the greatest longevity attained by any of the Eurypterida; whilst in space they extend from the United States and Canada to England, and so on to Oesel and Gotland, Poland, Russia, Bohemia, and Rhenish Prussia.

About 23 species are known belonging to this genus, 17 of which occur in the Upper Silurian, the rest are found in the Devonian and Carboniferous rocks (see p. 19).

Species 1.—EURYPTERUS SCOULERI:—Hibbert, 1836. Pls. XXV—XXVII.

Eidothea, *Scouler*, 1831. Cheek's Edinb. Journ. of Nat. and Geogr. Sc., new ser., No. vi, June, 1831, pl. x, p. 352.

Eurypterus Scouleri, *Hibbert.* Trans. Roy. Soc. Edinb., 1836, vol. xiii, part i, p. 280, pl. xii.

— — *Ib.* Salter, Quart. Journ. Geol. Soc., 1863, vol. xix, p. 82.

— — *Ib.* Page's Advanced Text-Book of Geology, 1859, 2nd edition, p. 189 (with a woodcut).

The Council of the Andersonian Institution have kindly granted me permission to

[1] 'Trans. Roy. Soc. Edinburgh,' vol. xiii, p. 280, pl. xii.

examine and figure the fine head of *Eurypterus Scouleri*, which forms the subject of our Pl. XXVII. This is the original specimen figured in 'Cheek's Edinburgh Journal,' by Dr. John Scouler, F.L.S., in June, 1831, under the name of *Eidothea.*

For the opportunity to figure the other carapace and conjoined posterior body-segments of this remarkable Crustacean, forming the subjects of Pls. XXV and XXVI of this Monograph (and which were with the preceding specimen all figured by Dr. Hibbert in the 'Trans. Roy. Soc. Edinburgh,' 1836, vol. xiii, pl. 12), I am indebted to the kindness of my friend James Powrie, Esq., F.G.S., of Reswallie, Forfarshire.

Of the first of these specimens Mr. Salter writes as follows :[1]—" The large carapace is all but perfect (a portion of the right side only being absent), and in its natural condition uncompressed ; so that the great convexity of the form is manifest. The carapace and the two front body-rings (preserved so as to show both their dorsal and ventral surfaces) are retained in this specimen, attached to one another ; and, bent upward beneath it, is a large fragment of a swimming-foot, consisting of the first four joints, all imperfect.

" The dimensions are as follows :—Carapace, forming more than a quarter of a sphere, [6][2] inches long by fully [8] broad, and the convexity such as to follow the shape of the body-rings, which are each [$6\frac{1}{2}$ inches] broad and [$\frac{3}{4}$ inch] deep from back to front. The greatest convexity is in the region behind the eyes, which are placed, not quite halfway up the head, near together, only an inch and a quarter apart. They are divided from each other by a pair of inflated triangular lobes, with a small central process lying in the deep hollow between them. This central prominence, the round approximate eyes, together with the rough, hirsute, spinous character of the convex region behind the eyes, give the whole head much the appearance of a deformed human countenance.

" The outline of the carapace is about two thirds of a circle, the short, broad, spinous ears being curved inwards, not outwards ; and the posterior edge is only gently arched. A very distinct depression indents the front, but does not affect the actual anterior margin. The round prominent eyes are also set in depressions, which run from them in a curved line to the inner margin of the broad posterior spines on each side, and thus enclose the convex, semicircular space which, lying behind the region of the eyes, is covered with thick-set spinous squamæ. Another deep triangular indentation lies between two thick lobes, diverging backward, which separate the eyes ; and, as these lobes are much swollen, the depression is really greater than any of the others. In the midst of it lies a short, triangular, prominent mass, broken in our specimen. Above, in front of this depression, is a slight boss (which would very probably be the place of the minute stemmata, were they preserved) ; but there are no wrinkles nor elevations of any kind in front of the eyes. The whole surface is evenly convex, divided by the semicircular furrows from the rugose portion behind the eyes, as above mentioned. The margin is narrow,

[1] 'Quart. Journ. Geol. Soc.,' 1863, vol. xix, p. 82.

[2] The specimen having been remeasured, the numerals within the brackets are the correct dimensions. —H. W.

thickened, and raised all round. The ornament of the surface is minute in front, and consists of small prominent tubercles, with minute granules between them; further down the sides the tubercles become triangular squamæ, with others interspersed; and these squamæ become larger and larger towards the ears (with raised borders, and generally a strong central tubercle), and attain their largest size on the posterior area, where they are also narrower and more pointed, as well as stronger, than elsewhere. On the extreme hinder border they become linear ridges, and in this form they also occur on the free edges of the body-segments. The crust is not thick; and the squamæ, except in the largest, appear to be more convex and prominent beneath the crust than above it, so as to indent the cast. This is particularly the case with the smaller squamæ, which are so concave above as to be truly convex below; the margin shows this conspicuously, and wherever the surface has been abraded or weathered, the hollows are much deepened and exaggerated.

"The body-rings have a great convexity, as above stated; the two anterior rings are very short, not more than [$\frac{3}{4}$ths] of an inch long even in this large specimen. On the under side they expand into the broad sternal flaps so characteristic of this family of Crustacea. One of the swimming-feet is [partially] preserved. The basal joint is either very small, compared with that of *Pterygotus*, or is imperfect. The shape of the other three is not well defined; but they are evidently thick, carinate at the edges, and have the usual triangular or wedge-like shape alternately in the lower joints."

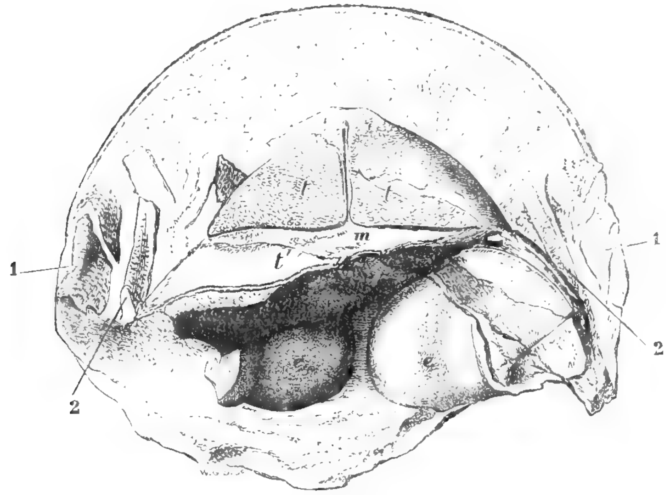


Fig. 41.—Under side of head of *Eurypterus Scouleri*, Hibbert. From specimen in Mr. James Powrie's collection.

In Dr. Hibbert's description of *Eurypterus Scouleri*, he says ('Trans. Royal Soc. Edinb.,' vol. xiii, p. 281):—"The *Eurypterus Scouleri* is to be distinguished from other species by the prolonged eminences intervening between the eyes, which, at their apex, form an angle wherein appears a central tubercle; also by the small, acutely angular protuberances, like spines, which are diffused over the surface of the head beneath the eyes. The characters of the feet cannot be given, as no vestiges of them, except very slight ones, have turned up. In truth, there is no known species with which it can be confounded, nor any approaching it in size."

Of the other specimens of *E. Scouleri* from Mr. Powrie's collection, the head (Pl. XXV) is principally important on account of its under side (Pl. XXV, fig. 1*c*, and Woodcut, Fig. 41), which, after careful and patient development, has revealed the bases of the great swimming-feet or maxillipeds (*e*, *e*), and a large elliptical plate (*t*, *t*), which I can only interpret as the thoracic plate forced in and displaced by pressure, so as to occupy its present position under the carapace. A second and inner plate, marked *t′*, underlies this opercular plate; there are also remains of two pairs of endognathary palpi (1 and 2) on either side. This assumed thoracic plate (?) is strongly arched, and is divided down the centre by a suture (*m*), extending nearly to its upper and anterior border.

A portion of one of the ectognaths is preserved upon the under side of the fine head from the Andersonian University collection[1] (Pl. XXVII) already described, but not in a sufficiently perfect state to be worth figuring here.

Body-segments.—We have evidence of ten body-segments belonging to this species, two of which, the most anterior, are attached to the large head figured on Pl. XXVII; the remaining eight are the most posterior of the body-rings, and are from Mr. James Powrie's collection.

These last named (Pl. XXVI) being united in series, give a very excellent idea of the peculiar short robust form of the body in *E. Scouleri* as compared with the other species of *Eurypteridæ*. The segments are very short in proportion to their breadth and thickness, and are folded in along each margin, so as to form a most powerful series of articular surfaces to the body-rings, capable of offering enormous resistance to external force.

The subjoined Woodcut (Fig. 42) may serve to illustrate this structure, which presents a stronger form of body-joint than that of any modern Crustacean with which I am acquainted, there being no interspace between the body-rings protected by connecting membrane, as in many Macrouran Decapods, but the solid somites are each furnished with a broad infolded margin (measuring, in the second segment from the head, three fourths of an inch in width), which is convex along the anterior border of each ring and concave along the posterior edge, while the lateral angles are compressed into a ball in front, and enlarged into a socket behind, so as to complete the powerful hinge of this armour-plated body-covering.

[1] It is possible that some further light might be afforded as to the appendages of this very remarkable species, by attempting to develope the underside of this last-named specimen, but the tough and concretionary nature of the matrix, which yields most unwillingly under the chisel-point, renders the task of removing it not only very difficult, but also somewhat dangerous to the specimen itself, which would be very apt to shatter from the repeated blows required. I have therefore thought it more prudent to desist.

The remains referred to give evidence of two individuals differing considerably in size; the head-shield of the larger specimen (Pl. XXVII) measuring 8 inches in breadth and 6 inches in length along the convex dorsal surface of the shield, whilst the smaller, (Pl. XXV) measures 7 inches in breadth and $5\frac{1}{2}$ inches in length.

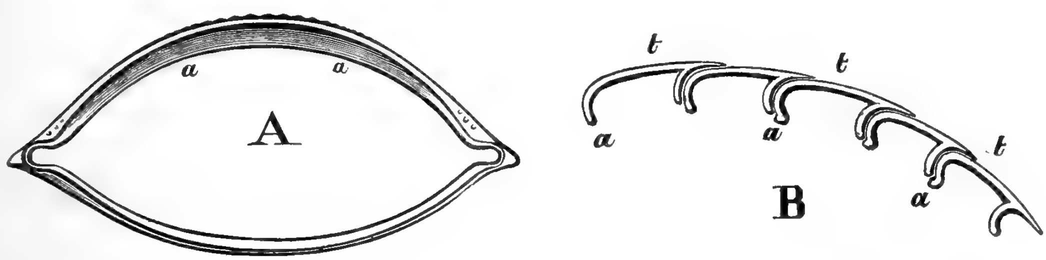


FIG. 42.—(A) Diagram of articular surface of posterior border of one of the body-rings of *Eurypterus Scouleri*. (B) Diagram of longitudinal section of body-rings of same, showing the mode of articulation of the segments; *t*, *t*, tergal pieces; *a*, *a*, infolded articular borders.

The detached series of posterior segments figured on Pl. XXVI may have belonged to an individual equal in size to that represented by the lesser head-shield. The posterior segments show a considerable increase in length, as compared with the two most anterior (thoracic) rings, but they have also diminished considerably in breadth.

These two anterior body-rings (attached to the head, see Pl. XXVII) are ornamented with a single row of narrow, acute, well-defined, spine-like squamæ, very like those on the posterior border of the head-shield. They are each $6\frac{1}{2}$ inches in breadth along the dorsal surface and $\frac{3}{4}$ths of an inch in length.

The posterior free margin of the series of abdominal somites (Pl. XXVI) is ornamented on its dorsal border with a series of blunt, rounded, equidistant spines, and the surface itself is covered with squamæ (Pl. XXVI, figs. 1 and 3), whilst the ventral border of the larger segments is roundly dentated (figs. 2 and 4), and that of the penultimate segment is more acutely so (fig. 5). The ventral surface is not covered with squamæ, but is finely punctate, reminding one of the structure of the carapace in many Brachyurous Crustaceans.

The circumference of the XIIth segment is $10\frac{1}{2}$ inches, and the breadth of its dorsal surface $5\frac{1}{4}$ inches. That of the XVIIth is $8\frac{1}{2}$ inches, and the breadth of its dorsal surface 4 inches. Girth of the penultimate segment 5 inches, breadth $2\frac{1}{2}$ inches. The length of the 8 posterior segments, measured down the dorsal line, is $6\frac{1}{2}$ inches.

Guided by the two thoracic segments (Pl. XXVII), and by the series of united abdominal segments seen in Mr. Powrie's specimen (Pl. XXVI), I have prepared a drawing of the entire body of *E. Scouleri* to the scale of the larger head-shield figured on our Pl. XXVII, from which I estimate the entire body to have been 22 inches in length divided as follows:

20

Head, $5\frac{1}{2}$ inches in length.			
Six anterior (thoracic) body-segments, $4\frac{1}{2}$ inches.			
Six posterior (abdominal)	do.	6	„
Caudal spine (?) . . .		6	„

The caudal spine and appendages of this species at present remain unknown, but as all the other species of Eurypterida possessed a more or less ensiform tail-spine, we may pretty safely conclude that *E. Scouleri* was furnished with a similar organ.

Although there is, at present, no absolute necessity to establish a distinct genus for *E. Scouleri*, not being as yet fully acquainted with all the details of its structure, nevertheless I think it right to point out that this species presents many anomalies and considerable divergence from the type-form of *E. remipes* (Fig. 40, p. 132). In the curious form of the eyes, elevated above the carapace, upon a round base or peduncle, and in the singular bifurcating median ridges or crests between the eyes, we are reminded of *Stylonurus Scoticus;* but the rounded, almost hemispherical, head-shield finds its analogue alone in the carapace of the modern *Limulus.* In point of size, also, *E. Scouleri* claims a place among the largest of the Merostomata. In geological position this species is one of the latest, if not the very last, representative of the Eurypterida in the Palæozoic rocks.

Formation.—Lower Carboniferous Freshwater Limestone.
Locality.—Burdie House, near Edinburgh.

The associated fossils with *E. Scouleri* at Burdie House are—

Reptilia :—*Pholidogaster pisciformis,* Huxley.

Fishes :—*Eurynotus crenatus,* Ag.
Uronemus lobatus, Ag.
Rhizodus Hibberti, Ag.
Megalichthys Hibberti, Ag.
Gyracanthus tuberculatus, Ag.
„ *formosus,* Ag.
Palæoniscus Robisoni, Hib.
„ *striolatus,* Ag.

Together with *Sphenopteris affinis,* Lindl., Stems, Leaves, and Fruits of *Lepidodendron, Calamites,* and many other plants.

The beds are also exceedingly rich in Entomostraca.

Original specimens in the collection of James Powrie, Esq., F.G.S., Reswallie, Forfar, and of the Andersonian University Museum, Glasgow.

A restoration of this singular Palæozoic Crustacean, based upon the specimens figured in Pls. XXVI and XXVII, is attempted on the opposite page. Only fragments of the appendages are at present known.

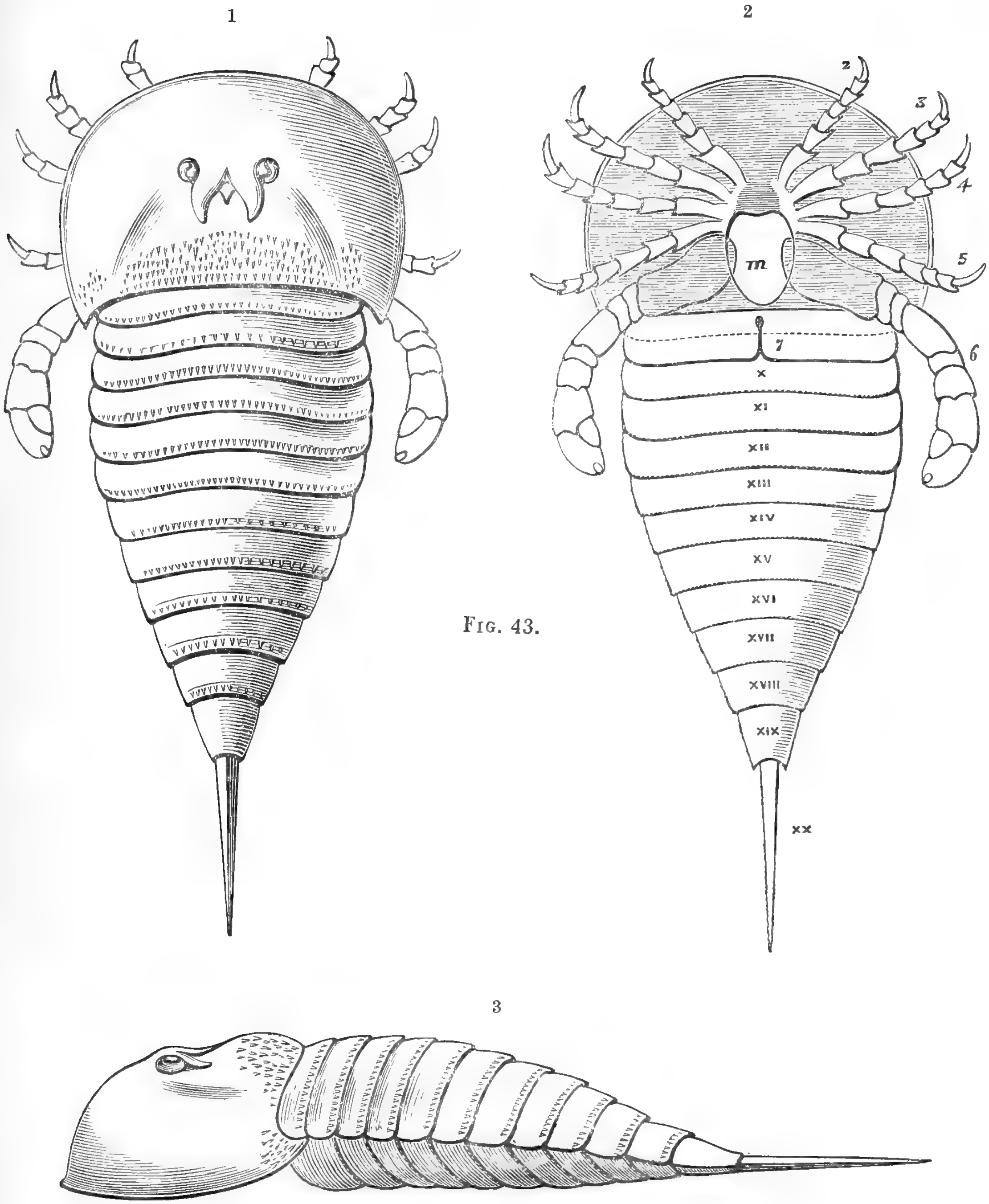


FIG. 43.—*Eurypterus Scouleri*, Hibbert (restored).

About one fourth the natural size. From the Freshwater Limestone of Carboniferous Coal-measures, Burdie House, near Edinburgh.

1. Dorsal view. 2. Ventral aspect. 3. Side view.

The appendages are restored after the American species figured by Prof. Hall; at present the evidence afforded by English specimens of this genus are too fragmentary to be of much assistance.

The figures and numerals correspond with those in the restored figures of *Pterygotus* given on Pl. VIII, Part I, of this Monograph. See also note on p. 107, Part III.

Species 2.—EURYPTERUS LANCEOLATUS:—Salter. Pl. XXVIII, figs. 1, 2, 3.

Himantopterus lanceolatus, *Salter*. Quart. Journ. Geol. Soc., 1856, vol. xii, p. 32,
— woodcut, p. 28, fig. 5.
Eurypterus lanceolatus, *Salter*. Mem. Geol. Surv., 1859, Mon. I, p. 65, pl. i, fig. 17.
— — *H. Woodward*. Geol. Mag., 1864, vol. i, pl. v, figs. 7, 8, and 9, p. 107.
— chartarius, *Salter*. Quart. Journ. Geol. Soc., 1859, vol. xv, p. 234.

This species was first noticed by Mr. J. W. Salter, under the generic appellation of *Himantopterus*, in a paper on some new Crustacea from the Uppermost Silurian Rocks of Lesmahagow, Lanarkshire, read before the Geological Society, November 21st, 1855.

At that time only the penultimate segment and the telson were known.

In 1859, Mr. Salter described eight species of *Eurypterus*, from the Upper Ludlow Rocks and the Old Red Sandstone, but he did not refer to *E. lanceolatus* in that paper.

Of the seven species there noticed for the first time, two, namely, *E. Symondsii*, and *E. megalops*, are now referred to *Stylonurus* (see ante, p. 124). Four others, viz.: *E. pygmæus*, *E. acuminatus*, *E. linearis*, *E. abbreviatus*, are still retained, whilst the seventh and last, named by the author *E. chartarius*, Mr. Salter some years ago, in reply to my inquiries concerning it, kindly informed me that he no longer considered to be a distinct species, but only an obscure specimen of *E. lanceolatus*. In this opinion I must acquiesce, as I have not been able to see the original specimen referred to in Mr. Salter's description (but not figured by him).

In the 'Memoirs of the Geological Survey' (1859), Monograph I, "On the genus *Pterygotus*," by Prof. Huxley and Mr. J. W. Salter, the entire body, with the swimming-feet, of a specimen of *Eurypterus lanceolatus* is described and figured (p. 65, pl. i, fig. 17); but, owing to the imperfect state in which the fossil is preserved, it was impossible to give a very detailed description of the separate parts, or even to be quite certain (except from the spine-like form of the caudal joint) that it was a true *Eurypterus;* it was the only specimen then known.

Mr. Slimon, of Lesmahagow, from whom all the Lanarkshire specimens of *Eurypterida* have been obtained, has laboured on incessantly since the discovery of the beds in 1851, and has increased our knowledge of these remarkable Crustaceans by more perfect specimens from year to year.

The British Museum lately acquired, among other specimens, the impression and counterpart of a very beautiful and nearly perfect example of *Eurypterus lanceolatus* from this locality. The specimen measures only 4 inches in length, and barely 1 inch across the fourth and widest thoracic segment. (See Pl. XXVIII, fig. 2.)

In the form of the joints of the swimming-feet, in the number of the body-segments, the shape of the telson and thoracic plate, it closely agrees with the American, and, so far as is known, with the Russian, species of *Eurypterus;* but the carapace is more oblong-ovate vertically, whilst that of the American species is much broader and shorter in proportion. The eyes in *E. lanceolatus* are placed much nearer to the margin of the carapace than in other species; the swimming-feet are longer and narrower, and the thoracic plate seems deeper in proportion to its width, compared with Prof. James Hall's figures of the American *E. remipes* (see ante, Fig. 40, p. 132), &c. This is *not absolutely* the case, however; but is, I believe, due in a great degree to the fact that in Prof. Hall's restoration the broad basal joints of the swimming-feet and part of the post-oral plate are placed considerably beyond the posterior margin of the carapace, so that they overlap nearly one half of the thoracic plate, a position which seems highly improbable, if not absolutely impossible, for them to have occupied during life, and in which they never occur in any examples that I have seen of the closely allied *Pterygoti* from Lesmahagow, many of which have these parts united and well preserved.

A single antennule discovered by Mr. Slimon shows these appendages to have eight articulations; the broad basal joint is serrated along its inner margin, and evidently served the purpose of a manducatory organ. The three succeeding pairs are serrated along their articulations, but are not quite so spinose as in the American species. The *metastoma,* or post-oral plate, is cordiform and quite destitute of any median ridge or ornamentation. Its lateral margin slightly overlaps the anterior margins of the broad basal joints of the swimming-feet, whose serrated palpi fulfil, in this as in all the other species of *Eurypterida,* the chief duty of manducation.

A slight groove or furrow surrounds the anterior and antero-lateral margins of the carapace, gradually thinning off and disappearing at the latero-posterior margins. In his 'Palæontology of New York' (1859, vol. iii, p. 397), Prof. Hall gives the number of articulations in the swimming-feet of *Eurypterus* as "eight, with a terminal palette." He evidently considers the intercalated plate to form a part of the seventh segment, for he says (op. cit., p. 397), "At the line *s* there is a soldered suture, connecting the fixed ramus of the chela with the penultimate joint." In the specimen from Lesmahagow I have been unable to discern more than seven articulations and a terminal palette. The third appears to be the absent joint. Prof. Hall says (p. 397), "In indicating the number of joints, I have been governed by no theoretical views, but simply by the appearances of separation in the parts; and though the two extremities of the *third joint,* as marked, show no articulating processes, the limitation of the parts is distinct, and they may have been separated only by a thin extension of the chitine, and may not be properly articulating surfaces." Supposing, then, this third joint of Prof. Hall's to be absent, we shall agree exactly in the number of articulations in the swimming-feet as well as in their general form. The intercalated plate and minute terminal palette are well seen in *E. lanceolatus,* and were formerly believed to be peculiar to the genus. They have since, however, been met with in *Pterygotus* (page 60), and in *Slimonia* (p. 112). There are at least eight articulations in the antennules, but I cannot positively discern a ninth.

The lateral lobes of the thoracic plate in the individual of this species originally described by us and figured on Pl. XXVIII, fig. 2, and 2 *a* are much deeper, in proportion to the pair of median appendages, and the two intercalated plates are larger than in the American *Eurypteri*.

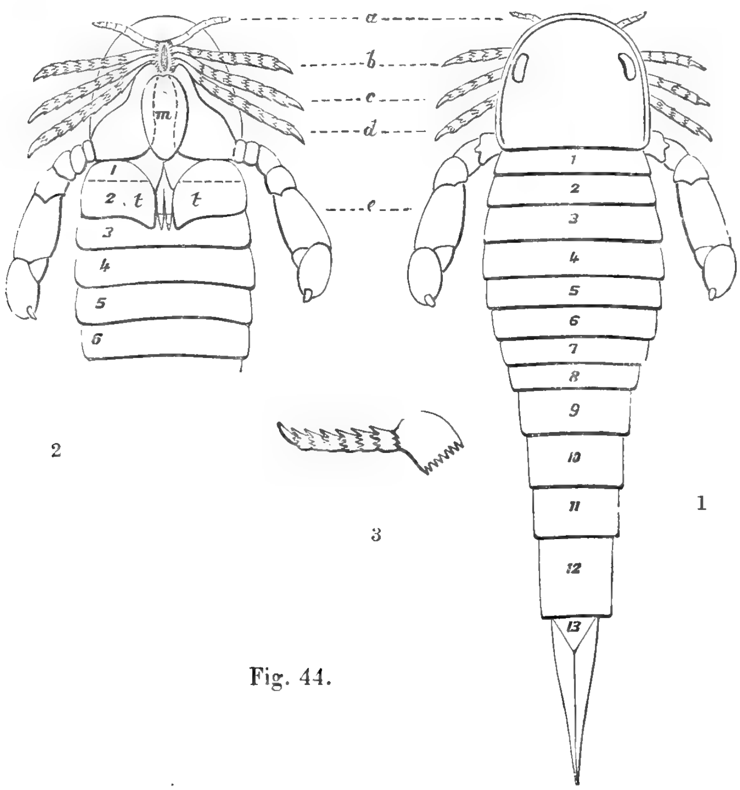


Fig. 44.

FIG. 44.—Diagram-figure of *Eurypterus lanceolatus*, Salter, restored chiefly from fig. 2, Pl. XXVIII. The endognaths are given upon the authority of Mr. Robert Slimon, of Lesmahagow, Lanarkshire.

1. The dorsal aspect of the body. 2. The ventral aspect of the body—*a*, the antennæ; *b*, *c*, *d*, the endognaths; *e*, the ectognaths; *t*, *t*, the thoracic plate, or operculum. 3. One of the antennæ enlarged, from a detached example found by Mr. Slimon.

1—12, body-segments; 13, telson. (See 'Geol. Mag.,' 1864, vol. i, p. 107, pl. v, figs. 7, 8, 9.)

In fig. 1, Pl. XXVIII, however, there is evidence of a much longer median appendage, seen as an impression lying beneath the 9th, 10th, and 11th segments, and probably not less than 8 lines in length. It is highly probable, as stated elsewhere (see ante, pp. 114—118), that this variation in the form of the central appendage is a sexual, and not a specific, character.

The central appendages are each divided into three joints, and the entire surface of the thoracic plate (Pl. XXVIII, fig. 2 *a.*) is closely covered with the usual minute scale-like markings peculiar to this group, which are also observable upon the anterior half of each thoracic segment, the abdominal segments being smooth and free from all ornamentation. The larval eye-spots—so clearly seen in the American species of *Eurypterus*, and in the British *Slimonia* and *Pterygotus*—can scarcely be discerned in *E. lanceolatus*, but they are present, nevertheless, although but feebly indicated.

There is, without doubt, a close affinity between the genera *Eurypterus* and *Slimonia*. The latter approaches the former and recedes from *Pterygotus* proper, not only in the absence of chelate appendages, but also in the more narrow and elongated form of the abdominal segments, and the more lanceolate form of the telson, which in *Pterygotus* proper is broader, less acute, or even bilobed. The chelate antennules in *Pterygotus* are not adapted for *palpi*, but in both *Eurypterus* and *Slimonia* the basal joints of the simple antennæ perform that office.

Eurypterus differs, however, from both *Pterygotus* and *Slimonia* in the position of the eyes, the form of the carapace and the telson, and, lastly, in the structure of the thoracic plate.

Dimensions of E. lanceolatus.—The largest and smallest specimens known are from Mr. Robert Slimon's collection and are now preserved in the British Museum, the former (Pl. XXVIII, fig. 1) measuring $7\frac{1}{8}$ inches in length, and 2 inches across its fourth and widest thoracic segment; the latter (Pl. XXVIII, fig. 3.), measuring only 18 lines in length by 4 lines across its widest segment. A specimen belonging to Mr. Wright, and examined by me in 1864, measures $6\frac{3}{4}$ inches in length, but is much distorted and compressed laterally. The length of the specimen (Pl. XXVIII, fig. 2) in the British Museum is $4\frac{1}{8}$ inches, of which the head forms $\frac{3}{4}$ of an inch, the six thoracic segments 1 inch, the six abdominal segments $1\frac{1}{2}$ inch, and the telson 10 lines. The fourth thoracic segment is the widest, and measures 1 inch across; the succeeding segments taper gradually to the ninth, which is scarcely 7 lines in width; and at the twelfth segment the abdomen is only $\frac{3}{8}$ of an inch wide. The first eight segments are of nearly equal depth, or about $\frac{1}{8}$ of an inch; the ninth, tenth, and eleventh segments are about $\frac{2}{8}$ of an inch in depth, and the twelfth more than $\frac{3}{8}$ of an inch deep. The swimming-feet reach down to the fifth thoracic segment.

The large specimen of *E. lanceolatus* (Pl. XXVIII, fig. 1) measures 7 inches in greatest length and $1\frac{3}{4}$ inch across the widest body-segment. The head-shield is $1\frac{1}{4}$ inch in length and 1 inch 7 lines in greatest breadth. The measurements of the body-rings are as follows:

	Breadth.	Length.
1st segment . . .	1 inch 7 lines and .	1 line.
2nd „ . . .	1 „ 8 „ .	2 lines.
3rd „ . . .	1 „ 9 „ .	3 „
4th „ . . .	1 „ 10 „ .	4 „
5th „ . . .	1 „ 10 „ .	4 „
6th „ . . .	1 „ 10 „ .	5 „
7th „ . . .	1 „ 8 „ .	4 „
8th „ . . .	1 „ 5 „ .	5 „
9th „ . . .	1 „ 2 „ .	3 „
10th „ . . .	1 „ 0 „ .	4 „
11th „ . . .	10 „ .	5 „
12th „ . . .	7 „ .	8 „
The telson measures at its widest (proximinal) end . .	4 „ is	1 inch 7 „

Formation.—Uppermost Ludlow Rock, Upper Silurian.

Locality.—Lesmahagow, Lanarkshire.

All the three specimens here figured are in the British Museum. The rest are in the Museum of Practical Geology.

Species 3.—EURYPTERUS PYGMÆUS:—Salter. Pl. XXVIII, figs. 5, 6, 7.

EURYPTERUS PYGMÆUS, *Salter*, in *Banks*, 1856. Quart. Journ. Geol. Soc., vol. xii, p. 99, pl. ii, fig. 4.
— — *Salter*, 1859. Op. cit., vol. xv, p. 232, pl. x, figs. 4—8.

In Mr. R. W. Banks's paper "On the Tilestones, or Downton Sandstones in the Neighbourhood of Kington, and their Contents," read before the Geological Society of London, December 5th, 1855, we find the first notice of this small Crustacean. The remains appear to have been derived from the quarry at Bradnor Hill, near Kington, between Bradnor Farm and the Quarry House. "The lowest fossiliferous bed exposed in the lane is the equivalent of the Ludlow Bone-bed, a soft liver-coloured layer, varying from two to three inches in thickness, and containing abundance of fossil remains, *Orthocerata, Goniophora, Orthonota, Orbicula, Holopella, Chonetes, Cornulites,*" &c. "Above this layer, before the 'Tilestone' is reached, layers of *Orthonota amygdalina* and *Trochus helicites,* much flattened, occur. The uppermost beds are thin shaly beds of Tilestone, containing a *Lingula* of a very small size (probably *Lingula minima*), grouped together in masses, and occasional traces of *Pterygotus*." The uppermost beds, about twelve feet in thickness, are composed of three beds of bluish-white stone, very hard, close-grained, and unfossiliferous.

"Between these upper beds and the underlying bed is a greyish layer, varying from three to six inches in thickness, occasionally of a blackish-grey colour, from the quantity of vegetable remains mixed up with it, and containing on the western side of the quarry the remains of Fish (*Pteraspis*) and of *Pterygotus* and other Crustaceans. This layer, when dry, is tough, and the remains are with difficulty removed from it; but when placed in water it separates easily, wherever the remains occur, and if left in water soon decomposes into mud. It appears to have been just such a muddy sediment, accompanied with sea-weeds, as was suited to Crustaceans. The organic remains in this layer retain their dermal covering, which is often glossy, and in a more perfect state than in the underlying beds of Downton Sandstone. Small, round, rusty nodules, sometimes irregular, occur in this layer in abundance, but no Mollusca.

"The next bed, which is probably identical with the Downton Sandstone, consists of a yellowish-white, close-grained sandstone, on the east side of the quarry passing gradually into a blue and still harder stone, which contains occasional traces of *Pterygotus*, but more frequently *Lingula cornea*. The yellow portion of this bed contains throughout *Pterygotus* and fish remains (*Pteraspis*), with an occasional *Trochus helicites*, but they are not so abundant as in the grey layers and underlying bed. This bed is from three to four feet in thickness.

"This is followed by a grey layer, similar in composition and contents to the grey layer already noticed. The next or bottom bed of the quarry is a yellow sandstone of still better quality, capable of being dressed to a very fine surface, and much used in building. It is about four feet in thickness. The lowest portion of it consists in many parts of the quarry of large flagstones, from a foot to eighteen inches thick, used for gravestones; these lie on the Ludlow Rock, here a very hard unmanageable stone, termed by the quarrymen 'greenstone.' The *Pterygotus* and fish remains occur down to the very bottom, where the spines of *Leptocheles* first appear in considerable abundance; *Trochus helicites*, much depressed, and the small Lingula before noticed, also occur in the lowest portions of the bed."[1]

Mr. Banks adds:—"A specimen of a Crustacean, probably a species of *Eurypterus*, was found in the grey layer before noticed; it is very imperfect; the trace of the dermal covering is slight, and the posterior segments, which would throw a greater light on its proper position, are wanting. The posterior portion of the head, at the junction with the thorax, is bounded by an almost straight line, of an equal width with the bands, which are entire from side to side and without any longitudinal depression. Mr. Salter proposes to name it *E. pygmæus*. One specimen which I lately found had a distinct swimming-foot on the left side, resembling those figured by various authors who have

[1] R. W. Banks, 'Quart. Journ. Geol. Soc.,' 1856, vol. xii, pp. 94 and 95.

written on the genus."[1] Mr. Banks figures (on plate ii, fig. 4, vol. xii, op. cit.) the small, half-oval carapace, with somewhat remote eyes, as well as a few front body-segments. Mr. Salter (' Quart. Journ. Geol. Soc.,' vol. xv, p. 232, pl. x, figs. 4—8) figures the entire body and caudal joint with the sculpture of the head and body-rings, and he also indicates the form of the small broad swimming-foot (reproduced on our Pl. XXVIII, figs. 5, 6, 7). "The body," writes Mr. Salter, "tapers rapidly backwards; it is not four times the length of the head, and is broadest at about the fourth segment. The first segment is very narrow, not above half the width of the second; and the rest are all transversely broad until the eighth, when they begin to lengthen out, the [twelfth][2] being square. The telson is regularly long-triangular, the length being scarcely more than twice the breadth. It is slightly keeled above; the sides are straight; the apex is not produced.

"The elongation of the last body-joints before the tail helps to distinguish this small species from a closely allied form in the shales of Lesmahagow, Lanarkshire. This has the tail of the same shape, but a shorter head; and the penultimate body-joints are nearly one and a half times as wide as long. In other respects it is very similar. It is described below as *E. chartarius*.[3]

"Of the swimming-foot we have the two expanded terminal joints; taken together, they are as long as the head, and form an oblong oval, the deep notch in the penultimate joint being filled exactly by the oval terminal palette. The lobes on either side of this notch are very unequal, the posterior being much the larger and longer."

Locality.—Downton Sandstone (Uppermost Ludlow Rock) of Kington, Mr. R. Banks's Collection. Upper Ludlow Shales, Ludford Lane, Ludlow, beds of passage at the base of the Old Red Sandstone, in the railway-cutting, Ludlow (Messrs. Lightbody and Marston's Cabinets).

Species 4.—EURYPTERUS ACUMINATUS :—Salter. Pl. XXVIII, figs. 13 and 15.

EURYPTERUS ACUMINATUS, *Salter.* Quart. Journ. Geol. Soc., 1859, vol. xv, p. 233, pl. x, figs. 17 and 19 (?).

"We have," writes Mr. Salter of this species, "the tail-joints only. They are much broader at the base than in *Eurypterus* [now *Stylonurus*] *megalops*;[4] but possibly they

[1] R. W. Banks, 'Quart. Journ. Geol. Soc.,' 1855 p. 99.

[2] The last segment before the telson is always spoken of by Mr. Salter as the eleventh; for at the time when his Memoir was published, 1859, he was unaware of the existence of twelve body segments between the head and the telson. See Introduction, Part I, of this Monograph.

[3] Mr. Salter subsequently concluded that *E. chartarius* was only the young of *E. lanceolatus* (see p. 140).

[4] There appears no reason (save their accidental association together in the same bed) for attributing the series of detached body-rings (referred to here by Mr. Salter, and reproduced on our Pl. XXVIII, fig. 8) to the head-shield of *S. megalops*, which there is good reason to believe, by comparison with the other species, had a more styliform telson than fig. 8 exhibits.

belong to the opposite sex, as the individuals are nearly of the same size, and occur in the same strata, namely the passage-shales between the Upper Ludlow Rock and the Old Red Sandstone, in the Ludlow railway-cutting.

"Telson expanded and cordate at base, the broadest portion being less distant from the insertion than one third the entire breadth. From thence the tail-joint is regularly acuminated, the length being only two and a half times the breadth. The edge is crenato-serrate like the last. We have only the flat under surface."

Locality.—Ludlow, associated with *Stylonurus* (*Eurypterus*) *megalops* and other forms of Eurypterida.

Species 5.—EURYPTERUS LINEARIS:—Salter. Pl. XXVIII, figs. 10, 11, 12.

EURYPTERUS LINEARIS, *Salter*. Quart. Journ. Geol. Soc., 1859, vol. xv, p. 234, pl. x, figs. 15, 16 *a* and *b*.

Of this form Mr. Salter writes—"As this occurs generally in a lower stratum (Upper Ludlow Rock) than *E. acuminatus*, it is little likely to have any relation to that species, though the differences are such as might be due to sex. If, however, *E. megalops* and *E. acuminatus* be one species, *E. linearis* must rank as distinct. The telson, the only part preserved, is greatly more elongated than in the other forms.

"Telson linear, lanceolate, nearly five times as long as wide; the base very little expanded, broadest near the point of insertion, or rather parallel-sided for a short distance, and then attenuated. A strong median carina runs the whole length, elevated into a steep ridge near the origin of the joint, and the edge is so faintly crenate as to appear smooth to the naked eye."

Fig. 10 "shows a broader telson, from the same bed, and it most probably bears the same relation to *E. linearis* that the last-described species does to *E.* [*Stylonurus*] *megalops*. From analogy we must suppose the broader tail-joint to belong to the female, and the narrower one to the male."[1]

[1] The only "analogy" which I can suppose was present in Mr. Salter's mind, in reference to the expanded form of the telson in *Eurypterus* being indicative of the female and the narrower one of the male, will, I fear, if followed, lead to error.

I can, of course, only infer, but it seems very probable, that Mr. Salter's observation had reference to the abdominal segments in the modern Brachyura, in which the female crab has a broadly expanded abdomen, and the male an exceedingly narrow one.

But as this diversity in form has a direct relation to the office performed by the caudal segments, whether in the female crab, lobster, or prawn, namely, the convoy and protection of the eggs after extrusion from the ovaries and before hatching, we can hardly imagine a part not fulfilling such offices to be so modified. As stated elsewhere (see *antè* pp. 109 and 110, and pp. 114—118) it, is the *antennæ* and the *opercular plate* which in this group of Crustacea undergo important sexual modifications. I consider that the form of the telson is of great value as a *specific* character.

Locality.—The Upper Ludlow Rock of Ludlow, and the Downton Sandstone of Kington, Herefordshire.

Species 6.—EURYPTERUS ABBREVIATUS :—Salter. Pl. XXVIII, fig. 14.

EURYPTERUS ABBREVIATUS, *Salter.* Quart. Journ. Geol. Soc., 1859, vol. xv, p. 234, pl. x, fig. 18.

Mr. Salter characterises this as "A thoroughly distinct species, yet with very similar characters to those of *E. acuminatus,* as if the telson of that species had been greatly abbreviated.

"Telson broadly trigonal at base, forming a nearly equilateral triangle, of which the smooth thickened base forms one angle; the sides expand with a curved outline for about half the length of the joint, then suddenly contract and form a narrow, acuminate, serrated point.

"We have only the under surface; the upper was probably keeled; the lower shows a faint longitudinal elevation proceeding from the thick base to the point. The serræ on the edge are very prominent. Length $\frac{7}{10}$ inch, width $\frac{5}{10}$ inch.

"*Locality.*—Downton Sandstone of Kington, Herefordshire."

Species 7.—EURYPTERUS HIBERNICUS :—Baily, sp. Pl. XXVIII, figs. 16, 17 and 17 *a.*

EURYPTERUS SCOULERI (?), *Salter.* Quart. Journ. Geol. Soc., 1859, vol. xv, p. 232, pl. x, figs. 2 and 3.
PTERYGOTUS HIBERNICUS, *Baily.* Brit. Assoc. Report, Section C, Exeter, 1869, p. 75.

In Mr. Salter's paper "On some new species of *Eurypterus,* &c.," communicated to the Geological Society, June 23rd, 1858, he notices certain fragments of a Crustacean (figured on our Pl. XXVIII, figs. 16, 17 and 17 *a*), from the Upper Old Red Sandstone, Kiltorcan, Co. Kilkenny, Ireland, which he refers doubtfully to *E. Scouleri,* Hibbert. He was led to this conclusion from a comparison of these fossil-remains with a *photograph* of the carapace of *E. Scouleri* in the Andersonian Museum, Glasgow. Mr. Salter calls attention to the curiously reticulato-squamose under-surface (?), with its margin raised into strong suborbicular plicæ and elongated tubercles (See Pl. XXVIII, figs. 17 and 17 *a*), which he compares with those on the margin of the carapace of *E. Scouleri.* From these however, I have satisfied myself they are quite distinct, so far as the fragmentary nature of the remains permit us to judge, although I have no doubt they belong to a species of the genus *Eurypterus*.

In a report to the British Association for the Advancement of Science, Section C, Exeter, 1869, "On the Fossils of Kiltorcan, Co. Kilkenny," by W. Hellier Baily, Esq., F.L.S., F.G.S., Acting Palæontologist to the Geological Survey of Ireland, the author recorded the discovery of some portions of a Crustacean which he considered to afford clear evidence of their having belonged to *Pterygotus*.

Mr. Baily then stated his belief as to the probable identity of some of these specimens with others collected at the same locality several years previous, and which have been doubtfully referred by the late Mr. Salter to *Eurypterus Scouleri*. For these Mr. Baily proposed the name *Pterygotus Hibernicus*.

I am informed by Mr. Baily that upon a subsequent visit to this rich locality he obtained other Crustacea to which he applied the names of *Belinurus Kiltorkensis* and *Proracaris Machenrici*.

He has also kindly prepared and forwarded to me careful drawings of several of these fragments, accompanied by notes, from which, by his permission, I have made the subjoined extracts.

The most distinctly marked fragments exhibit the same ornamentation as that seen on figs. 16 and 17, Pl. XXVIII.

Mr. Baily writes as follows:

"In the collections of the Geological Survey of Ireland there are nearly a dozen specimens from this place (Kiltorcan), which appear to me to be referable to *Pterygotus* or *Eurypterus*.

"There are two examples of the carapace or head, which although pressed out of shape, sufficiently indicate the subquadrate form and marginal position of the eyes peculiar to *Pterygotus*.[1] One of these specimens is 3 inches in breadth by about 2 inches in length, the posterior margin being imperfect (it is numbered B. 3400).

"Of thoracic or abdominal segments there are two or three specimens, one being the original fragment before mentioned as doubtfully referred by Salter to *Eurypterus Scouleri*, and figured by him in the 'Quart. Journal Geol. Soc.,' vol xv, pl. x, figs. 2 and 3 *a, b*; the characteristic semilunar markings of the surface are well shown in this specimen (F. 1317). See Pl. XXVIII, figs. 16 and 17.

"In another fragment the margin of the lower edge is more irregular in outline and uniformly scalloped (B. 3382). See the subjoined Woodcut, Fig. 45.

[1] I should be unwilling to form an opinion upon this specimen; judging from the drawing, I should conclude the original is crushed completely out of all recognisable form. It may have been a head-shield, but I cannot say with certainty to what it is referable; if really *subquadrate* in form, it may be *Slimonia*, assuming the eyes to be marginal. The head-shield in *Pterygotus* is now known to be semicircular in outline.

"There is one example of the serrated portion of a 'maxillipede' or 'endognath' which is very well preserved[1] (L. 1688). See Woodcut, Fig. 46.

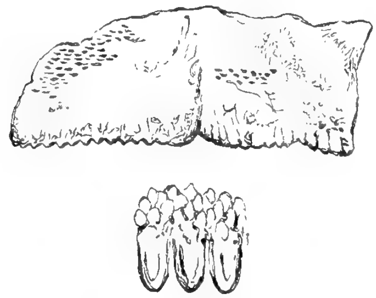


Fig. 45.—Part of one of the body-segments of *Eurypterus Hibernicus*, Baily; and part of the margin enlarged: Devonian, Kiltorcan.

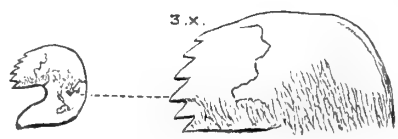


Fig. 46.—Serrated maxilla of one of the endognaths of *Eurypterus Hibernicus*, Baily (natural size and enlarged); Devonian, Kiltorcan.

"Another specimen appears to be the lower portion of a swimming appendage 'ectognath'[2] (D. 1867).

"The chelate termination of an antenna (B. 3374) is not unlike that of one of the modern Crabs, being thick and short, much curved, and provided with one or two blunt tooth-like processes.[3] See Woodcut, Fig. 47.

Figs. 47 and 48.—Chela, and detached lower ramus of chela of Crustacean, from the Devonian of Kiltorcan.

"Another specimen (B. 3376), which would seem to be the lower ramus of an antennary chela, is larger, more slender, and also much curved.[4] See Woodcut, Fig. 48.

"These specimens being all detached fragments, it is impossible at present to state with any degree of certainty the relation of one with another, or to define the species from such insufficient data. I therefore merely propose the name as a provisional one.

"Wm. Hellier Baily."

[1] This endognath or maxillipede is so peculiar in form that I cannot readily suggest a reference for it. It most nearly approaches *Eurypterus punctatus*.

[2] I am unable to recognise the *form* of the ectognath or swimming-foot in this fragment, owing to the distortion of the specimen.

[3] So far as I may venture to speak with certainty of such a detached specimen, I would be unwilling to refer it to the Eurypterida at all. Its form is quite distinct from that of the known chelate antennæ belonging to this group.

[4] If this be the detached lower ramus of a chela, it very probably belongs to some Crustacean not a Eurypterid.

Formation.—Upper Old Red Sandstone.

Locality.—Kiltorcan, Co. Kilkenny, Ireland.

The specimens are preserved in the Museum of the Geological Survey of Ireland, Hume Street, Dublin.

Species 8.—EURYPTERUS BREWSTERI :—H. Woodward. Pl. XXVIII, fig. 4.

EURYPTERUS BREWSTERI, *H. Woodward.* Brit. Assoc. Report, Section C, Bath, 1864, p. 73.
— — *H. Woodward.* Geol. Mag., 1864, vol. i, p. 200, pl. x, fig. 3.

This species of *Eurypterus* was obtained by the Rev. Henry Brewster, of Farnell, near Brechin, from the Old Red Sandstone of Kelly Den, near Arbroath, and its specific name was suggested in honour of its discoverer by Mr. Powrie in 1864, through whom I obtained the loan of the specimen for description.

It consists of a carapace and a portion of the first thoracic segment, slightly displaced; close to which is seen an ovisac, in which are more than twenty ova, more or less compressed.

The carapace measures 2 inches 2 lines in breadth at its posterior border, and 7 lines in length. The sides curve rapidly inwards, leaving the front border only 8 lines broad. The eyes, which are one line in length, are reniform, and within the anterior half of the carapace; they are four lines apart, and have their convex surfaces directed outwards. The margin of the carapace is slightly striated, and there is an inner elevated border in front, 1 line in breadth, which thins out and disappears on the lateral border. The surface of the carapace is slightly wrinkled, but not ornamented in any way.

This species agrees most nearly in general form with *Eurypterus lacustris* of Harlan[1] from the Upper Silurian of New York, but the relative proportions differ considerably.

Interesting as this carapace is, it is rendered still more so by the ovisac associated with it. The so-called *Parka decipiens* of Fleming may include many widely different organisms, but I fully believe that the oviform bodies from the Old Red Sandstone are chiefly the eggs of Crustacea belonging to the order Merostomata.

Formation.—Old Red Sandstone.

Locality.—Kelly Den, near Arbroath, from the Museum of James Powrie, Esq., F.G.S., Reswallie.

[1] See Hall's 'Palæontology of New York,' p. 407, pl. lxxxi, fig. 3.

Species 9.—EURYPTERUS SCORPIOIDES:—H. Woodward. Pl. XXIX, fig. 1; Pl. XXX, Fig. 9.

EURYPTERUS SCORPIOIDES, *H. Woodward.* Quart. Journ. Geol. Soc., 1868, vol. xxiv, p. 292, pl. ix, fig.; pl. x. fig. 2.

Among the rich collection of fossil Crustacea from Logan Water exhibited by Mr. Robert Slimon at the Meeting of the British Association at Dundee, in September, 1867, were several new forms belonging to the order Merostomata, which have since been acquired for the British Museum.

One of these new forms is represented on Pl. XXIX, fig. 1, by an almost entire individual, measuring 11 inches in length and 5 inches in breadth, having one entire swimming-foot and three pairs of palpi *in sitû*, and presenting a part of the dorsal aspect of the body to view.

The counterpart of the anterior part of the same individual is preserved in the Museum of Practical Geology, Jermyn Street (see Pl. XXX, fig. 9), exhibiting the ventral aspect with the post-oral plate or metastoma; the bases of the swimming-feet and three pairs of perfect spinose palpi.

Carapace semicircular in front, twice as broad as it is long. Eyes not distinctly preserved, nor ocelli.

Organs of the mouth consisting of five pairs of appendages; the first and most anterior pair not preserved (probably simple palpi, as in *Slimonia*, *Stylonurus*, and other species of *Eurypterus*). Second, third, and fourth pairs 7-jointed, very robust; fifth, sixth, and seventh joints each armed with a pair of strong recurved spines, the palpi and spines in both specimens directed forwards; fourth joint armed with several short incurved spines; second and third joints without spines; first joint serving as a *maxilla*, and armed with serrated teeth. Length of palpi $3\frac{1}{2}$ inches, breadth at fourth joint $\frac{1}{2}$ inch. Spines varying from $\frac{3}{4}$ to $1\frac{1}{4}$ inch in length, and 2 lines in breadth.

Swimming-feet or *maxillipedes* 7-jointed, $6\frac{1}{4}$ inches in length. Basal joint somewhat triangular in form, 14 lines long, 10 lines in breadth at posterior border; maxillary border concealed beneath the metastoma; breadth of articulation between the ectognath and second joint 8 lines, length of second joint 8 lines, of third joint 8 lines, of fourth joint 10 lines, of the fifth joint $1\frac{1}{2}$ inch, and breadth 10 lines; sixth joint $1\frac{1}{2}$ inch long by 11 lines broad (a small triangular plate is inserted here as in *Slimonia* and in *Pterygotus*); seventh joint $1\frac{3}{4}$ inch in length and 9 lines in breadth, with a minute nail 2 lines in length and $1\frac{1}{2}$ line in breadth, inserted at its distal extremity.

Lip-plate or metastoma shield-shaped, having its broadest border directed forward, 10 lines in breadth and the same in greatest length, anterior angles truncated, sides gradually converging towards the posterior border, which terminates in an obtuse angle.

Thoracic plate imperfect, but having a median appendage as in other species. Surface punctate.

Body-segments.—First $\frac{1}{2}$ inch long by 4 inches in breadth, curving upwards at the centre-line downwards on each side and upwards and inwards on its lateral borders.

Second segment 7 lines long in the centre by $4\frac{3}{4}$ inches in breadth ; margin curved in a corresponding manner to the first segment, ornamented with two subcentral wart-like spots ; surface punctated.

Third segment 10 lines long in the centre by $5\frac{1}{4}$ inches in breadth ; ornamented in the same manner as the second segment.

Fourth segment 10 lines in length and $5\frac{1}{4}$ inches in breadth ; border curved, marked subcentrally by two drop-shaped prominences $4\frac{1}{2}$ lines long.

Fifth segment 9 lines in length and $4\frac{1}{2}$ inches in breadth ; ornamented as the fourth segment.

Sixth segment 8 lines in length by $3\frac{3}{4}$ in breadth ; surface punctated.

Seventh segment 11 lines in length by $2\frac{3}{4}$ in breadth ; surface punctated.

Eighth segment 1 inch in length and $1\frac{3}{4}$ inch in breadth ; surface punctated.

Ninth segment 10 lines in length and $1\frac{1}{2}$ inch in breadth.

Tenth segment 10 lines in length and $1\frac{1}{2}$ inch in breadth.

Eleventh segment 11 lines in length and $1\frac{1}{4}$ inch in breadth.

Twelfth segment 1 inch in length and 1 inch in breadth.

Telson wanting, probably ensiform, as in other species of *Eurypterus.*

The punctate ornamentation is well seen on the anterior body-segments, and is at once readily to be distinguished from the scale-like markings observable on the body of *Pterygotus* and *Slimonia.*

Formation and Locality.—Uppermost Silurian, Lesmahagow, Lanarkshire.

Species 10.—EURYPTERUS PUNCTATUS :—*Salter,* sp. Pl. XXIX, fig. 2.

PTERYGOTUS PUNCTATUS, *Salter.* Mem. Geol. Surv., Mon. I, 1859, p. 99, pl. x ; pl. xi, figs. 5—9, and 12—15 ; pl. xiii, figs. 5, 6, 9, 10, 11, 14.

EURYPTERUS PUNCTATUS, *H. Woodward.* Quart. Journ. Geol. Soc., 1868, vol. xxiv, p. 290.

This species, established by Mr. Salter in 1859, upon a series of detached appendages and fragmentary remains from the Upper and Lower Ludlow Rocks of Leintwardine, Shropshire, is closely related to, but distinct from, *Eurypterus scorpioides,* just described, from Logan Water.

I include under this species the fragments of body-joints drawn on pl. x, 'Mem. Geol. Surv.,' Mon. I, the more or less fragmentary remains of six endognathary palpi and three swimming-feet or ectognaths drawn on pl. xi (op. cit.) [the most perfect of these last-named organs is reproduced on Pl. XXIX, fig. 2]; also the remains on pl. xiii (op. cit) attributed to *Pterygotus* (now *Eurypterus*) *punctatus* by Mr. Salter.

I would, however, venture to exclude:—Firstly, the remains of the *chelate antennæ*[1]—my reasons for so doing being that all the species of Merostomata with spinose palpi have *small, simple antennules* (*e. g. Eurypterus, Stylonurus, Slimonia*).

Secondly, the *lip-plate*.[2] The form of the lip-plate is very characteristic of the separate divisions of this genus; and I am not aware of any other species which possesses such a metastoma as is found in *E. scorpioides,* and which, from the detached plate now figured (see Woodcut, Fig. 50, p. 155), I doubt not, also marked *E. punctatus,* the Leintwardine species. I would therefore suggest that the detached lip-plate ('Mem. Geol. Surv.,' Mon. I, pl. xi, fig. 4) must have belonged to some species of another genus—the form of the plate being nearer that of *Slimonia acuminata.*

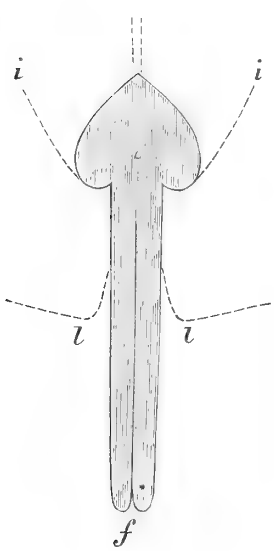


FIG. 49.—Median appendage of the thoracic plate, or operculum, of *Eurypterus punctatus. a* would be the centre of the attached border; *i, i,* the position of the intercalated triangular plates uniting the median appendage with *l, l,* the two lateral alæ of the operculum; *f,* the free extremity of the median appendage.

Thirdly, the *telson.* Mr. Salter observes that "it is yet wanting," and that "in all probability it was not unlike that figured on pl. x, fig. 11, which has possibly something to do with it." On the fragment referred to I will not venture to give an opinion, but will only observe that, as far as I can ascertain by a careful comparison, such a form as *E. punctatus* would have had an ensiform telson, as in the other *Eurypteri,* with which I venture to place it.

The characters by which the fragmentary remains associated together under this name have been distinguished are—the form of the joints of the palpi, with their pairs of long, slender, recurved spines, and their well-marked basal joints (*coxognathites*); the form of the great swimming-feet (see Pl. XXIX, fig. 2), expanded in the penultimate joint, and attenuated at their extremities; the peculiar shield-shaped *metastoma* or post-oral plate (Woodcut, Fig. 50); and, lastly, the distinct punctate ornamentation which characterises the surface of the body-segments and appendages.

Mr. Salter writes (op. cit., p. 99), "Of the *carapace* or *eyes* we have yet no trace. But the *epistoma* presents us with a singularly neat character for the species." This

[1] Pl. xi, figs. 1, 2, 3, 'Mem. Geol. Surv.,' Mon. I.

[2] Pl. xi, fig. 4, op. cit.

specimen, of which we give a woodcut above (see Fig. 49), is undoubtedly the median appendage of the thoracic plate.[1] The upper portion is broadly sagittate or spear-shaped; the lower portion is quite straight and linear and is divided down the centre into two equal parts for $1\frac{3}{4}$ inch, or nearly its entire length; reminding one of the corresponding appendage in the thoracic plate of *E. lanceolatus*, which is also bifid (see Pl. XXVIII, fig. 2 *a*). The surface is destitute of ornamentation.

Although I cannot accept the detached *lip-plate* (see pl. xi, fig. 4, 'Mem. Geol. Surv.,' Mon. I), referred by Mr. Salter to this species, as really belonging to it, I am fortunately in possession of a very fine example, also from Leintwardine, which was left with me by Mr. Salter for examination some years ago, and from the fact of its close agreement in form with the lip-plate of *E. scorpioides* just described (see Pl. XXX, fig. 9), I feel little hesitation in ascribing it to *E. punctatus*.

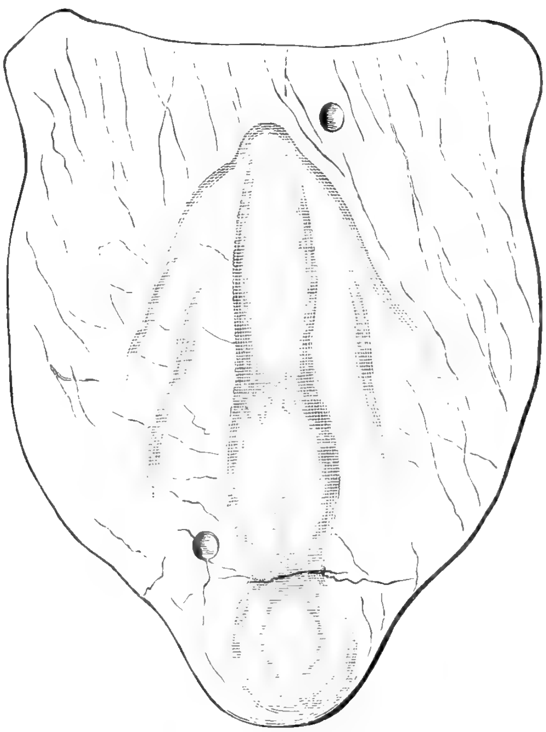


Fig. 50.—Lip-plate of *Eurypterus punctatus*, Salter, sp., from the Lower Ludlow, Leintwardine, Shropshire. Reduced one-third.

Form and dimensions of detached lip-plate (see Woodcut, Fig. 50), referred to *E. punctatus*:—Form, that of an armorial shield with its anterior corners truncated; greatest anterior breadth 4 inches, length 5 inches; sides curving inwards, and again expanding, then terminating posteriorly in a rounded margin only $1\frac{1}{2}$ inch in breadth.

[1] This part is described by Mr. Salter as the "epistoma" or the "conjoined epistoma and labrum" in this and in all other species in his Monograph.

The other appendages of the head of *E. punctatus* are—1. The *endognaths* and *palpi* (see Mem. Geol. Surv., Mon. I, pl. xi, figs. 5—8; and pl. xiii, figs. 9, 10, 11). Mr. Salter writes:—"There are several specimens, and they present some strong characters for the species. Pl. xiii, fig. 9, and pl. xi, figs. 7 and 8, show portions of the palpi, and fig. 5 an endognath with its entire palp attached, and in the proper position in respect of the great swimming-foot *c*." From this specimen it would appear that the remarkable spines of the palpus were directed forward. "Figs. 8, 9, show the great size these appendages obtained. The teeth of the maxillary piece (fig. 6 *a*, *a**) are small, short, and obliquely conical, not curved, and as in some other species striate; there are about seven distinct and six smaller ones, which last are either connected by a horny plate (as in *P. anglicus*, pl. vii, fig. 5 *b*), or are confused with setæ; the state of preservation does not permit us to decide which. The margin near the teeth is punctate, indicating the presence of hairs or setæ. In some specimens the teeth are narrower and sharper. The great palpi (of which fig. 6 only shows the base at *b*, and fig. 5 a nearly perfect one *in sitû*) are broader at their base than the length of the serrate border *a*. They consist of only five joints, all except the basal one bearing (a pair ? of) curved processes, while the terminal one, *g* in fig. 8, might even be considered as an additional joint.[1] The specimen (pl. xiii, fig. 9) obtained since plate xi was completed shows all the joints complete, and these resemble plate xi, fig. 7, in their elongate form.

"Fig. 5 has much shorter joints, and may very possibly belong to a different pair of maxillæ. In this figure the first joint is very broad and large, subquadrate, tapering but little, rather longer than broad, and bears apparently no curved process. Its edge is spinose (fig. 6 *b*). The third, fourth, and fifth are, in figs. 5 and 8, not very different in size, and nearly square, while in fig. 7 the proportions are longer. All have the great curved spines placed about the middle of the joint.

"In the perfect palpus (pl. xiii, fig. 9) the proportions of the joints are as follows:—The basal one is smaller than the second, about two thirds its length, and of a roughly triangular or trapezoidal shape, the base smallest. The second is longest, half as long again as its breadth; the third and fourth much shorter, the fifth only half as long as broad, and bearing one curved spine at its outer angle, and the other (*g*) at its tip.

"The second, third, and fourth joints are subcylindrical, convex at their outer margin, and bear the curved spines about the middle of the joint. The terminal articulation (*g*), if it be a separate joint, consists only of the curved process, but is probably only the opposite spine of the fifth joint, seen obliquely; and in this view there would be five joints only to the palpus, each joint bearing a pair of processes, as is certainly the case in pl. xiii, fig. 11.

[1] Although the specimens from Church Hill look as if there were only a single process to each joint, yet, as in the palpus of this species figured in plate xiii, fig. 11, there is a pair of these organs; it is most likely all the other specimens had two. In this view the two processes, *f*, *g*, would belong to the terminal fifth joint.

"The processes themselves are directed obliquely outwards and forwards; they are long, curved, sabre shaped, and much compressed, fully three times as long as the width of the joints, to which they are attached by a swelled base. They are striated longitudinally, the striæ, eleven or twelve in number, sharply impressed, not continuous except near the tip, but interrupted alternately (pl. xiii, fig. 10) for wide spaces, so that the number of striæ appears little more than half what it really is. Nor are the striæ quite parallel to the sides, for they abut obliquely against the concave side towards the tip of the process. Here and there some striæ are stronger than the rest.

"Near the base of the processes the striæ are still more interrupted and run into short impressed lines or punctæ."

The subjoined woodcut (Fig. 51) of the endognath of *E. punctatus* (the outline of which is partially restored from *actual* specimens figured by Mr. Salter and from others in the British Museum) will, perhaps, best explain the peculiar form of these organs, and also exhibit their close correspondence with the same appendages in *E. scorpioides* (see Pl. XXIX, fig. 1, and XXX, fig. 9, accompanying this part).

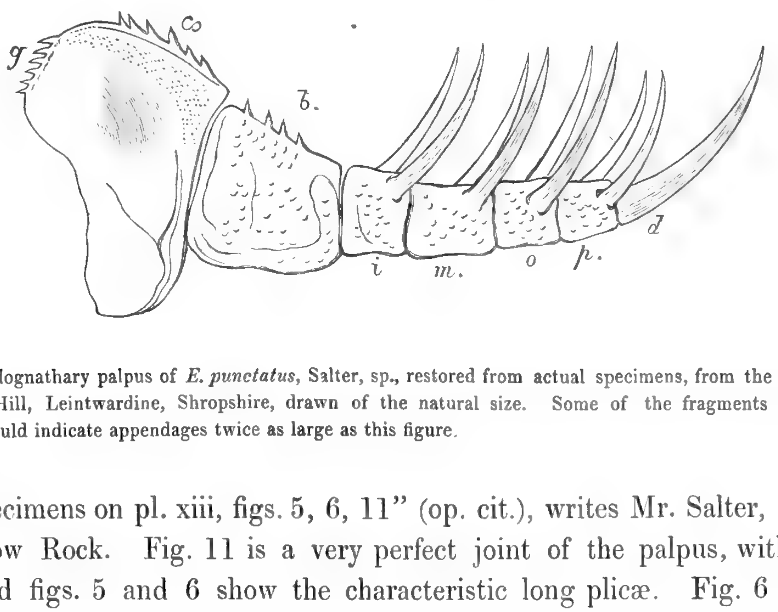


FIG. 51.—Endognathary palpus of *E. punctatus*, Salter, sp., restored from actual specimens, from the Lower Ludlow, Church Hill, Leintwardine, Shropshire, drawn of the natural size. Some of the fragments figured by Mr. Salter would indicate appendages twice as large as this figure.

"The specimens on pl. xiii, figs. 5, 6, 11" (op. cit.), writes Mr. Salter, "are from the Upper Ludlow Rock. Fig. 11 is a very perfect joint of the palpus, with both spines attached; and figs. 5 and 6 show the characteristic long plicæ. Fig. 6 at least would answer best to one of the long joints of the antennæ; it is but a cylindrical fragment of the proximal end, and has the contraction which is visible in the corresponding joint of *P. anglicus* (see pl. iv, fig. 4 *c*, op. cit.) At this part the plicæ are very numerous and small; in the body of the joint they are large, prominent, and elongate, and with the channel-like depression and its bounding ridges (fig. 6 *a*) magnified. They are somewhat unequal in size, and set at more than their diameter apart from one another."

"The *swimming-feet*," writes Mr. Salter (plate xi, figs. 12—15) "are very different in proportion to those of *P. anglicus*, the terminal joints occupying a considerably greater length, and being abruptly wider than the rest. Of the great basal joint (*c o*, in fig. 5) but little is preserved, but a larger specimen (fig. 12) shows it to have been roughly squamose, especially along its basal edge, the narrow squamæ projecting as small spines; the rest of the surface is closely imbricated with smaller plicæ. Pl. xiii, fig. 14, is very possibly the serrate inner lobe of this joint. The second joint (*b*) is large in proportion to the rest, and widens from the base to its truncated apex. The third (*i*) is subtriangular, the blunt apex of the triangle being anterior, and the edge articulating with the next joint nearly straight or but slightly curved. The fourth joint, on the contrary, is an obtuse triangle, of which the broad base is forward and moderately arched, but not projecting as in the *P. anglicus*. It contracts rapidly behind, where it has a narrow deep notch to receive the articulating process of the next joint. This (*c a*) is the fifth, a remarkably short wide articulation, almost buried in the concave edge of the great penultimate joint, and curved to follow the convex border of the triangular fourth joint. It is marked by a strong transverse ridge. All these joints may be seen in fig. 5, but in a far less perfect state than in the fine specimen, fig. 13. The penultimate joint (*p*) is very large, nearly three inches long, and about half as broad. It is oblong, with two rounded unequal lobes, and deeply notched at each end (the distal notch at the end being the deepest), so that the joint overlaps the proximate joints at either end. The hinder margin of the joint is more convex at first, then somewhat excavated, while the anterior margin is straight, or nearly so; the hinder lobes at both ends are larger than the anterior ones, the proximal one, which overlaps the small fifth and fourth joints, being broader and rounder, and the distal one, which abuts against the terminal palette, being long and narrow.

"The terminal joint (*d*) is very long, nearly three inches by nine tenths of an inch wide, elongato-lanceolate, but rounded at the tip, its anterior margin a little convex and plain-edged half way down, the posterior slightly concave and rather strongly serrate; the serræ are shallower on the anterior margin, and deepest round the tip."

The largest and most perfect of these organs are reproduced on Pl. XXIX, fig. 2, which corresponds with Mr. Salter's pl. xi, fig. 15, 'Mem. Geol. Surv.,' Mon. I, 1859.

Body-segments.—Concerning these Mr. Salter writes—"Of the first *body-ring* a fragment an inch and a half long and one inch wide is figured (pl. x, fig. 2).

"It is the semicircular sweep of the outer edge of the segment, where it fits into the scooped-out portion of the succeeding (second) one. The rounded margin *a* is serrated, the serrations pointing backward. The sculpture is very minute, prominent, and confined to the forward half, except a few marginal plicæ on the hinder edge. All are longer than wide. Fig. 2 *a* shows them magnified. Fig. 3 is, without much doubt, the second thoracic segment. It is wider at the sides than in the middle, and turns up abruptly at the forward angle to form the characteristic process. Fig. 4 appears to be a larger specimen of the third ring, it has the same characters of ornamentation. In both the central portion is less arched than in *P. anglicus* or *P. arcuatus*, and the sides less obliquely and minutely crenulate.

"A narrow (articular?) furrow runs along the middle portion of the anterior edge, followed by a convex ridge, which is bounded by a row of prominent minute tubercles, extending a good way out, and nearly to the lateral margins. Behind this the anterior third of the segment is occupied by the sculpture, which is much more prominent and tubercular, and less scale-like than in the large Scotch species."

Mr. Salter adds—"There is evidence of at least three, if not more, of the thoracic rings. The hinder segments were decidedly longer in proportion to their width than in *P. anglicus* or *P. gigas*. We have also the swimming paddles, which, without the great coxal joints, were seven inches long, expanded in the penultimate joint, and attenuated at their tips; and the mandibles, the palpi of which were strongly fringed with long curved processes. As all these present distinctive peculiarities from other species, and as the tuberculation on the various specimens found in this bed agrees in character, it is fair to combine them as a single species, and figure them all upon one plate."

As regards the form of the body-segments, Mr. Salter's evidence is most valuable in confirmation of the identity of these remains; for in the Survey Monograph he figures (p. 101) five of the anterior body-rings from Leintwardine, which agree closely in form with the specimen from Lanarkshire. He also observes (p. 99) that "the hinder segments were decidedly longer in proportion to their width than in *Pterygotus Anglicus*, or *Pt. gigas*." Indeed, one of the segments which he has figured (Mon., pl. x, fig. 5) most clearly shows this to be the case.

From the evidence derived from the nearly related Lanarkshire specimens (already described), I venture to refer this form to *Eurypterus;* it will probably come near Hall's *Eurypterus pachycheirus*.[1]

But the specimens from the Lower Ludlow Rock give evidence of a species *twice the size* of that occurring in Lanarkshire; there are also sufficient points of distinction in the form of the metastoma, the joints of the swimming-feet, the armature of the palpi, &c., to distinguish them specifically. I therefore propose to retain the name of *punctatus* for the Ludlow remains, as indicated, adding thereto the great lip-plate (see Woodcut, Fig. 50) already referred to.

I will merely add that I have received from Mr. Charles Ketley a series of five narrow abdominal segments of a crustacean from the Wenlock Limestone, Dudley, the markings upon which lead me to refer it to *Eurypterus punctatus*. Other portions, bearing similar *punctate* ornamentation, easily distinguished from the ordinary squamate markings so characteristic of *Pterygotus*, have been obtained, and obligingly submitted to me for examination, from both the Wenlock Shale and Limestone, by Mr. John Gray, Mr. E. Hollier, Mr. Allport, and Mr. Johnson.

Formations and Locality:—Upper Ludlow Rock, Whitcliffe, Ludlow, Kendal, Westmoreland; Lower Ludlow Rock, Church Hill, Leintwardine; Wenlock Limestone and Shale, Dudley.

[1] And probably also near his subgenus *Dolichopterus*.

Species 11.—EURYPTERUS OBESUS :—H. Woodward. Pl. XXX, fig. 8.

EURYPTERUS OBESUS, *H. Woodward.* Quart. Journ. Geol. Soc., 1868, vol. xxiv, p. 293, pl. x, fig. 1.

This little form is remarkable for the great obesity of the thoracic somites, the breadth of the fourth segment being equal to the length of the first eight segments.

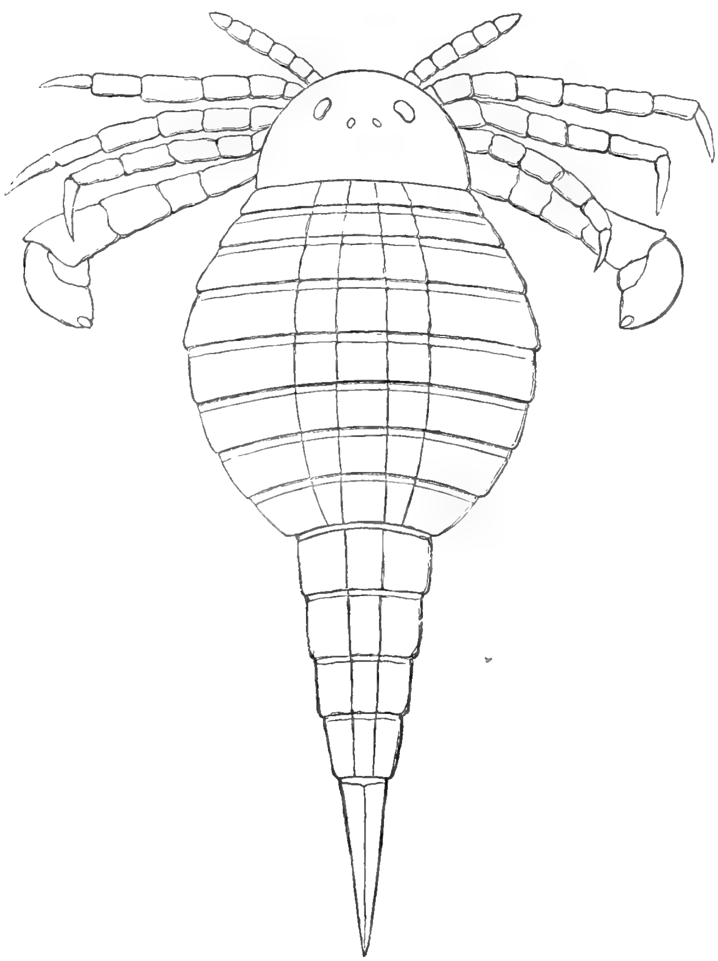


FIG. 52.—Diagram-figure of *Eurypterus obesus,* H. Woodw.
Restored and enlarged from the specimen figured on Plate XXX, fig. 8.

The carapace is 6 lines in breadth at its posterior border; the lateral and anterior borders form a semicircle; the length is 3 lines.

The integument of the carapace and segments was extremely thin, as shown by the puckered condition of the entire surface. The dorsal surface, which is exposed to view, displays two eyes, placed $2\frac{1}{2}$ lines apart, and two subcentral ocelli.

Five pairs of appendages are preserved *in sitû*:—

First, a pair of simple cylindrical antennæ (7 ?-jointed), 4 lines in length.

Second, third, and fourth pairs alike, and about 9 lines in length; seventh joint unguiform.

Swimming-feet, 1 inch in length; third, fourth, and fifth joints small and somewhat narrow; sixth as broad as it is long; seventh, nearly oval, with small terminal talon, and united to the sixth joint by a small intercalated triangular plate.

Body-segments.—No ornamentation is visible on these, save a quadrilinear series of markings extending to the seventh segment, but bilinear markings are seen on the eighth and ninth segments. First segment 6 lines in breadth and 1 line in length; second segment 8 lines in breadth and 1 line in length; third segment $9\frac{1}{2}$ lines in breadth and 1 line in length; fourth segment 11 lines in breadth by $1\frac{1}{4}$ line in length; fifth segment 11 lines in breadth by 2 lines in length; sixth segment 11 lines in breadth by $1\frac{3}{4}$ line in length; seventh segment 10 lines in breadth by $1\frac{1}{2}$ line in length; eighth segment 7 lines in breadth by 2 lines in length; the border of this segment slopes rapidly inwards posteriorly, and is arched laterally; ninth segment 3 lines in breadth and 2 lines in length; tenth segment 3 lines in breadth and 2 lines in length; eleventh segment $2\frac{1}{4}$ lines in breadth and $2\frac{1}{4}$ lines in length; twelfth segment 2 lines in breadth and $2\frac{1}{2}$ lines in length; telson broken, no doubt ensiform when properly preserved.

The annexed woodcut (Fig. 52) restoration may serve to convey some idea of this singular form of Eurypterid, which may possibly be a larval stage of *E. scorpioides* already described (see Pl. XXIX).

Formation.—Uppermost Ludlow Rock (Upper Silurian).

Locality.—Lesmahagow, Lanarkshire.

The specimens are preserved in the British Museum.

Species 12.—EURYPTERUS BRODIEI:—*H. Woodward.*

EURYPTERUS BRODIEI, *H. Woodward.* Quart. Journ. Geol. Soc., 1871, vol. xxvii, p. 261.
— — *H. Woodward.* Trans. Woolhope Club, 1871.
— — *H. Woodward,* Brit. Assoc. Report, Section C, Liverpool, 1870, p. 91.

In March, 1869, the Rev. P. B. Brodie, F.G.S., communicated to the Geological Society a short account of the occurrence of remains of *Eurypterus* and *Pterygotus* at Purton (see 'Quart. Journ. Geol. Soc.,' xxv, p. 235). Mr. Brodie stated that the specimens collected at that time and submitted to me were not considered to be new; in fact, they consisted, for the most part, of fragments of *Pterygotus*[1] (*P. Banksii*) and *Eurypterus*[2] (*E. pygmæus*, *E. acuminatus*, *E. abbreviatus*, &c.), already noticed in this Monograph and previously described by Mr. Salter elsewhere.

Since that communication was read, Mr. Brodie has again explored this locality, and has forwarded to me several parts and an almost entire example of a *Eurypterus*, which differs considerably from any species previously examined by me, and of which I subjoin a short notice.

The most perfect specimen, from which the restored outline (Fig. 53) is taken, measures $2\frac{3}{4}$ inches in length and 10 lines in its widest thoracic segment. All the somites are united; and one of the swimming-feet, although injured, is still in place. The head, which is semicircular in outline, measures 4 lines in length by 9 lines in breadth; the eyes are sub-central, and the ocelli nearly central, as in the other species of *Eurypterus*. The first six segments (thoracic) succeeding the head measure together 9 lines in length; commencing with a breadth of 9 lines, they increase at the third segment to 10 lines, and diminish at the sixth segment to 7 lines in breadth. The segments increase in length and diminish in breadth very evenly from the third segment backwards. The borders of all the anterior segments are curved, and the posterior angles slightly produced and acutely pointed.

53.

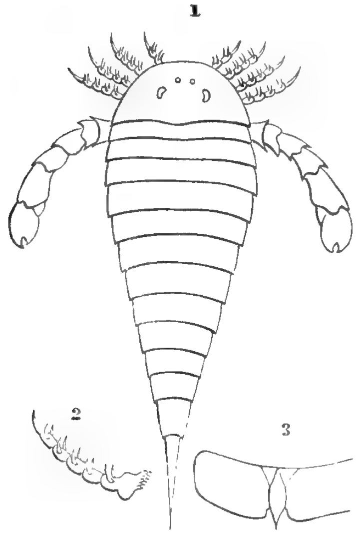


Fig. 53.—*Eurypterus Brodiei*, H. Woodw.
1.—Outline restored, natural size. Passage-beds from the Uppermost Silurian to the Old Red Sandstone, Perton, near Stoke Edith, Herefordshire.
2.—Palpus (enlarged).
3.—Thoracic plate (enlarged).

The six posterior (abdominal) segments diminish in breadth backwards from 6 lines to 2 lines, and increase, in the same direction, in length, from $1\frac{1}{2}$ line to $2\frac{1}{2}$ or nearly 3 lines, the body being terminated by a slender ensiform telson, or tail-spine, 7 lines in length. No sculpture is apparent on the segments or head; but the integument composing the former indicates its tenuity by abundance of plicæ and wrinkles. The thoracic plate (Fig. 53, 3) is very characteristic, differing in the form of its median appendage from that of any previously described species. It is 9 lines broad and $2\frac{1}{2}$ in depth; the median appendage is spindle-shaped in outline, and is $3\frac{1}{2}$ lines in length and $1\frac{1}{2}$ line broad. The swimming-foot is $2\frac{1}{2}$ lines in width and $\frac{3}{4}$ of an inch in length, exclusive of the basal joint. The species agrees closely, in the form of its swimming-feet, with the American and Russian *Eurypteri*, having

[1] See 'Mem. Geol. Surv.,' Mon. I, 1859, pl. xii, figs. 22—46, p. 51.
[2] 'Quart. Journ. Geol. Soc.,' 1859, vol. xv, pl. x, p. 229.

the same intercalated plate between the ultimate and penultimate joints, and also the minute terminal palette at the end of the seventh segment.

Numerous detached endognathary palpi occur associated with this form, furnished with short recurved spines (Fig. 53, 2) arranged in pairs upon each segment, doubtless referable to the same species. I have proposed to name this form *Eurypterus Brodiei*, after its discoverer.[1]

Formation.—Passage-beds from the Uppermost Silurian to the Old Red Sandstone.

Locality.—Purton, near Stoke Edith, Herefordshire.

BAD AND DOUBTFUL SPECIES.

*** The following species have been somewhat *doubtfully* referred by Mr. J. W. Salter to *Eurypterus*, but I think sufficient evidence is given below to prove that a portion, at least, of the remains referred by him to *Eurypterus ? mammatus* are really plant-remains, and that the remainder must, for the present, be classed with M. Jordan's *Arthropleura armata*, from the Coal-measures of Saarbruck, Rhenish Prussia, a very anomalous Crustacean, but certainly not a *Eurypterus*.

Eurypterus ferox, I think, may with propriety be referred to the MYRIAPODA under Messrs. Meek and Worthen's genus *Euphoberia* (see below, p. 171).

"*EURYPTERUS? MAMMATUS?*"—*Salter*. Pl. XXIV, figs. 2—6.

EURYPTERUS (ARTHROPLEURA ?) MAMMATUS, *Salter*. Quart. Journ. Geol. Soc., 1863, vol. xix, p. 85, figs. 1—7.

This species was determined by Mr. J. W. Salter in 1863, from fragments referred by him to the head (Pl. XXIV, figs. 2 and 3), to the lateral portions of the body-segments, and parts nearer to the tail; but of the central surface of the carapace, of the eyes, or of the appendages, nothing is known.

The first fragment was discovered by Mr. Gibbs, the intelligent Collector of the Geological Survey, in splitting up the shales at the mine-top, Pendleton Colliery, Manchester. Other specimens[2] were afterwards obtained by Messrs. Gibbs and Rhind,

[1] See 'British Association Reports,' Liverpool, 1870, p. 91.

[2] The specimens drawn on Pl. XXIV, figs. 2, 3, 4, 5, and 6, and preserved in the Museum of Practical Geology, Jermyn Street, are all which have been met with of this species. From the account given by Mr. Salter, one would have expected a larger series of fragments.

who ascertained the exact bed from which these remains were derived, and which proved to be the "Ferny Metal," under the "Big Coal" or "Ram's Mine."

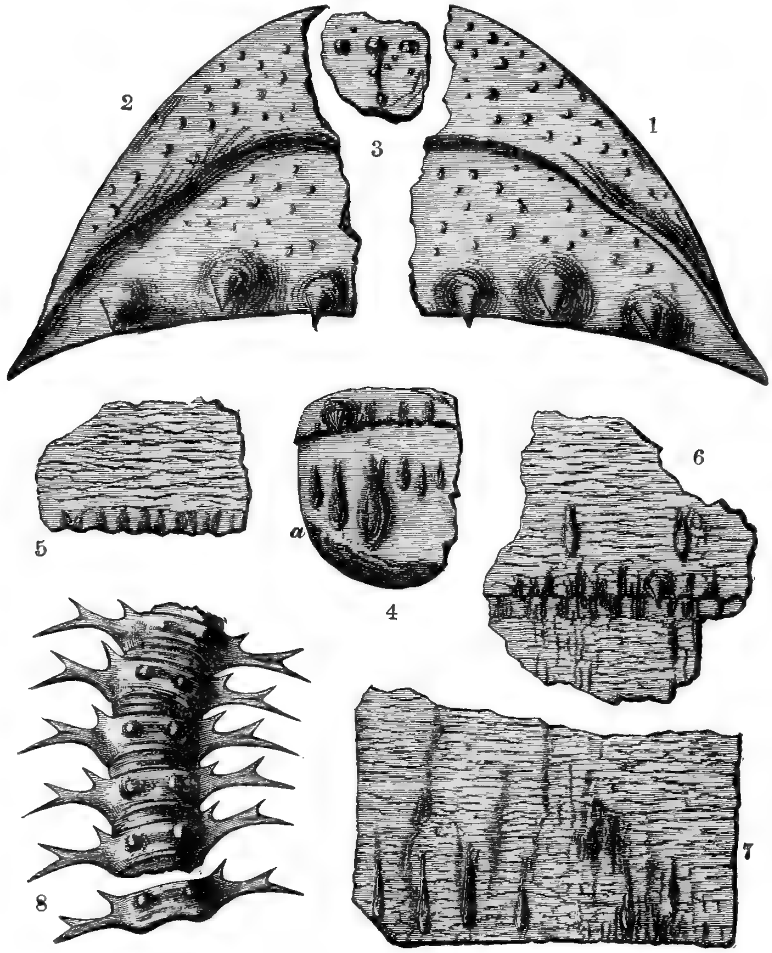


Fig. 54.—(1–7).—*Eurypterus* (*Arthropleura?*) *mammatus*, Salter.
(8).—*Arthropleura* (*Euphoberia?*) *ferox*, Salter.
(Woodcut from the 'Quart. Journ. Geol. Soc.,' 1863, vol. xix, p. 84.)

The plants occurring in this bed, noticed by Mr. Salter, are—

Lepidodendron obovatum, Sternb.	*Neuropteris gigantea*, Sternb.
,, *Sternbergii*, Brong.	*Cyclopteris flabellata*, Brong.
,, *elegans*, ,,	*Sphenopteris obtusiloba*, ,,
Neuropteris Loshii, Lindl.	,, *latifolia*, ,,
,, *heterophylla*, Sternb.	and some others.

The bed lies rather high in the "Middle Coal series."

The specimen figured on Pl. XXIV, fig. 2, is considered by Mr. Salter to be the lateral portions of the head-shield, which he thinks must have been at least 8 or 9 inches across. It shows a strongly arched border running out into a short acuminate broad spine, into which a strongly curved sharpish ridge runs from about the upper central portion. The space outside and above the ridge is flat, and is ornamented with small rounded tubercles scattered irregularly over its surface; below the ridge there are fewer tubercles, but near the hinder border there are two large mammillated tubercular spines (and part of a third) ranged about equidistant from one another; they are directed backwards, and are fully a third of an inch in length, and as much in diameter at the swollen base.

Another fragment (Pl. XXIV, fig. 3), also referred by Mr. Salter to the head, shows large and small tubercles upon its surface.

Mr. Salter speaks of "at least six, and probably more, of the large mammillated tubercular spines along the hinder border" (of fig. 2, Pl. XXIV). The explanation of this is to be found by referring to the woodcut illustrating Mr. Salter's paper, which by the kindness of the Council of the Geological Society we are able to give above, p. 164, Fig. 54 (see 'Quart. Journ. Geol. Soc.,' vol. xix, p. 84), when it will be seen that this specimen (fig. 2) has been drawn *twice over* (once reversed, and once in its natural position) so as to give the effect of a crescent-shaped shield. But only the piece represented on our Plate as fig. 2[1] exists, and after careful comparison I am quite unable to refer it to the head-shield of any known Crustacean.

Referring to the above woodcut Mr. Salter observes, "Although I have supposed figs. 1 and 2 to belong to the head, I have really little else to recommend this view than the great comparative size and breadth, and the general form, which is like that of the hinder angles of the head of the Scotch *Eurypterus*."[2]

Mr. Salter then proceeds to contrast his *Eurypterus mammatus* with the *Arthropleura armata* of Jordan, a species founded upon the fragments of a large Crustacean from the Coal-measures of Saarbruck, Rhenish Prussia.

If the subjoined woodcut (Fig. 55, B) of *Arthropleura armata* be compared with Pl. XXIV, fig. 2, a somewhat similar piece (marked *p*), having a corresponding raised border and similar arrangement of tubercles, will be seen, suggesting that this pointed portion (fig. 2) may more likely be the pleuron of a trilobed segment. This interpretation, although rejected by Mr. Salter, seems to me, on many accounts, more probable than the alternative one which he has adopted, namely, that of supposing it to be the posterior angle of the head-shield of *Eurypterus*, with which indeed it seems exceedingly difficult to associate it.

[1] It is quite apparent, however, from Mr. Salter's description, that he was under the impression that *two* specimens existed *in reality* as well as in his figure. I have therefore specially noticed this, lest hereafter it should be supposed that one of these curious fragments had been lost.

[2] If by the Scotch *Eurypterus* Mr. Salter refers to *E. Scouleri*, a comparison between the fragment of *E. mammatus* (Pl. XXIV, fig. 2) and the entire head of *E. Scouleri* (Pl. XXVII) will satisfy us that such a hinder angle could not possibly be fitted to the carapace of the latter; the *curvature* and ornamentation being both incongruous. No other form with which we are acquainted could have required so large an epimeral piece save the great Devonian *Stylonurus Scoticus*.

Assuming it to be, like Jordan's *Arthropleura armata,* part of the body-segment of some large palæozoic Crustacean (such as *Stylonurus Scoticus,*[1] or that singular form named

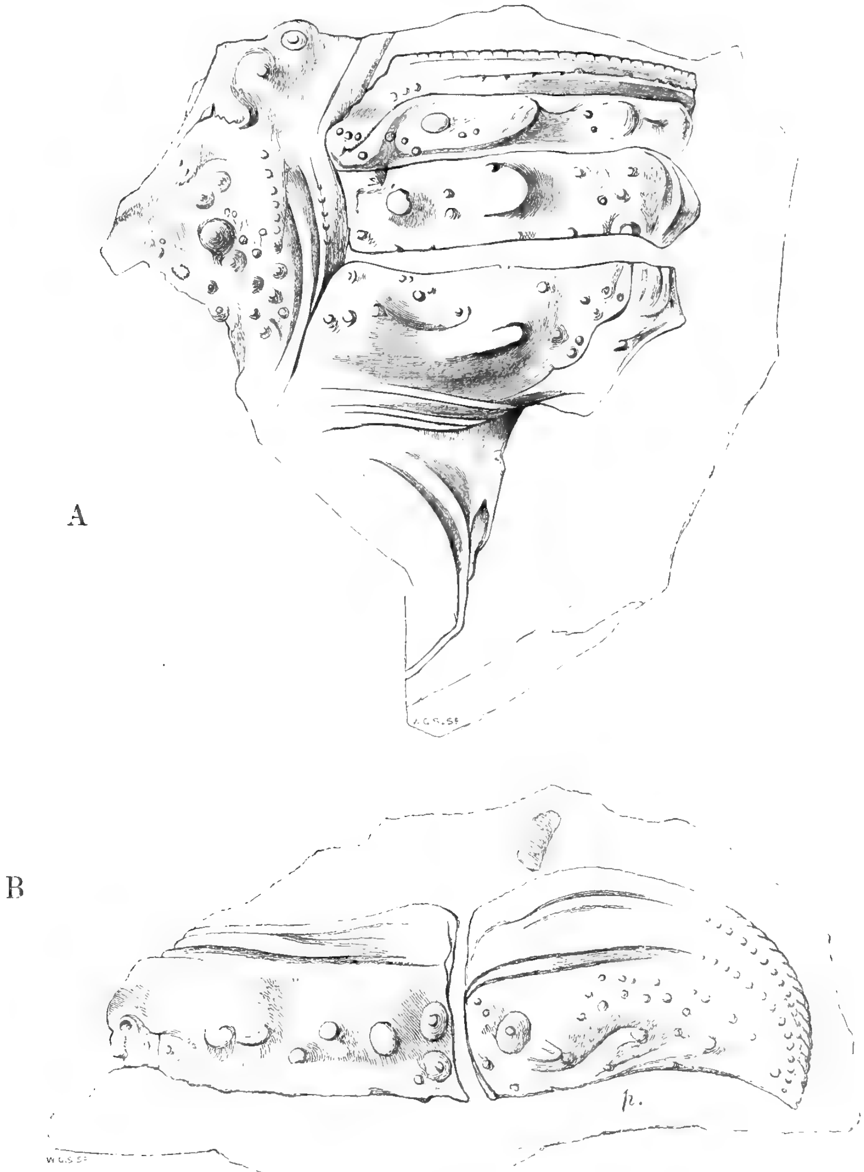


FIG. 55.—*Arthropleura armata,* Jordan.
Coal-measures, Saarbruck, Rhenish Prussia. See 'Palæontographica,' 1856, Band iv, taf. 2, figs. 4 and 5.

by me *Præarcturus gigas,* from the Old Red Sandstone of Herefordshire),[2] it seems highly probable that this fragment has no affinity with *Eurypterus* at all.

[1] See below, page 126, and Pl. XXII and XXIII.

[2] 'Trans. Woolhope Naturalists' Field Club,' 1870, p. 266; 'Fossil Sketches,' No. 9, figs. 1 and 2, and No. 10.

With regard to the remaining fragments referred by Mr. Salter to *Eurypterus mammatus* (see Pl. XXIV, figs. 4, 5, 6), I am in no little difficulty; for here again Mr. Salter's description is borne out by his woodcut figures, but not by the specimens.

For instance, he speaks of the peculiar "tear-drop" ornamentation along the hinder margin of the segments, such as is seen in certain other fragments referred to *Eurypterus* (see Pl. XXVIII, figs. 16, 17, and 17 *a*). But in figs. 4, 5, and 6, these are really *cracks* in the tissue, as correctly represented on our plate by Mr. Griesbach, and not raised tubercular ornamentations thereon, as seen in the woodcut, p. 84 (figs. 4, 6, and 7). Mr. Salter himself says:

"The remaining pieces are evidently parts of a great Crustacean, and almost certainly belong to this one, for they have the same ornaments on the hinder edge; but they differ remarkably by having a curious set of short, wavy, interrupted ridges (or furrows, it is impossible to say which) lying transversely to the length, and which are equally distributed over the whole segment. They are not all of the same size, small rounded ridges being mixed with those of a more linear shape."

I carefully studied these fragments, and also submitted them to the examination of my colleague, Mr. William Carruthers, F.R.S., who has devoted himself specially to the study of fossil plant-remains, hoping that he would accept them as parts of some plant, like *Calamites* or *Knorria;* but for some time he was unable to do so. I was therefore obliged to treat them as animal, and probably Crustacean, although I could not compare them (like figs. 2 and 3) with any other form belonging to the order; for the scale-like ornamentation so characteristic of *Pterygotus* and *Eurypterus* is altogether wanting, nor could I detect any evidence of spines such as are preserved on fig. 2.

Fortunately at this juncture a portion of an undoubted plant-stem from the Ironstone of the English Coal-measures, which Mr. Carruthers had laid aside for examination, turned up, and furnished evidence of markings *identical* with those exhibited on figs. 4, 5, and 6 of Pl. XXIV, so that there is no longer any reason to doubt their vegetable origin. Mr. Carruthers has very kindly drawn up the subjoined account of these remains, which may now be considered as disposed of in a satisfactory manner.

The remaining specimens (figs. 2 and 3, Pl. XXIV) will be retained to represent Mr. Salter's species, which we refer provisionally to M. Jordan's genus as *Arthropleura mammata,* Salter, sp., about the affinities of which we cannot at present speak with any degree of certainty.[1]

[1] Just as this sheet was passing through the press I received two additional contributions to Salter's *Eurypterus* (*Arthropleura*) *mammatus.* The first is a very curious compressed fragment of what appears to be the sternum of the thorax of a *Brachyurous Decapod* from the Coal-measures near Manchester, sent me for examination by W. Johnston Sollas, Esq., of St John's College, Cambridge.

The other consists of three tuberculated epimeral pieces so exactly resembling that marked *p* in our fig. B, Woodcut 55, p. 166, that, except for the variation in the wart-like tubercles, two of them might at once be mistaken for Jordan's type. There is the same deep groove in each, the same falcate border, the same admixture of large and small tubercles upon its surface occupying relatively the same positions. The

Formation.—Coal-measures. In the "Ferny Metal" beneath the "Seven-foot Coal" or "Ram's Mine."

Locality.—Pendleton Colliery, near Manchester.

The specimens are preserved in the Museum of Practical and Economic Geology, Jermyn Street.

NOTE ON SOME SUPPOSED FRAGMENTS OF A *EURYPTERUS.*

By W. Carruthers, Esq., F.R.S., &c., &c.

(*Communicated to the Author.*)

The specimens figured and described by the late Mr. Salter as portions of a *Eurypterus*, regarding which you have expressed to me doubts, are certainly fragments of a large Equisetaceous plant. They are very different in their general aspect from the common *Calamites* of the Coal-measures, and belong to a group of plants whose known remains are very fragmentary, and about the precise nature and affinities of which there has been considerable difference of opinion.

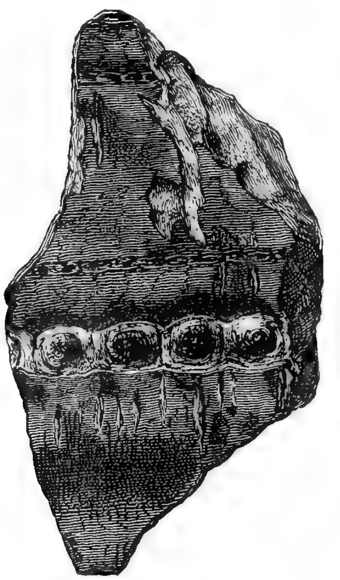


Fig. 56.—*Phytolithus parmatus*, Steinh. *Ulodendron parmatum*, Carr, Coal Measures, reduced ½ natural size.

In the British Museum there is a fragment of this plant showing portions of four joints of the stem (Fig. 56); two of these joints exhibit the oblong scars of the leaves, and a third has a series of large round scars, which have been produced by a whorl of axillary appendages. The surface of the stem is smooth, and immediately below the large round scars there are a number of cracks, through which the mud filling the medullary cavity has been pushed. In form and position these exactly agree with the "tear-drop" ornaments on Mr. Salter's fragments (see Fig. 56).

The counterpart of this specimen was figured by the Rev. H. Steinhauer, in his very valuable paper on "British Fossil Plants," published in the 'Transactions of the American Philosophical Society' (vol. i, new series, p. 286, pl. vi, fig. 1). This remarkably acute observer, however, referred it to his *Phytolithus parmatus* (*Ulodendron parmatum*, Carr.).

third specimen is more waved along its anterior curved border, and the hinder border is straighter than in Jordan's figure. These are from the roof-shale of "Top Little Vein" Camerton Collieries, near Bath, and were obtained by W. G. M'Murtrie, Esq., of Camerton, who has paid much attention to the Geology and Palæontology of this interesting district.

Both the Manchester and the Camerton specimens are from Plant-beds, and are associated with remains of *Neuropteris*, *Pecopteris*, &c. I have thought it proper to notice these remains here, but as they are not referable to the Eurypterida I shall figure and describe them at more detail elsewhere. They deserve, however, a passing notice in connection with the history of Mr. Salter's *Eurypterus mammatus*.

Lindley and Hutton met with a less perfect fragment, showing four of the large round scars ('Fossil Flora,' pl. cxxx); unable to determine anything as to the affinities of this fossil, they were satisfied with attaching to it a new generic name—*Cyclocladia*—and leaving their successors to throw some light on it when better materials should turn up.

They had, however, already published the portion of a stem with leaves belonging to the same plant under the name of *Hippurites gigantea* ('Fossil Flora,' pl. cxiv). This represents parts of three joints, two of them very obscure, from the way in which the specimen was broken, and the broken pieces pressed upon each other in the bed in which they were preserved. The surface of the stem, Lindley says, is in some places perfectly smooth, without the slightest trace of furrows or scars, but in other places it presents the appearance of transverse wrinkles. These transverse markings are shown on the lower joint (Fig. 57), and are obviously the same as the short, wavy, interrupted ridges lying transversely to the length, described and figured by Mr. Salter. The leaves occupy their natural position; they are acicular, somewhat dilated downwards, and united at the base, but not so as to form a sheath. There are indications of a central rib to the leaf. In a second species from the Forest of Dean (*H. longifolia,* Lindl. and Hutt., 'Fossil Flora,' pl. cxc) the long leaves are more obviously free to the very base.

Fig. 57.—*Hippurites gigantea,* Lindl. Coal-measures, Newcastle-on-Tyne. (Lindl. & Hutt., pl. 114, ½ nat. size.)

Germar has figured a larger specimen under the name of *Calamites varians,* Sternb. ('Steinkohlen v. Wettin und Löbejün,' p. 47, pl. xx, fig. 1), in which the scars of the leaves and of the axillary appendages are shown on the same specimen, as well as the furrowed structure of the interior so characteristic of Calamitean stems. (See Woodcut, Fig. 58.)

The very thin layer of coal which here represents the cylinder of the hollow stem, shows that this cylinder was very slender. This is obvious also from the cracks in Fig. 56, and the scarcely increased thickness from the overlying portions of the upper joint of Fig. 57. The perfectly smooth outer surface of the stem is also well shown in this specimen. The slender nature of the stem and the delicate transverse wrinkles resulting from this are very well shown by Ettingshausen in his memoir on *Calamites* ('Sitzungsbericht d. math.-natur. Class. d. K. Akad. Wissensch.,'

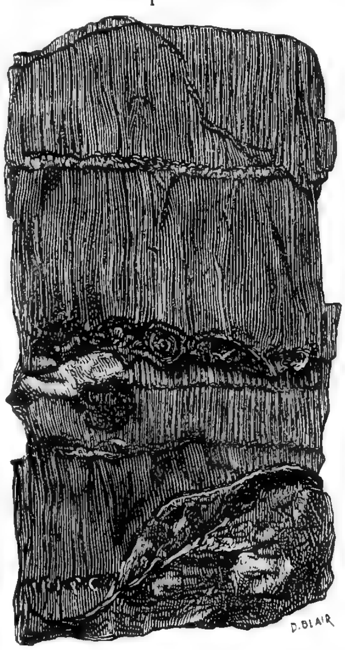


Fig. 58.—*Calamites varians,* Sternb. Coal-measures. (Germar, l. c., pl. xx, fig. 1, ½ nat. size.)

vol. ix, pl. ii, fig. 1); and the tear-drop ornamentation is represented in the figure on pl. i, fig. i.

Geinitz, in his beautiful work 'On the Coal Formation in Saxony,' has added considerably to our knowledge of this set of Equisetacean stems. He figures a portion consisting of several joints, two of which are furnished with verticils of large scars, and a larger and more slender specimen with many joints (a portion of which is reproduced, Fig. 60) shows the position of the two sets of scars as in Steinhauer's specimen, as well as the ridges of the inner surface. The aspect of the larger upper whorl of scars in Fig. 59, and the character of the furrowing of the medullary cavity shown in Fig. 58 from Germar, seem to justify Geinitz in referring to this plant the *Calamites verticillatus*, Lindl. and Hutt., 'Fossil Flora,' pl. cxxxix. That these scars may have been produced by the cones, as held by Geinitz, I cannot doubt, but the specimen of *Hippurites longifolia*, Lindl. and Hutt., figured in 'Fossil Flora,' pl. cxc, shows that they were produced also by the ordinary leaf-bearing branches. The drawing of *Asterophyllites grandis*, Lindl. and Hutt., 'Fossil Flora,' pl. xvii, further corroborates this view.

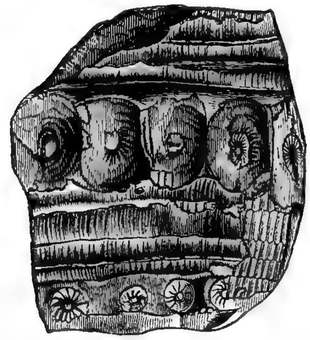


FIG. 59.—*Equisetites infundibuliformis*, Bronn, Coal-measures, Zwickau. (Geinitz, 'Steink. in Sachsen,' pl. x, f. 4, ½ nat. size.)

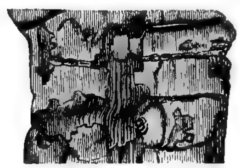


FIG. 60.—*Equisetites infundibuliformis*, Bronn, part of stem with verticils of leaf-scars, Coal-measures Zwickau. (Geinitz, op. cit., pl. x, f. 5 in part, ½ nat. size.

Geinitz also figures the leaves, which agree in their general character with those of *Hippurites gigantea*, Lindl. and Hutt. Geinitz correlates with this plant a large cylindrical fruit, with a short, thick, and slightly curved base; and he believes that the larger scars are the impressions of the articulations of these cones. One of these scars is shown on fig. 6 of Salter's illustrations.[1] Schimper does not think it possible that this fruit, his *Macrostachya infundibuliformis*, can belong to Geinitz's plant, but I see no reason for doubting it. The Calamitean plants of the Coal-measures are so fragmentary that it is very difficult to correlate the different parts; and this difficulty is vastly increased from the immense numbers of worthless "species" that exist, based, in the infancy of our knowledge, on characters then supposed to be important, but which are now known to be of no value. Nevertheless these very characters are, up to the present time, being employed to burthen our pages with synonyms. Schimper reduces the whole of the true Calamites to seven satisfactory and nine unsatisfactory species. I would not hesitate to go yet a little further with Ettingshausen, though perhaps his wholesale demolition of supposed species is somewhat too thorough; and I cannot, at any rate, defend his placing the plant we are now dealing with among the crowd which

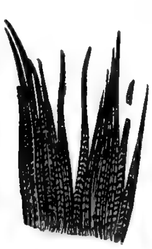


FIG. 61.—Foliage of *Equisetites infundibuliformis*, Bronn. Coal-measures, Zwickau. (Geinitz, op. cit., pl. x, f. 8 in part, ½ nat. size.)

[1] See Woodcut, Fig. 54, 6, p. 164; also the accompanying Pl. XXIV, fig. 4.

compose his *Calamites communis.* Of course, if Geinitz is right in his correlation of the fruit, Ettingshausen himself would eliminate it from the synonyms; but even apart from this, it seems to me that the delicate stem made up of a large series of very small vascular ridges with intervening cellular structures, and the form of the persistent leaves sufficiently separate them from what we know as the ordinary type of Calamite in this country as to make a good generic distinction, and to justify Lindley and Hutton in their placing them in a distinct genus. Their name (*Hippurites*), however, indicates a false affinity, and must be set aside for Sternberg's *Equisetites,* unnecessarily altered by Schimper into *Equisetides.* Probably the "thin-walled *Calamopitus,*" figured by Prof. Williamson in his recent memoir on "Calamites" ('Phil. Trans.,' 1871, pl. xxv, figs. 19, 20), belongs to this plant; and the Calamitean strobilus which he has so well worked out in the 'Memoirs of the Literary and Philosophical Society of Manchester,' vol. iv, p. 248, may be the fruit.

"*EURYPTERUS? (EUPHOBERIA) FEROX:*"—*Salter.*

EURYPTERUS ? (ARTHROPLEURA) FEROX, *Salter.* Quart. Journ. Geol. Soc., 1863, vol. xix, p. 86, woodcut, fig. 8.

CATERPILLAR ?, *J. O. Westwood,* in Brodie's Fossil Insects in the Secondary Rocks of England, 1845, p. xvii, p. 115, pl. i, fig. 11.

Accompanying Mr. Salter's description of *Eurypterus* (*Arthropleura !*) *mammatus*[1] is a notice of another form named by him *Eurypterus ?* (*Arthropleura*) *ferox.* The specimen described forms Fig. 54, 8, of the Woodcut reproduced at p. 164 from Mr. Salter's paper, and was obtained by Mr. Charles Ketley (of Smethwick) from the Clay-ironstone nodules in the shale over the "Thick Coal" of the Coal-measures, Tipton, Staffordshire, associated with abundance of fossil plants.

Mr. Salter observes, "At first sight it would strike an entomologist as a fossil Caterpillar of the *Saturnia* genus, so strong is its resemblance in size, form, and ornament to the larvæ of that group. Unlike most Crustaceans from the old rocks, it is extravagantly ornamented with long forked spines." Such spines are found on the carapace of *Lithodes,* and also on the segments of the abdomen of the "Murray River Cray-fish," *Potamobius astacus.*

Mr. Salter considers von Meyer's *Arthropleura armata* (already referred to) to belong to *Eurypterus* (see Woodcut, Fig. 55, p. 166), and thinks it possible to assign both his *E. mammatus* and *E. ferox* to the same group.

In a 'History of Fossil Insects of the Secondary Rocks of England,' by the Rev. P. B. Brodie, M.A., F.G.S., 8vo, published in 1845, some specimens are figured from the collection of the Rev. F. W. Hope,[2] now preserved in the Oxford Museum.

[1] 'Quart. Journ. Geol. Soc.,' vol. xix, p. 86. See also Woodcut, Fig. 54, 8, p. 164.

[2] The Founder of the Hope Professorship of Zoology in the University of Oxford, so ably filled by Prof. J. O. Westwood, M.A., F.L.S., the eminent Entomologist and Carcinologist.

Among others is a specimen "from Coalbrook Dale, which has very much the appearance of some large Caterpillar, furnished with rows of tubercles, to which setæ or bristles were attached, as in the case of the Caterpillar of our common English Emperor Moth (*Saturnia Pavonia minor*): unfortunately the specimen is imperfect at each end, and therefore it is impossible to judge of the appendages of the head or tail. It will be seen that there appear to be distensions of the membrane connecting several of the segments of the body together, as between the first and second, second and third, fourth and fifth (on the right hand side), and seventh and eighth. Now this could not, I think, occur to so visible an extent in a Lepidopterous larva, because it seems to intimate that the broader parts of the body (or the true segments) are of a firmer texture than the connecting distendable membrane. The lateral series of long, slender, and *evidently articulated* appendages seem also to throw a doubt on the Insect being a Lepidopterous larva.

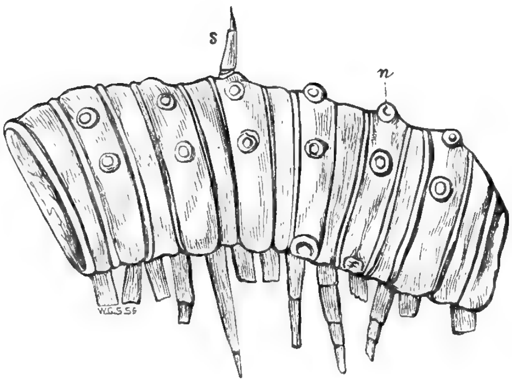


FIG. 62.—*Euphoberia ? major*, M. & W., Coal-measures, Grundy Co., Illinois, U.S.A. See Messrs. Meek and Worthen's 'Palæontology of Illinois,' 1868, vol. iii, p. 558. One dorsal spine (*s*) still remains *in situ*; the nodes (*n*) are evidently the bases of spine. Several pairs of the legs are seen below.

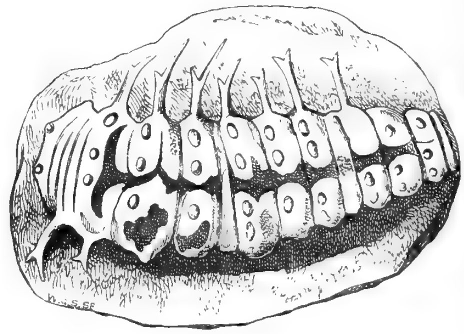


FIG. 63.—*Arthropleura ferox*, Salter, specimen figured by the Rev. P. B. Brodie, preserved in the Hope Collection, Oxford, from the Coal-measures, Coalbrookdale. [Copied from Plate I, fig. 11, of Brodie's 'Fossil Insects.']

These appendages have some remote analogy to those of a portion of the segments of *Squilla*, but this is only in appearance, and not a real relationship. The dark line which runs down the back seems quite analogous to the great dorsal vessel or heart of the Caterpillars. ("Introductory Observations," by J. O. Westwood,[1] M.A., F.L.S., &c., &c.). See Woodcut, Fig. 63.

Among the numerous interesting remains of Arthropoda from the Coal-measures of Illinois, figured and described by Messrs. F. B. Meek and A. H. Worthen, in the Palæontology of Illinois, published in vol. iii of the publications of the Geological Survey of Illinois (1868), is a specimen which there can be little doubt is identical with

[1] In Brodie's 'Fossil Insects of the Secondary Rocks,' p. xviii.

that figured and described by Mr. Salter as *Eurypterus? ferox,* and by Mr. Westwood as the "larva of some unknown insect." See Woodcut, Fig. 62.

Messrs. Meek and Worthen provisionally refer their specimen to the Myriapoda and to their genus *Euphoberia,* under the name of *Euphoberia? major,* M. and W.

A smaller species of *Euphoberia,* also armed with forked spines, named *E. armigera,* was found in the Coal-measures of Grundy, County Illinois, and is described in the same work by Messrs. Meek and Worthen. A specimen equalling in size their *E. armigera* was figured and described by the writer in the 'Geological Magazine,', 1871, vol. viii (pl. iii, fig. 6, p. 97), from the Coal-measures near Glasgow, under the name of *E. Brownii.*

Messrs. Meek and Worthen write as follows respecting their specimen of *Euphoberia? major* (see Woodcut, Fig. 62):

"We unfortunately yet know it only from fragments, one of the best of which is represented by the annexed cut. If as long in proportion as the other species, it probably attained a length of twelve to fifteen inches, and must have presented a formidable appearance. The node-like prominences marked *n* in the figure are evidently the bases of spines that have been broken away. One of these, however, is seen lying in the matrix at the point marked *s.* Another specimen shows a direct view of the dorsal side compressed flat. In this traces of two rows of these node-like prominences are seen along the middle, while a row of spines can be seen projecting out into the matrix on each side. This latter specimen so nearly resembles a fossil figured by Mr. Salter, in the 'Quarterly Journal of the Geological Society of London,' vol. xix, p. 84, fig. 8, from the Staffordshire Coal-measures, under the name of *Eurypterus* (*Arthropleura*) *ferox,* that we can scarcely entertain a doubt that they are congeneric. Indeed if it were not for the fact that the species *ferox* has its spines provided with three instead of two prongs, we would even suspect that our specimens might possibly belong to the same species.

"Mr. Salter thought his specimen probably a part of the central lobe of a trilobate *Eurypterus* or some allied genus, an opinion he would not have entertained for a moment (provided we are right in our suggestion respecting its relations to our fossil), if he had seen a specimen showing a side-view of even a few of the segments with their legs attached. At any rate our fossil is certainly distinct from the genus *Arthropleura* of Jordan and Von Meyer, which is almost beyond doubt a Crustacean."[1]

After carefully examining the English *E. ferox* of Mr. Salter, and comparing it with Messrs. Meek and Worthen's figure and description, I am disposed fully to agree with the latter writers, and to refer it to the Myriapoda and to their genus *Euphoberia,* feeling certain that it has no relation whatever with *Eurypterus.*

Having in the first part of this Monograph placed *E. ferox* in the list of species given on p. 15, it seemed desirable to show the reason why it should no longer be so retained

[1] Op. cit., p. 558.

in our classification. The reasons may briefly be stated:—(1) We know of no undoubted *Eurypterus* with body-segments ornamented with spines or tubercles like those of *E. ferox*. (2) The segments, when seen in series, are never (in *Eurypterus*) of a uniform size, but invariably diminish, as regards their breadth, from the seventh segment towards the telson. With the single exception of *Eurypterus Scouleri* (a most aberrant form of the *Eurypteria*), all the members have the segments but very slightly arched, and (save in the three most posterior segments) always much broader than long.

We may therefore consider Mr. Salter's *Eurypterus ? ferox* as excluded from the genus *Eurypterus*, and also from Jordan's genus *Arthropleura*, and may refer it with considerable confidence to Messrs. Meek and Worthen's Myriapodous genus *Euphoberia*.

Formation.—Coal-measures. Clay-ironstone.

Localities.—Coalbroak Dale, Shropshire; Tipton, Staffordshire.

Foreign Localities.—Coal-measures, Grundy, County Illinois, U.S. America.

Genus 5.—Hemiaspis:—*H. Woodw.* 1865.

Species 1.—HEMIASPIS LIMULOIDES:—*H. Woodw.* Pl. XXX, figs. 1, 2.

Hemiaspis limuloides, *H. Woodward.* Brit. Assoc. Report, Bath Meeting, 1864, Section C.

— — *H. Woodward.* Quart. Journ. Geol. Soc., 1864, vol. xxi, p. 490, pl. xiv, figs. 7*a*, 7*c*.

When I first drew attention to this genus at the Bath Meeting of the British Association in 1864, only one nearly perfect specimen was known.

Mr. Salter was acquainted with it, however, so long ago as 1857, and referred to this individual, among other new and undescribed Crustacea, in a paper "On some New Palæozoic Star-fishes" found at Leintwardine, Shropshire,[1] under the name of *Limuloides*.

Portions of several others had also been met with, to which Mr. Salter attached MS. names in the Museum of Practical Geology, Jermyn Street, but they have not been heretofore described.

The most perfect of these Limuloid forms was described by me in a paper read before the Geological Society in June, 1865.[2]

[1] See 'Ann. and Mag. Nat. Hist.,' 2nd series, 1857, vol. xx, p. 321.

[2] See 'Quart. Journ. Geol. Soc.,' 1865, vol. xxi, p. 490, pl. xiv, fig. 7.

Since that date other fragments have been obtained, and also another nearly perfect example (obtained by the late Mr. Henry Wyatt-Edgell) of the species named by me *Hemiaspis limuloides*, which, having the upper central portion of the carapace preserved, nearly completes our knowledge of this species.

The great interest attaching to this form arises from the fact that it offers just the desiderated link by which to connect the *Xiphosura* with the *Eurypterida*.

Limuli, apparently differing but little as regards their carapace from the recent species now found living on the Coasts of China, Japan, and the north-east coast of North America, occur as early as the deposition of the Solenhofen Limestone of Bavaria; and in the Coal-measures of England and Ireland several species of *Bellinuri* and *Prestwichiæ* occur, in which the cephalic shield is composed of the cephalothorax; and the segments of the abdomen, if not anchylosed in all, are so in most.

But in the specimen under consideration we have the cephalic, thoracic, and abdominal divisions still remaining distinct, and apparently capable of separate flexure. This important character at once separates it from *Limulus*, *Bellinurus*, and *Prestwichia*.

I did not on this account (*with the concurrence of Mr. Salter* given at the time) use his MS. name of *Limuloides* as a generic appellation, but proposed the name *Hemiaspis* (from ἥμισυς, *half*, and ἀσπὶς, *a shield*), reserving Mr. Salter's MS. name *Limuloides* for the specific title of the most perfect species of the genus (see Pl. XXX, figs. 1, 2).

But it will be observed that *Hemiaspis* is also, *in general appearance*, strongly severed from the other species of Eurypterida, as well as from the Xiphosura, in structure.

The three divisions into head, thorax, and abdomen are more strongly marked. The abdomen is reduced to very slender proportions, less than one third the length of the animal (the entire specimen measuring 2½ inches in length by one inch in width.

The carapace in general outline resembles *Limulus*, but is more dilated laterally. There is a small stellate ornamentation in the centre of each cheek, having five to six rays, and measuring about a line in extent; but whether this represents the position of the eyes I am quite unable to say. It is so unlike the eye of any other member of the group, that I am inclined to doubt its relation to that organ. It seems probable that the eyes were placed along the lateral margin of the glabella, not upon the centre of the cheek.

There is a faint indication on one side of fig. 1 and on fig. 2 of a facial suture to the head-shield (as in the Trilobites), with a small aperture upon its border, which may possibly indicate the true position of the eye, but it is by no means clearly defined.

The surface of the glabella when perfect (as shown in our Plate XXX, fig. 2) appears to have been almost smooth,[1] save that it is traversed by two ridges which, commencing

[1] In the original description of the glabella of *Hemiaspis limuloides* (see 'Quart. Journ. Geol. Soc.,' vol. xxi, p. 490) I have described the glabella, *from a detached portion*, as "ornamented with a semicircle of nine tubercles, and a tenth immediately within the circle upon the elevated front, and two small tubercles at the posterior margin." The acquisition of the second specimen (fig. 2, pl. xxx) proves this fragment to belong to another species, not to *H. limuloides*, as formerly supposed.

as raised tubercles on the posterior border of the head-shield, three lines apart, gradually converge and unite, so as to form an arch, the summit of which nearly touches the front border of the glabella.

Nine ray-like corrugations descend from the glabella towards the margin of the shield, and the whole surface of the carapace is very minutely granulated. The lateral margins of the shield are ornamented with minute spines, and the rounded posterior angles of the carapace terminate in a broad triangular point directed backwards. A fringe of lesser spines arms the lateral border of the glabella.

The thorax is composed of six strongly trilobed plates; the epimera being equal in breadth to the central portion of each segment.

The first segment is the largest, being 1 line in depth and 7½ in breadth, including the epimera, which are pointed at their extremities and slightly overlap the following segment. The four following segments have the borders of their epimeral pieces rounded, and gradually decrease in breadth downwards from 9 lines to 7, and increase in depth from ½ line to 1 line.

A section of one of the segments would present an outline like that of *Phacops* among the Trilobites, namely, a triple corrugation.

The sixth thoracic segment is more strongly arched than the preceding ones, and the lateral borders are divided into two rounded lobes on each side: breadth 5 lines, depth 1 line.

The abdomen consists of only three segments each, 2 lines in breadth and 1½ lines in depth. The first has no epimera, and appears to move freely at its articulation with the six thoracic segment. The second and third segments have small epimeral pieces, which are bilobed, with the posterior lobe more pointed. A line of small tubercles runs down the centre of these three joints, which are somewhat raised at their articular borders.

The telson is 12 lines in length and 1¼ line in breadth where it articulates with the abdomen. It tapers gradually to a fine point.

If we regard the first six body-rings from the head as thoracic, and the remaining three segments as abdominal, we must presume that each of these latter is a double segment, as compared with the segments of the *Eurypterida* proper.

On the other hand, the presence of these three segments precludes our considering the head to be the cephalothorax and the succeeding segments the abdomen, a view controverted by me in my examination of the structure of the *Xiphosura*.[1]

The smallness of the abdomen, and its reduction from the assumed normal number of six to three, seems to indicate a form by which, with the help of others, we may bridge over the interval that has hitherto existed between these two groups, the *Eurypterida* and the *Xiphosura*.

Although *Hemiaspis* is the only genus met with in Britain having this remarkable form, we know of three Russian genera which present almost identical peculiarities of

[1] See paper by the author, 'Quart. Journ. Geol. Soc.,' 1867, vol. xxiii, p, 28, pl. i and ii.

structure. Dr. J. Nieszkowski has described two forms from the Upper Silurian of the Island of Oesel, namely, *Pseudoniscus aculeatus* (Woodcut, Fig. 65), and *Exapinurus Schrenkii* (Woodcut, Fig. 66); and Dr. d'Eichwald has described a third form under the title of *Bunodes lunula* (Woodcut, Fig. 67), from the same rich locality and formation.[1]

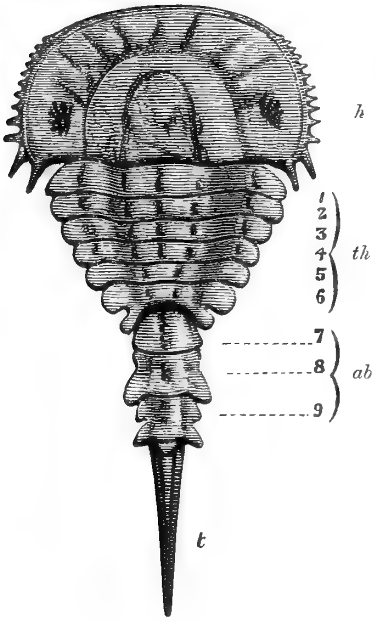


FIG. 64.—*Hemiaspis limuloides*, H. Woodward, Lower Ludlow, Leintwardine.

h, the head; *th*, the six thoracic segments; *ab*, the three abdominal somites; *t*, the telson.

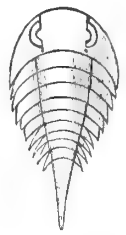


FIG. 65.—*Pseudoniscus aculeatus*, Nieszk., Upper Silurian, Isle of Oesel, Baltic.

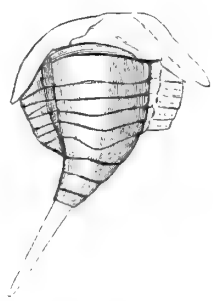


FIG. 66.—*Exapinurus Schrenkii*, Nieszk., U. Silurian, I. of Oesel, Baltic.

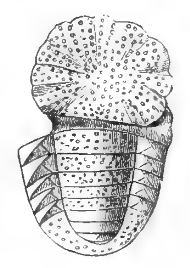


FIG. 67.—*Bunodes lunula*,[2] Eichw., U. Silurian, I. of Oesel, Baltic.

All these forms have the three well-marked divisions to their bodies into head, thorax, and abdomen, and all, save *Bunodes*, possessed a telson, or tail-spine, and free articulated thoracic somites.

In addition to *Hemiaspis limuloides*, already described, there are certain other specimens in the Museum of Practical Geology, to which Mr. Salter has appended MS. names, namely—

Hemiaspis (*Limuloides*) *speratus*, Salter MS.
,, ,, *optatus*, ,,
,, ,, *tuberculatus*, ,,

[1] 'Archiv für die Naturk. Liv- Ehst- und Kurlands,' erste Series, vol. ii, pl. ii, figs. 12, 13, and 15, pp. 378—382, Dorpat, 1859, 8vo.

[2] It is just possible that *Bunodes* may prove to be an Arachnid related to Scudder's *Architarbus rotundatus* from Illinois, U.S.

In Lowry's Chart of the Genera of Fossil Crustacea designed by Mr. J. W. Salter and myself, Mr. Salter has figured a head-shield of *Hemiaspis* under the name of *H. Salweyi.* There can be no doubt that this form is identical with *Limuloides tuberculatus* of Salter. I consider his *Limuloides speratus* and *L. optatus* to represent but one species, closely allied to *H. limuloides.* A portion of the head-shield of another form distinct from the foregoing, from the Wenlock Shale, Dudley, completes the known species of *Hemiaspis.* *Formation and Locality.*—Lower Ludlow; Leintwardine.

Species 2.—HEMIASPIS SPERATUS:—H. Woodw. Pl. XXX, figs. 5 and 7.

LIMULOIDES SPERATUS, *Salter*, MS.
— OPTATUS, *Salter*, MS.

This species is represented by four head-shields only; body-segments are not known.

It is no doubt closely related to *H. limuloides* already described, but the carapace is broader in proportion to its length, and the radiating lines or ridges which in that species take their rise around the margin of a well-defined central glabella, in *H. speratus* extend over the whole surface, save a small quadrate area at the centre of the posterior border. From this small area seven diverging costæ are given off; the three in front being nearly equidistant and straight, the two next, which rise from the outer angles of the central area, divide and form a Y-shaped ridge on each latero-anterior border; the two most posterior costæ curve upwards and outwards from the posterior border of the glabella to the lateral margins of the shield, and are marked midway by a minute lenticular space which probably indicates the position of the eye (see Fig. 68, *e*).

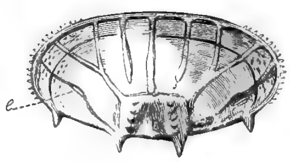


FIG. 68.—Head-shield of *Hemiaspis speratus,* Salter, MS. Nat. size. (Restored.) *e.* position of the eye?

The head-shield is broadly arcuate in front, and the margin, especially on the cheeks, is fringed with a closely set row of minute spines; the lateral angles of the shield are truncated not produced posteriorly; the hinder border of the head-shield is armed with four equidistant spines. The surface of the carapace, especially around the border, is covered with a very minute granular ornamentation. The following measurements show the relative size of the head-shields of *Hemiaspis speratus:*

Breadth.	Length.
15 lines	7½ lines (Pl. XXX, fig. 7), Mus. Brit.
10½ ,,	6 ,, (,, ,, 5), ,,
13 ,,	8½ ,, (Woodcut, Fig. 68.) Mus. Pract. Geol.
11½ ,,	9 ,, ,,

Formation and Locality.—This species is found in the Lower Ludlow Rock of Leintwardine, and is represented by specimens of the head only, preserved in the British Museum, and in the Museum of Practical Geology, Jermyn Street.

Species 3.—HEMIASPIS HORRIDUS :—H. Woodw. Pl. XXX, fig. 6.

This species represented by a single example obtained by Charles Ketley, Esq., from the Tunnel shale, Dudley, and now preserved in the British Museum is the oldest example in time of this curious genus.

When entire the carapace must have measured $1\frac{1}{4}$ inch in breadth by 8 lines in length; the edge is thickly set with prominent sharp-pointed spines $\frac{1}{2}$ a line to a line in length, whilst two strongly marked spines, 2 lines in length, project from each posterior angle of the carapace; the spines along the hinder border of the shield, if present in this species, are not preserved in this example. The median line of the carapace, which is slightly tumid, is marked by one rounded and prominent tubercle and two elongated confluent ones, whilst on either side of this median line three other divergent lines of elongated tubercles arise and radiate outwards to the border of the shield. The surface of the carapace between the tubercles is finely granulated, with here and there a slightly larger pimple upon its surface. Eyes not visible.

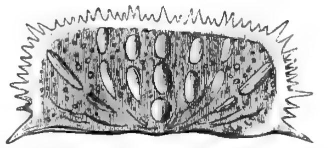


FIG. 69.—Head-shield of *Hemiaspis horridus*, H. Woodward. (Restored.) Wenlock shale, Tunnel, Dudley.

There are some other fragments which may indicate another species (see Pl. XXX, fig. 3), but they are too fragmentary for determination, and I therefore think it best merely to notice them in passing.

Formation and Locality.—Wenlock shale, Dudley. The specimen is in the British Museum.

Species 4.—HEMIASPIS SALWEYI :—Salter. Pl. XXX, fig. 4.

LIMULOIDES TUBERCULATUS, *Salter*, MS. (Mus. Pract. Geol.).

HEMIASPIS SALWEYI, *Salter*. Lowry's Chart of Fossil Crustacea; Eurypterida, Fig. 3, 1865.

This species is represented by two head-shields only; the body-segments, as with the preceding species, are not preserved. The carapace, which is very tumid, is nearly circular in outline, and measures $1\frac{1}{2}$ inches in breadth and 1 inch in length. The posterior border of the glabella is armed with two large spines, 3 lines in length and 4 lines apart, whilst three smaller ones, also directed backwards, are arranged on either side of the genal border. The surface of the carapace is covered with a minute granular ornamentation; the raised central portion is flanked by a border of somewhat elongated tubercles; within the central area are three or four ronuded tubercles arranged in two oblique rows about four lines apart, commencing on the posterior border of the head at the base of the two large spines. One central prominent tubercle and two lesser lateral ones on the front of the glabella, complete the ornamentation of the head-shield.

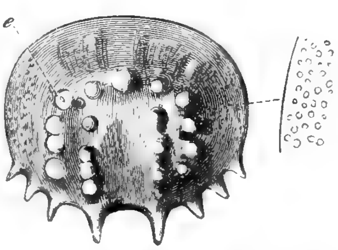


FIG. 70.—Head-shield of *Hemiaspis Salweyi*, Salter. (Restored.) U. Ludlow, near Ludlow.

The spot marked *e* on the annexed Woodcut (Fig. 70), near the latero-anterior border of the raised glabella, probably indicates the position of the eye. There is a slight indication of costæ on the front border of the head.

Formation and Locality.—Upper Ludlow, near Ludlow; Mus. Pract. Geology, Jermyn Street; Lower Ludlow, Ledbury; British Museum.

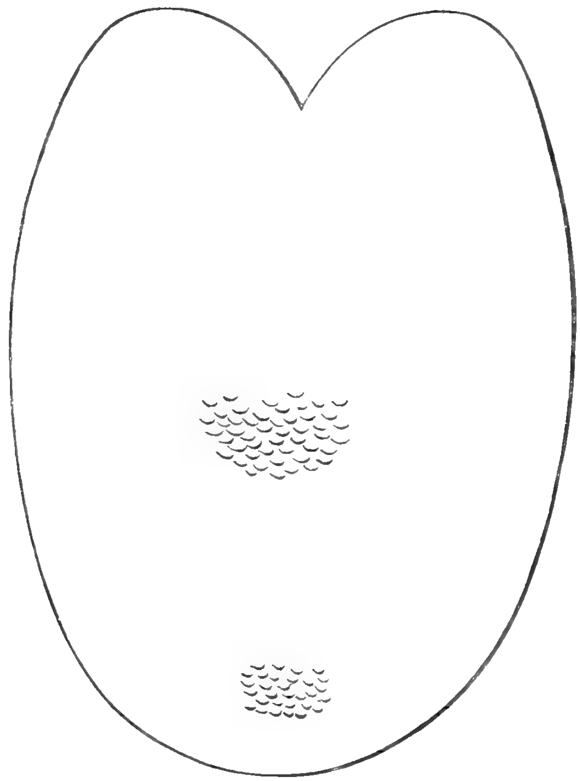


FIG. 71.—Lip-plate of *Pterygotus* from the Upper Silurian; Rootziküll, Isle of Oesel, Baltic; associated with *Pseudoniscus*, *Exapinurus*, and *Bunodes*.[1]

POSTSCRIPT.—After the foregoing pages had gone to press, Mr. James Armstrong, whilst visiting the British Museum, carefully examined the matrix in which the specimens of *Eurypterus Scouleri* are contained (figured on Plates XXV, XXVI, and XXVII, and stated to be from Burdie House, near Edinburgh), when he at once pronounced them to be from a quarry at Kirkton, near Bathgate, West Lothian; which is *not* in the Coal proper but in the Carboniferous Limestone. This bed also contains *Sphenopteris Hibberti* (described in vol. iii, p. 73, of Lindley and Hutton's 'Fossil Flora').

The Limestone is a freshwater deposit, and abounds in bands of silex alternating with calcareous matter, and presents all the appearance of having been deposited by thermal waters during the carboniferous epoch.—H. W.

BRITISH MUSEUM; 17*th September*, 1872.

[1] 'Archiv für die Naturk. Liv- Ehst- und Kurlands,' Dorpat, 1859, Series 1, vol. ii, p. 382, pl. i, fig. 19.

PLATE XXI.

DEVONIAN AND SILURIAN CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

FIG.

1. *Stylonurus Powriei*, H. Woodw., nat. size.
   Old Red Sandstone; Turin Hill Range, near Pitscandly, Forfarshire. (P. 122.)
   From the Collection of James Powrie, Esq., F.G.S., Reswallie.

2. *Stylonurus Powriei ?* two detached swimming feet of large size, probably belonging to this species. (P. 123.)
   Upper Silurian; Lesmahagow, Lanarkshire.
   From the Collection of James Powrie, Esq., F.G.S.

3. *Stylonurus megalops*, Salter, sp. Head-shield, nat. size. (P. 124.)

3 *a*. „ „ part of the head magnified, showing the granular surface.
   From the Collection of Robert Lightbody, Esq., F.G.S., Ludlow.

4. *Stylonurus Symondsii*, Salter, sp. (P. 124.)
   Upper Beds of the Cornstones, Old Red Sandstone; Rowlestone, Brecknockshire.
   Head-shield, nat. size.
   From the Museum of Practical Geology, Jermyn Street.

5. *Stylonurus ensiformis*, H. Woodw. Tail-spine, nat. size. (P. 126.)
   Old Red Sandstone; Turin Hill Quarries, Forfarshire.
   From the Collection of James Powrie, Esq., F.G.S.

C.I. Griesbach del et lith   Mintern Bros imp

STYLONURUS.

PLATE XXII.

DEVONIAN CRUSTACEA.

Order—Merostomata.

Sub-Order—Eurypterida.

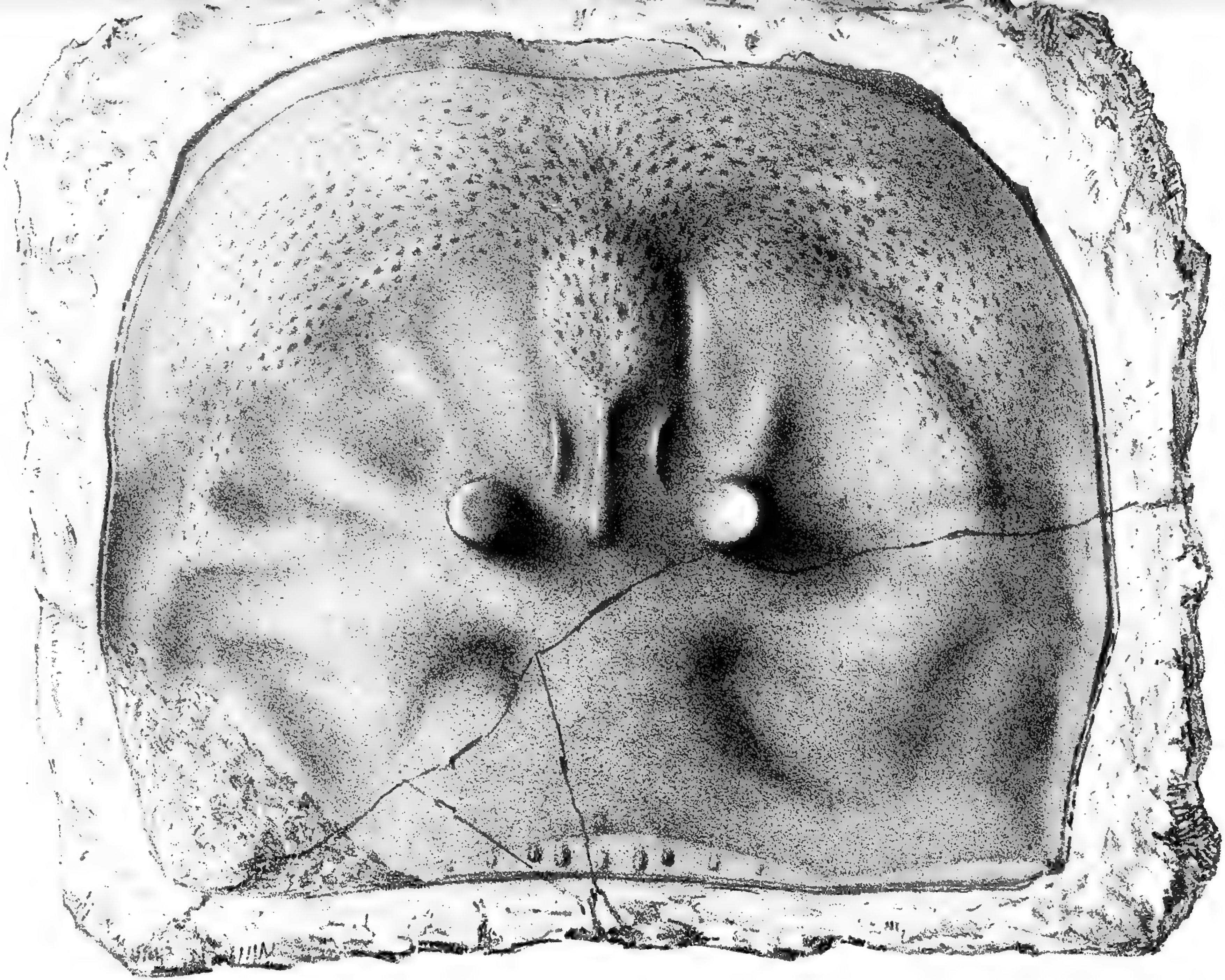
Stylonurus Scoticus, H. Woodw. (P. 126.)

Cast, in Grey Sandstone, of the inner surface of the head-shield; natural size.

From the Old Red Sandstone Quarry, Montroman Muir, near the Forfar and Montrose Pike.

The *intaglio* half (showing the inside of the carapace itself) is preserved in the British Museum.

The *relievo* is in Lady Kinnaird's Cabinet, Rossie Priory.



C. Gruesbach del et lith. Mintern Bros.

S[illegible]ONURUS SCOTICUS, H. Woodward

PLATE XXIII.

DEVONIAN CRUSTACEA.

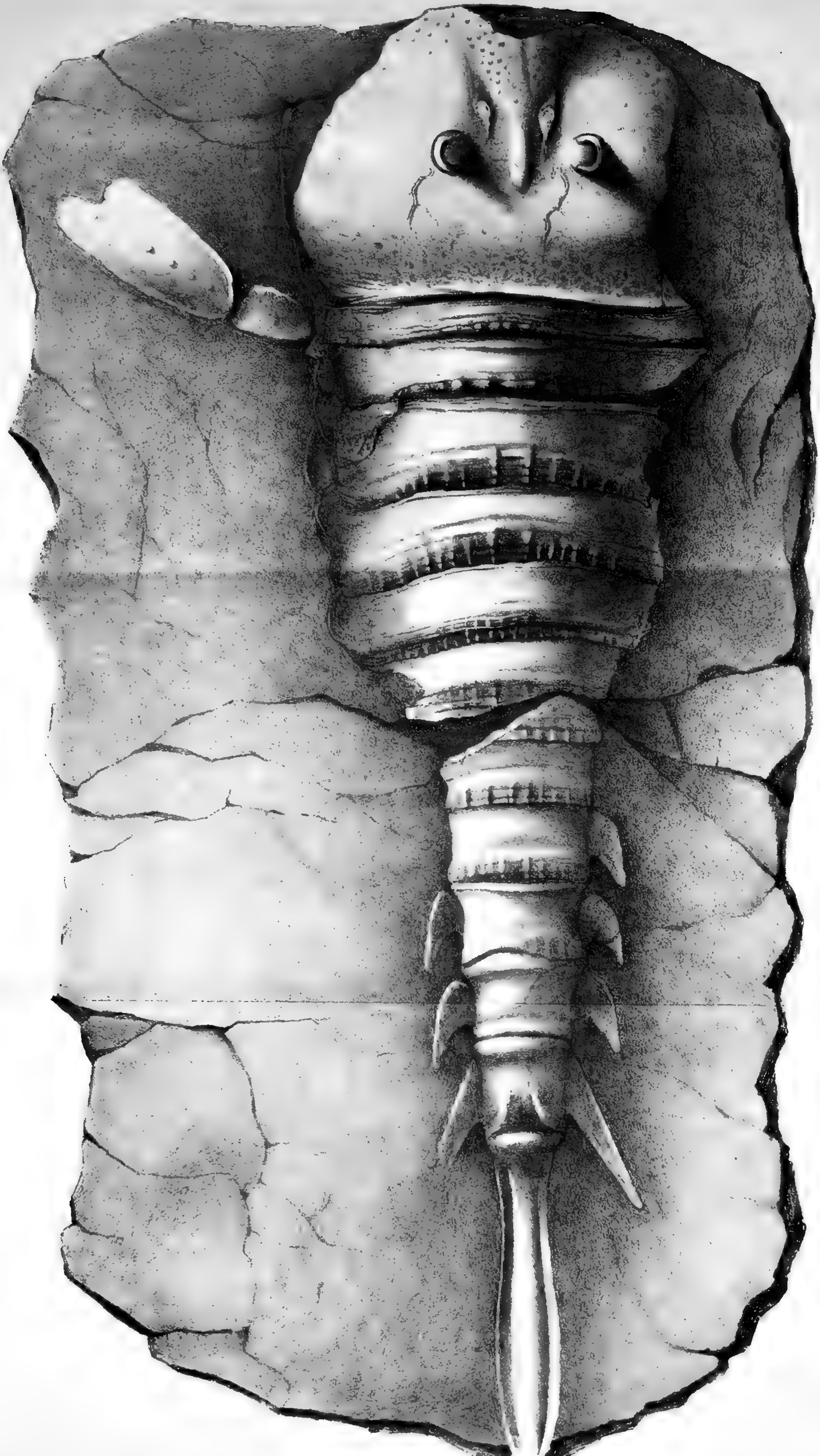
Order—Merostomata.

Sub-Order—Eurypterida.

Stylonurus Scoticus, H. Woodw. A nearly entire specimen, having its dorsal surface exposed on a slab of sandstone, and the last five body-segments detached entire, so as to exhibit both the ventral and dorsal surfaces; reduced to three eighths its natural size, the original specimen measuring three feet four inches in length. (P. 126.)

Lower Devonian, Forfarshire.

From the Collection of James Powrie, Esq., F.G.S., Reswallie, near Forfar.



J. Dr. C. Gde del et lith. M & N Hanhart imp.

STYLONURUS SCOTICUS, *H. Woodward*
L[r] Devonian, Forfarshire

PLATE XXIV.

UPPER SILURIAN CRUSTACEA.

Order—Merostomata.

Sub-Order—Eurypterida.

Fig.

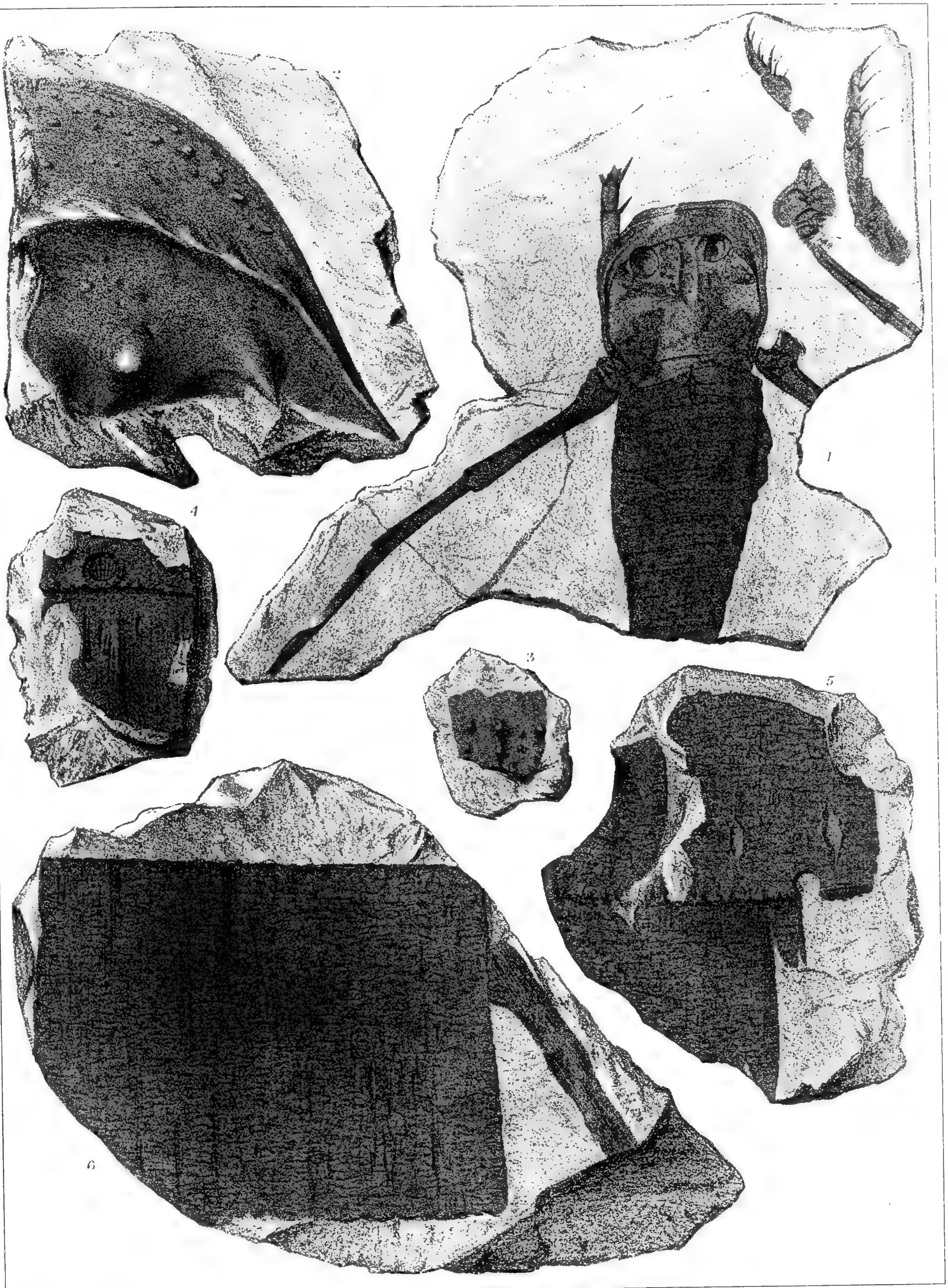
1. *Stylonurus Logani*, H. Woodw. (P. 129.) Drawn of the natural size, from the specimen in the Museum of Practical Geology, Jermyn Street. The Counterpart is in the Collection of James Powrie, Esq. From the Upper Silurian, Lesmahagow, Lanarkshire.

Miscellaneous Specimens.

2—6. Represent the specimens described by Mr. J. W. Salter, under the name of *Eurypterus mammatus*, from the "Ferny Metal," Coal-measures, Pendleton Colliery, Manchester. (See p. 163.)

2 and 3 are referred to M. Jordan's genus *Arthropleura*, under the name of *A. mammata*. (See p. 167.)

4, 5, and 6 are referred to Plant-remains by Mr. Carruthers. (See p. 168.)



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1 STYLONURUS LOGANI. *H. Woodward*. U. SILURIAN.
2-6 EURYPTERUS MAMMATUS. *Salter*. COAL MEASURES.

PLATE XXV.

CARBONIFEROUS CRUSTACEA.

Order—Merostomata.

Sub-Order—Eurypterida.

Fig.

1. *Eurypterus Scouleri,* Hibbert. (P. 133.)

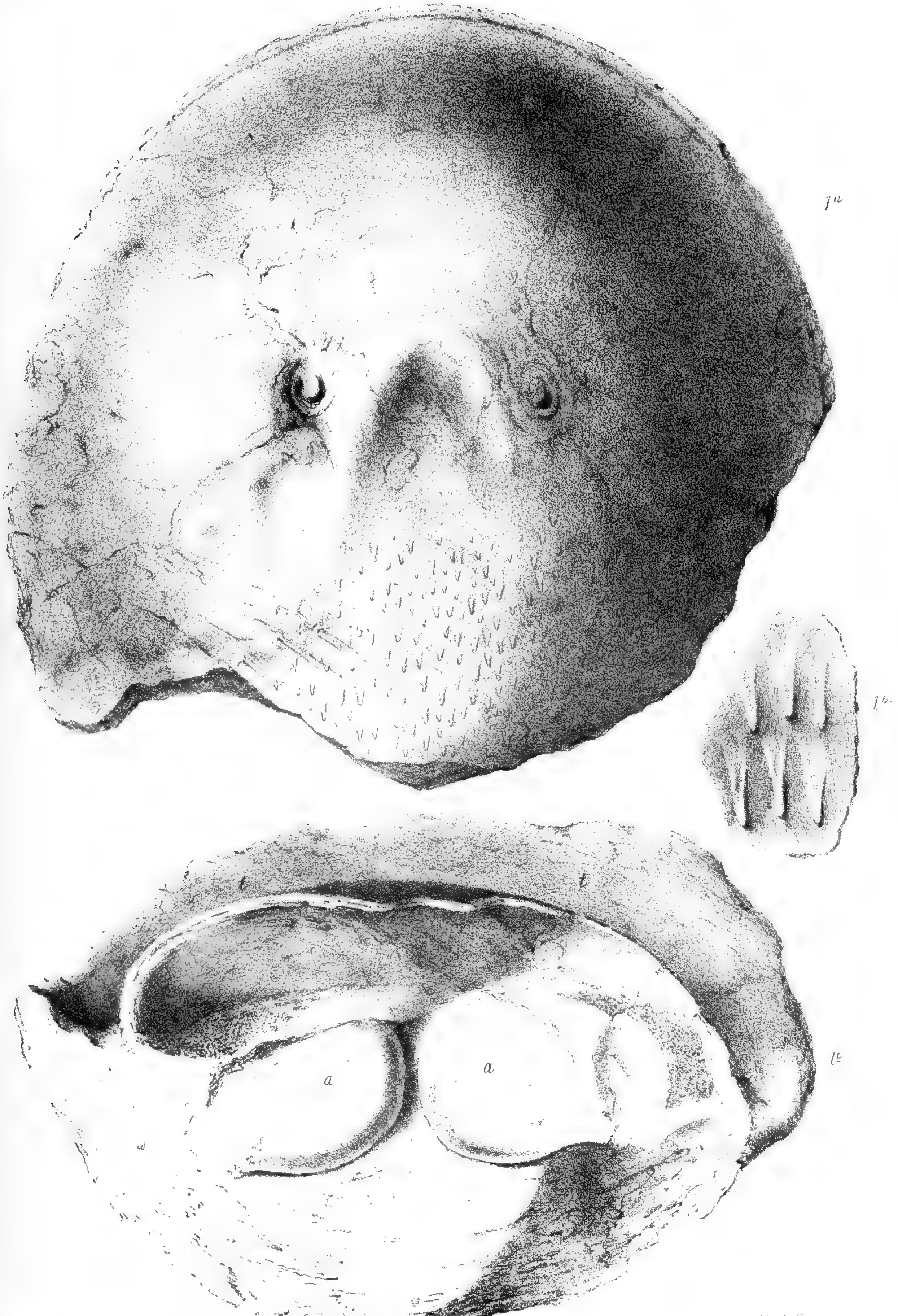
1 *a*. Dorsal aspect of head-shield (natural size), showing position of great subcentral eyes.

1 *b*. The peculiar ornamentation of the posterior border of head (enlarged).

1 *c*. The under side of head exposing *a, a,* the bases of the ectognaths and *t, t,* the thoracic plate ? or operculum, thrust forward out of its natural position behind the mouth, so as to be found overlapping it in its present abnormal position. (See p. 136, and Woodcut, Fig. 41.)

From the Freshwater Limestone, Lower Carboniferous, Burdie House, near Edinburgh.

Coll. of James Powrie, Esq., F.G.S., Reswallie.



EURYPTERUS SCOULERI, *Hibbert.*
Coal Measures, Burdie House, near Edinburgh.

PLATE XXVI.

CARBONIFEROUS CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

Eight most posterior body-rings of *Eurypterus Scouleri*, Hibbert; natural size. (P. 136.)

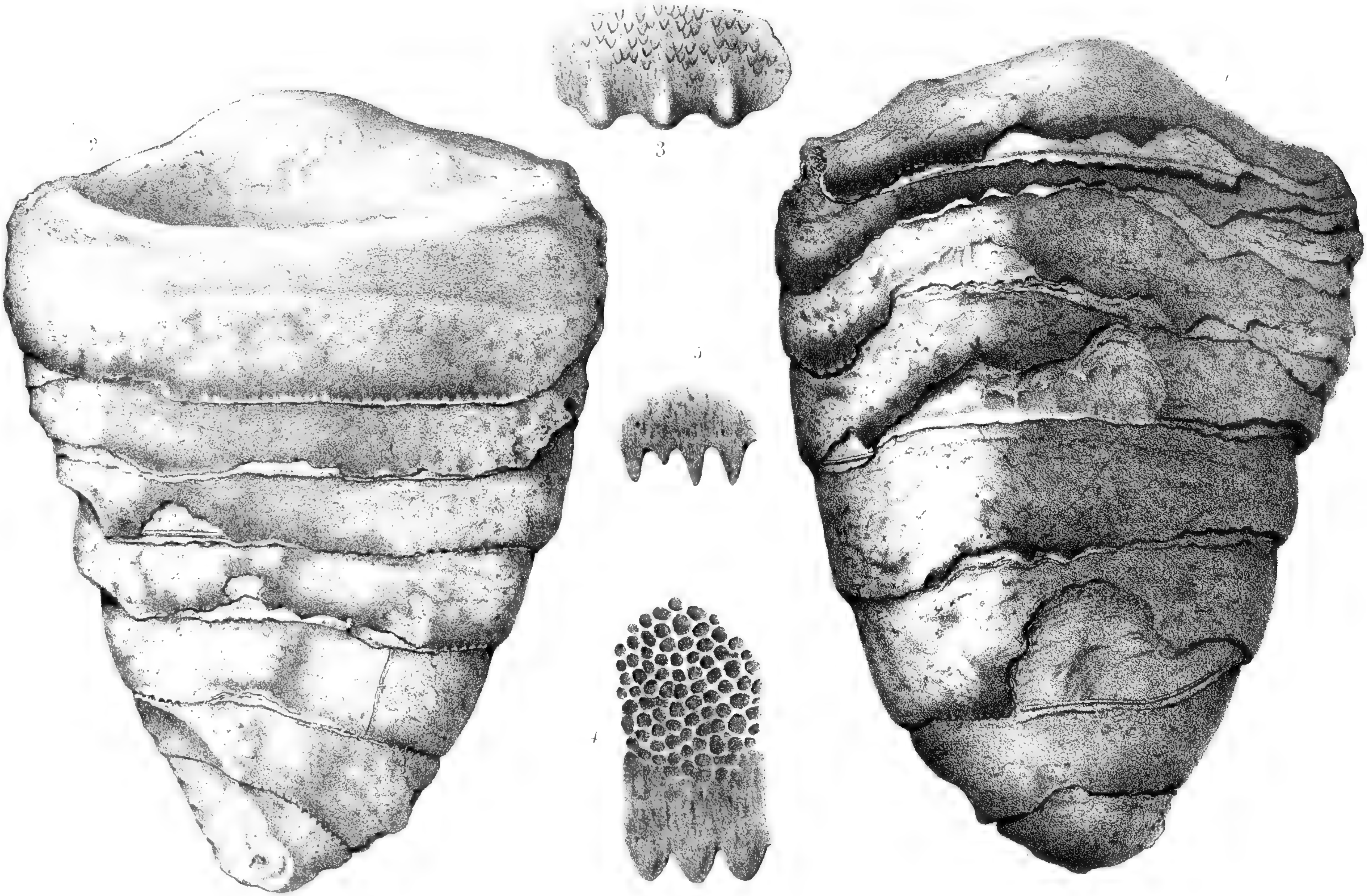
FIG.

1. The dorsal surface.
2. The ventral surface.
3. The characteristic scale-like ornamentation of the dorsal surface, and the spinous border of the segments, magnified.

4 & 5. The characteristic punctate ornamentation of the ventral surface, and the serrated border of the segments, magnified.

From the Freshwater Carboniferous Limestone, Burdie House, Edinburgh.

Coll. of James Powrie, Esq., F.G.S., Reswallie.



M&N Hanhart imp

EURYPTERUS SCOULERI, *Hibbert.*

Coal Measures Burdie House, near Edinburgh

PLATE XXVII.

CARBONIFEROUS CRUSTACEA.

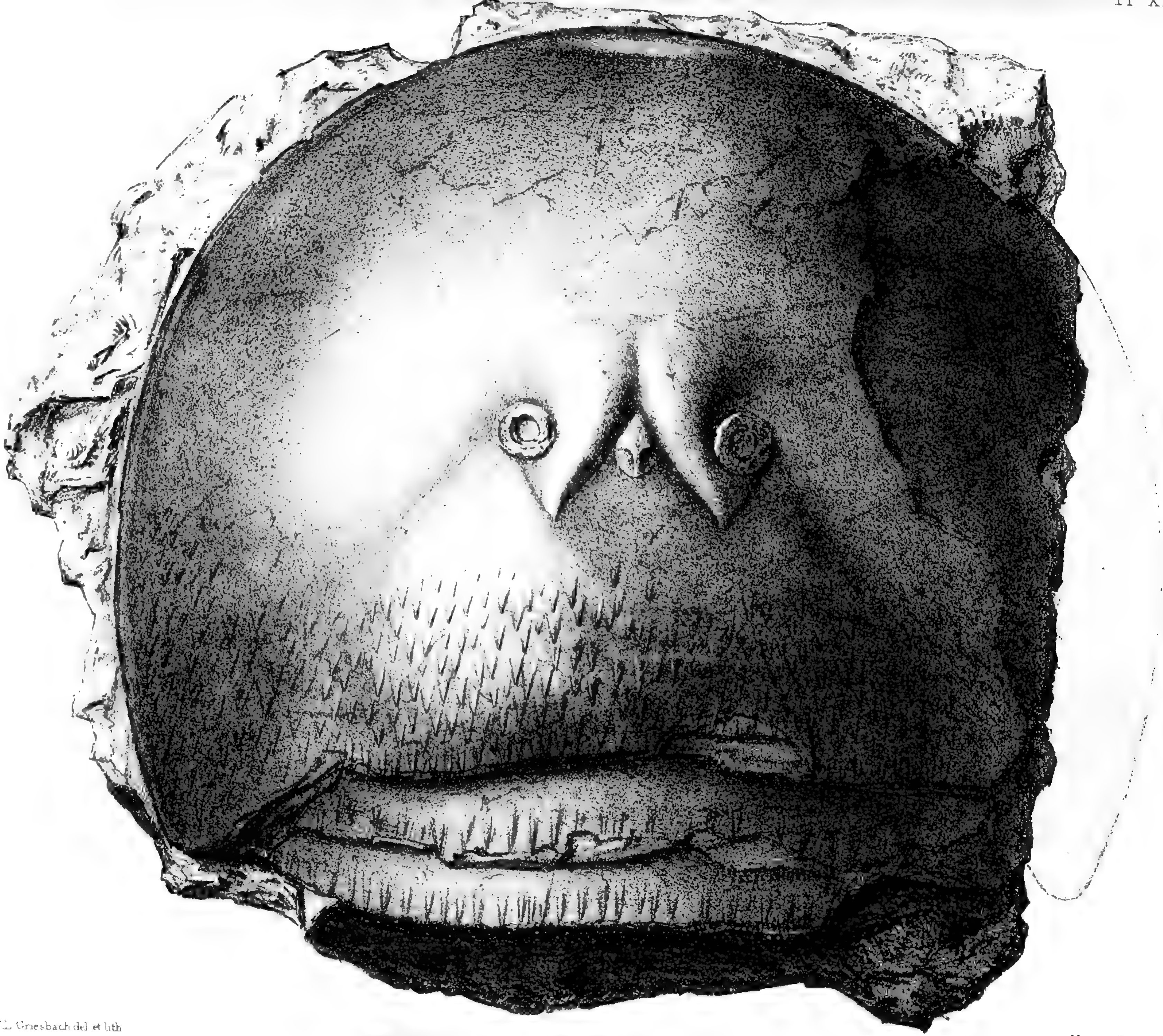
Order—Merostomata.

Sub-Order—Eurypterida.

Head-shield of *Eurypterus Scouleri*, Hibbert, with the two most anterior body-segments still united thereto (natural size). (P. 134.)

From the Freshwater Carboniferous Limestone, Burdie House, near Edinburgh.

Coll. Andersonian University Museum, Glasgow.



C.L. Griesbach del et lith

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EURYPTERUS SCOULERI. *Hibbert*

COAL MEASURES, BURDIE HOUSE, NEAR EDINBURGH.

PLATE XXVIII.

SILURIAN AND DEVONIAN CRUSTACEA.

Order—Merostomata.

Sub-Order—Eurypterida.

Figs.

1—3. *Eurypterus lanceolatus*, Salter.

Uppermost Silurian; Lesmahagow, Lanarkshire. Drawn of the natural size. (P. 140.)

1. The largest specimen obtained. One of the great swimming-feet (ectognaths) and about four of the endognathary palpi are seen lying close to the borders of the head-shield. The impression of the long median appendage of the thoracic plate is also seen underlying the 4th and 5th thoracic somites. (P. 142.)

2 has both the swimming-feet preserved and the thoracic plate (fig. 2 *a*) displaced, so as to show its form completely. In this specimen the median thoracic appendage is short, bifid, and divided into three joints. (P. 143.)

3. The smallest example of *E. lanceolatus* obtained. (P. 143.)
Figs. 1—3 are preserved in the British Museum.

4. *Eurypterus Brewsteri*, H. Woodw. (P. 151.)
Head-shield and ovisac; natural size.
Old Red Sandstone; Kelly Den, near Arbroath.
Coll. James Powrie, Esq., F.G.S., Reswallie, Forfar.

5, 6, 7. *Eurypterus pygmæus*, Salter. (P. 144.)

Fig. 5. Head-shield, thoracic segments, and swimming-foot (nat. size).
Downton Sandstone; Kington.
Coll. R. Banks, Esq., F.G.S., Kington.

Fig. 6. Head-shield, body-joints, and telson (nat. size).

Fig. 7. Body-joints and telson (nat. size).
Basement-beds of the Old Red Sandstone; Ludlow.
Coll. Robert Lightbody, Esq., F.G.S., Ludlow.

8. This series of body-segments are referred by Mr. Salter to *Eurypterus* (now *Stylonurus*) *megalops*; but the telson is broader and shorter than is usual in *Stylonurus*. (P. 146.)

9. Another telson referred to the same species.
Base of the Old Red Sandstone; Ludlow Railway.
Coll. R. Lightbody, Esq., F.G.S.

10—14. A series of detached telsons or tail-spines of *Eurypterus*, described by Mr. Salter.

Figs. 10—12. *E. linearis*, Salter. (P. 147.)
Fig. 10. Upper Ludlow Rock; Ludford, Kington.
Figs. 11 and 12. Downton Sandstone; Kington.

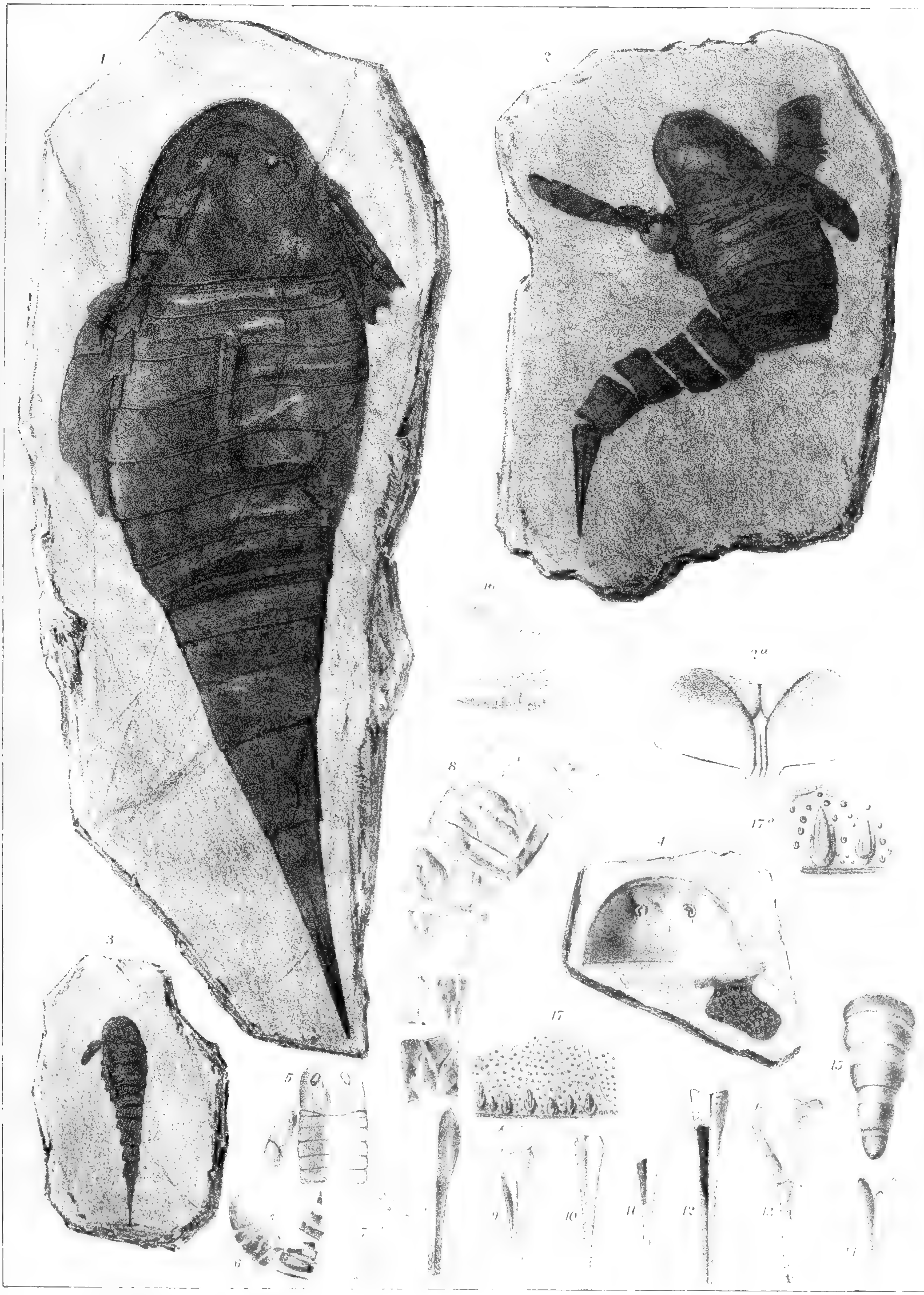
Fig. 13. *E. acuminatus*, Salter. (P. 146.)
Passage-beds, base of the Old Red Sandstone; Ludlow Railway.

Fig. 14. *E. abbreviatus*. (P. 148.)
Downton Sandstone; Kington.

15. Body-segments doubtfully referred to *E. acuminatus*. (P. 146.)

16, 17, and 17a. *Eurypterus Hibernicus*, Baily. (P. 148.)
Upper Old Red Sandstone; Kiltorcan, Co. Kilkenny.
Museum Geol. Surv. Ireland, Dublin.

[Figs. 5—17 copied from the Plate illustrating Mr. Salter's paper. See 'Quart. Journ. Geol. Soc.,' 1859, vol. xv, p. 232, pl. x.]



C.L. Griesbach del et lith

EURYPTERUS.

Mintern Bros imp

PLATE XXIX.

UPPER SILURIAN CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

FIG.

1. *Eurypterus scorpioides,* H. Woodw. (nat. size). Uppermost Silurian; Lesmahagow, Lanarkshire. (P. 152.)

   Drawn from the original specimen preserved in the British Museum.

2. *Eurypterus punctatus,* Salter, sp. One of the swimming-feet or ectognaths (nat. size). Lower Ludlow Rock; Leintwardine. (P. 153.)

   [Copied from Mr. C. R. Bone's pl. xi, fig. 15, illustrating Messrs. Huxley and Salter's Monograph on EURYPTERIDA, 'Memoirs Geol. Surv.,' Mon. I, 1859.]

   Coll. of Mr. H. Pardoe, in the Ludlow Museum.

C. L. Griesbach del et lith

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EURYPTERUS SCORPIOIDES, *H. Woodw.* [illegible] *Salter, sp.*

PLATE XXX.

SILURIAN CRUSTACEA.

Order—MEROSTOMATA.

Sub-Order—EURYPTERIDA.

FIG.

1—7. *Hemiaspis*, H. Woodward (nat. size).

1 & 2. *H. limuloides*, H. Woodw. (P. 174.)

Lower Ludlow ; Leintwardine.

1. Preserved in the Museum of Practical Geology, Jermyn Street.
2. Preserved in the British Museum.

3. Fragment of a head-shield of *Hemiaspis*. Brit. Mus.

4. *H. Salweyi*, Salter. (P. 179.)

Lower Ludlow ; Ledbury.

Coll. British Museum.

5 & 7. *H. speratus*, H. Woodw. (P. 178.)

Lower Ludlow ; Leintwardine.

Coll. British Museum.

6. *Hemiaspis horridus*, H. Woodward. (P. 179.)

Wenlock Shale ; Dudley.

Coll. British Museum.

8. *Eurypterus obesus*, H. Woodw. (nat. size).

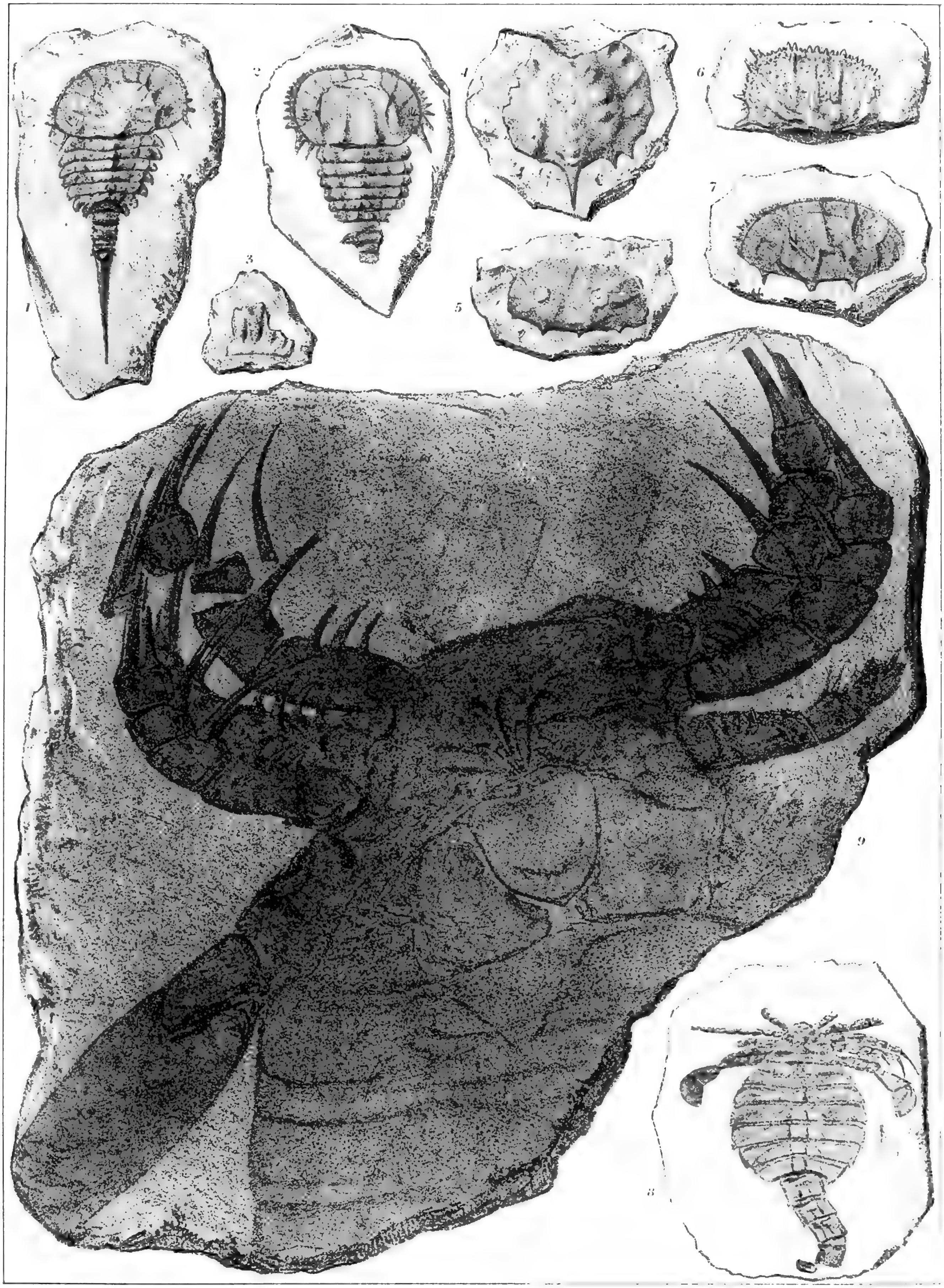
Uppermost Silurian ; Lesmahagow, Lanarkshire. (P. 160.)

Coll. British Museum.

9. *Eurypterus scorpioides*, H. Woodw. Counterpart of fig. 1, Pl. XXIX. (P. 152.)

Uppermost Silurian ; Lesmahagow, Lanarkshire.

Coll. British Museum.



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1-7 HEMIASPIS AND 8-9 EURYPTERUS

THE

PALÆONTOGRAPHICAL SOCIETY.

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A MONOGRAPH

OF THE

BRITISH FOSSIL TRIGONIÆ.

BY

JOHN LYCETT, L.R.C.P.E., &c.

No. I.

PAGES 1—52; PLATES I—IX.

LONDON:
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1872.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

A MONOGRAPH

OF

BRITISH FOSSIL TRIGONIÆ.

GENERAL OBSERVATIONS AND SYSTEMATIC ARRANGEMENTS.

Throughout the great Mesozoic epoch there are, perhaps, no testaceous forms, with the exception of the Ammonites, of importance superior to the Trigoniæ, or which demand from the Palæontologist more careful discrimination and more extensive acquaintance with their various aspects, to enable him to overcome the difficulties that meet him when he attempts their certain determination. The importance of the genus is based upon its great stratigraphical range, its world-wide occurrence, its great diversity of aspects, locally also by its individual numbers. Its prominence and distinctness as a genus immediately arrests the attention of the observer, and, notwithstanding the diversity of its aspects, a Trigonia is a form recognised without difficulty even by a tyro. The generic characters are so well known that to give a minute description of them would amount to a mere useless repetition of that which has been so fully accomplished by Agassiz and by other Palæontologists. I prefer, therefore, to allude to them with the greatest possible conciseness, and will adopt the terse and brief definition given by my late lamented friend, Dr. S. P. Woodward, in his well-known 'Manual of the Mollusca:'—" Shell thick, tuberculated, or ornamented with radiating or concentric ribs; posterior side angular, ligament small and prominent; hinge-teeth 2—3, diverging, transversely striated; centre tooth of the left valve divided; pedal impressions in front of the posterior adductor, and one in the umbo of the left valve; anterior adductor impression close to the umbo. Shell almost entirely nacreous, and usually wanting or metamorphic in limestone strata."

Moulds which represent the internal cavity of the shell may readily be obtained whenever the investing matrix is in its structure more coherent or compact than the fossilized test, and it usually happens that a rock or matrix or great hardness is associated with a test more than usually friable. The value of these internal moulds to the Palæontologist who wishes to discriminate species is, however, only limited; it rarely happens that any of the external ornaments are visible upon them; and even under the most favourable conditions the impressions of these ornaments are only faintly and insufficiently shown, so that by means of these alone the external aspect even of a single species could never be fully ascertained, and even when both the mould and test have been obtained it is not in every instance that the mould can with certainty be discriminated from those of other allied species. The practice of authors, therefore, who have described supposed new species even partially, and have named them from internal moulds alone, is objectionable, as tending to create doubt and hesitation in the minds of students, and encumbering the list of species with things which for all practical purposes are little more than mere names. Roemer, and afterwards Agassiz, sometimes unfortunately acted in this manner, and D'Orbigny went even further in the same direction; in his 'Prodrome' are new names, together with a few words to each, which are intended to indicate moulds only, that have not even been figured. For the most part, therefore, internal moulds afford but little more than so many proofs that Trigoniæ were buried in the stratum to which they refer, and also that the species had apparently certain peculiarities of figure more or less conspicuous.

The figures of Trigonia given in the 'Petrefacta' of Goldfuss are not very numerous, but are almost invariably founded upon good specimens, and the execution of the plates is equally satisfactory; but the descriptions are only remarkable for a general vagueness and brevity that so often is found to prevail in descriptions of fossils at the period when they were written; it is also certain that the geological positions mentioned are sometimes erroneous. The well-known memoir by Agassiz on the genus Trigonia contains eleven plates, illustrative of forty-eight species; it is much to be regretted that in many instances these figures represent very indifferent specimens or fragments only, and that these deficiencies are not compensated for by sufficiently copious or minute descriptions; they have been felt as a frequently recurring source of embarrassment, and more especially when an author has adopted the name of one of these doubtful forms in a list or description of species. It is, however, only just to remark that the work, upon the whole, exhibits much of that discriminative faculty of mind which we should expect to find in the production of so eminent a naturalist; the sectional divisions which he proposed to establish are so far in accordance with nature, and are so well indicated by his typical examples, that it would, perhaps, have been quite possible to follow out these groups with little error throughout the entire genus, even if the author had given to each of them simply a name without description; in fact, the sectional descriptions are both meagre and imperfect, and appear to have been intended as mere outline sketches, susceptible of future enlargement or modification. D'Orbigny, in his 'Prodrome de Paléontologie' and in his 'Paléontologie Française,' has in some instances endeavoured to correct errors in the identification of species by Agassiz, but not uniformly with success, and apparently with only an imperfect knowledge of British Trigoniæ. Our thanks are, however, due to him for having greatly extended our knowledge of the genus so far as regards the species of the Cretaceous System; but in the Jurassic System his stratigraphical distribution of them is full of errors, and is, perhaps, more calculated to mislead than to instruct. These critical, and it is hoped not unfair, remarks are not however, intended to apply to the descriptions of Trigoniæ to be found in various memoirs and monographs which date within the last twelve years, referred to in the following pages; in these the requirements of modern science are more fully complied with, and by authors whose names are a guarantee for the faithfulness and value of their contributions. The descriptions by Dujardin, Hébert, Munier-Chalmas, de Loriol, Credner, Coquand, and Pictet, are more especially prominent and satisfactory to the student in Palæontology. For the most part, however, each such contribution refers only to the species which pertain to a single formation and locality.

The British Jurassic Trigoniæ are remarkable both for their number of species and the variety in their ornamentation; no other country has produced so considerable an assemblage. The British Cretaceous species, on the other hand, although eminently characteristic, represent only a portion, perhaps scarcely a moiety, of the foreign Cretaceous forms, if we include those of South America and Southern Asia.

The woodcuts illustrative of various foreign forms allied to British Trigoniæ, together with the concise notes which refer to them, will, it is hoped, add somewhat to the value of the Monograph, and be found more satisfactory than any unaided descriptions, however copious they may be. In the order of arrangement each species is placed in its sectional position, adjacent to its allied forms, and at the end of the Monograph a general table will be given indicating the stratigraphical position of each species. The general description of sectional characters which follows conduces to some abbreviation, and obviates the necessity for repetition in the description of each separate species, so far as these sectional characters apply. There are also a few terms employed by which a single word or two suffices to indicate the portion of the shell referred to, and, therefore, materially aids in the same result. Throughout all the fossil species of Trigoniæ there are certain features connected with the general figure and ornamentation which, although only of subordinate importance when considered in relation to the generic characters, nevertheless furnish valuable aids both in the separation of the several groups into which the genus may be divided, but also afford guides to the determination of the stratigraphical position which they occupy. The living Australian species are in their external characters to a great extent unconnected with these distinctive features; they assimilate more nearly to other generic forms of the Conchifera, and therefore constitute a group apart and disconnected from the chain of fossil Trigoniæ of the various Secondary Formations, between which and the living species the missing connecting links will probably only be discovered when other examples of the genus shall be procured in some one of the Lower or Middle Tertiary Formations.

The surface of every fossil Trigonia is clearly divided into two portions; one of these occupies the anteal, the other the posteal portion of the valve; the two parts have their surfaces upon different planes, so that at their junction there is a divisional angle which passes obliquely from the apex of the valve or umbo to the lower and posterior extremity; the divisional angle commonly takes the form of a ridge; this is the *marginal carina,* and the portion of surface posteal to it is the *area.* At the superior border of the area is another ridge or carina, which, like the other, originates at the apex, and forms a curvature posteally to meet the corresponding carina of the other valve. This is the *inner carina,* and the space enclosed between the inner carinæ of the opposing valves is usually heart-shaped, or more lengthened and lanceolate. This is the *escutcheon,* which in its turn embraces at the upper and anteal portion of its border the nymphal or ligamental plates and the ligament itself, which is also not unfrequently preserved. The area is usually divided into two portions longitudinally by a slight furrow, and the superior portion is frequently more depressed than the other; a slight ridge or row of tubercles may border this *median furrow,* and, when present, it constitutes the *median carina.* The anteal portion of the valve, or that adjacent to the pallial border, is invariably more or less ornamented with ribs, which are either plain or tuberculated; the area also usually has some kind of ridges; but, in lieu of designating the former as pallial costæ and those upon the area as cardinal costæ, I prefer, for brevity, to speak of the former as *costæ* and the latter, which are usually smaller, as *costellæ.* One other feature common to the surface of all, and therefore constituting a portion of the attributes of the genus, may also be adverted to, more especially as it has usually remained altogether unnoticed. I allude to the epidermal granulated tegument; in common with the whole group of the Anatinidæ, and with certain other genera of Conchifera, including the allied genus Opis, the granules are arranged in lines perpendicular to the pallial border. They are more minute and closely arranged than is usual in other genera; in the *Trigoniæ clavellatæ* more especially the lines of granules can only be discovered by the aid of considerable magnifying power; in this particular the distinction between the *Clavellatæ* and *Costatæ* is strongly marked, the latter having the lines of granules so much larger and more widely separated that they may frequently be distinguished by the unaided vision.

The seven sections into which Agassiz divided the fossil Trigoniæ are all exemplified by British species, and to those I propose to add an additional section, the *Byssiferæ.* The sectional distinctions are founded upon the figure of the shell and of its proportions, of the ornamentation upon the pallial or costated portion of the surface, of that upon the area, and of that upon the escutcheon; lastly, upon the consideration conjunctively of all these parts in any particular group in comparison with the corresponding parts pertaining to other groups of the same genus. An attentive examination will, it is believed, exhibit fully the natural affinity of the various species comprising these separate groups or sections, and also the changes that the genus underwent in geological time during the great epoch of the Secondary Formations.

1st.—Scaphoideæ.

This section, of which the type is the *Trigonia navis* of Lamarck, was constituted by Agassiz to include species in which the form is usually triangular, having a remarkable straightness or truncation of the anterior border; the other two borders converge and terminate posteriorly in an extremity which is more or less truncated or obtuse. The area is nearly smooth, bounded above by an inner, and beneath by a marginal carina; these are always small and sometimes evanescent. The costæ form two series, the larger or posteal series pass almost perpendicularly downwards from the marginal carina to the pallial border, the smaller or anteal series have their general direction horizontal or at right angles to the other series; they are short and occasionally, as in *T. navis*, terminate posteally in a large varix. Agassiz described and figured five species, three of which are Jurassic and two Cretaceous; the present Monograph adds four species, all of which are from the Lower Oolites, and one is new. These are the following:—*T. duplicata*, Sow., *T. gemmata*, Lyc., *T. Bathonica*, Lyc., and *T. recticosta*, Lyc.

2nd.—Clavellatæ.

An essentially and almost exclusively Jurassic section have their sides ornamented with tuberculated costæ in rows, which are either concentric or oblique; the tubercles in the rows usually become indistinct or cord-like as they approach the pallial border, and the last-formed rows of costæ are often interrupted or broken and obscured by numerous plications of growth. The area, which is well separated, is bounded by two tuberculated carinæ, and has usually also a smaller mesial oblique carina bordering upon a furrow, thus dividing the area into two parts. The escutcheon is always plain, as in the *Undulatæ*; it is depressed and is usually well circumscribed by the inner tuberculated carina. Few species have the rows of costæ regular and symmetrical over the whole of the side, or adjacent to the pallial border; most commonly there is some irregularity in the rows near to their anteal terminations; some individuals of certain species have this irregularity so considerable that the tubercles become altogether confused and crowded, in other instances they become absorbed in the longitudinal plications, which form squamous elevations. It rarely happens that this section has the granulated tegument preserved; and it may be remarked that the same clays and shales which have preserved this feature in the *Costatæ* have failed to do so in the *Clavellatæ*. The species of the *Clavellatæ* are very numerous, and in their habits they were usually gregarious, but it seldom happens that any one species can be traced over any considerable geographical area. The interior of the valves have near to their posteal slope a prominent lengthened ridge, which indicates the position and separation of the siphonal currents. The following species, twenty-eight in number, are British examples of this section:—*T. clavellata*, Sow., *T. perlata*, Ag., *T. corallina*, D'Orb., *T. Rupellensis*, D'Orb., *T. impressa*, Sow., *T. signata*, Ag., *T. spinulosa*, Y. & B., *T. striata*, Miller, *T. Bronnii*, Ag., *T. irregularis*, Seebach, *T. triquetra*, Seeb., *T. Pellati*, Mun.-Chal., *T. Phillipsi*, Mor. and Lyc., *T. Moretoni*, Mor. and Lyc., *T. imbricata*, Sow., *T. muricata*, Goldf., *T. parcinoda*, Lyc., *T. Woodwardi*, Lyc., *T. radiata*, Benett, *T. Ramsayi*, Wright, *T. incurva*, Benett, *T. complanata*, Lyc., *T. Scarburgensis*, Lyc., *T. Juddiana*, Lyc., *T. formosa*, Lyc., *T. tuberculosa*, Lyc., *T. Griesbachi*, Lyc., *T. ingens*, Lyc. Of these, the only species that occurs in the Cretaceous Rocks is *T. ingens*.

3rd.—Undulatæ.

This section was constituted by Agassiz to receive species whose general form approximates to the *Clavellatæ*, but whose costæ, whether with or without distinct tubercles, have an undulation or an angle towards the middle or the posteal portions of the costæ; it also not unfrequently happens that the costæ are broken into two distinct series of rows, of which the anteal series are the smaller and more numerous; the rows are usually ridge-like, sometimes nearly plain, or in other species with a few tubercles or varices; the area is narrow and the bounding carinæ inconspicuous; there is also a mesial furrow, bordering which a line of small tubercles may occasionally be traced in immature forms; the escutcheon is always plain. The boundaries between this section and the *Clavellatæ* are by no means clearly defined, as some species of the latter have not uncommonly a kind of angle or undulation in their costæ either mesially or posteally; this feature, therefore, appears more appropriate to a species than to a section, and it is not probably of any further value than as a convenience in the arrangement of the species. Like the *Clavellatæ*, it is a Jurassic section. It has afforded nineteen British species, as follows:—*T. angulata*, Sow., *T. litterata*, Young and Bird, *T. Clytia*, D'Orbigny, *T. tripartita*, Forbes, *T. conjungens*, Phillips, *T. Carrei*, Mun.-Chal., *T. subglobosa*, Mor. and Lyc., *T. Leckenbyi*, Lyc., *T. v-costata*, Lyc., *T. producta*, Lyc., *T. Sharpiana*, Lyc., *T. compta*, Lyc., *T. Painei*, Lyc., *T. paucicosta*, Lyc., *T. flecta*, Lyc., *T. minor*, Lyc., *T. costatula*, Lyc., *T. composita*, Lyc., *T. arata*, Lyc.

4th.—Glabræ.

The *Glabræ* or *Læves* was a section founded by Agassiz upon very insufficient materials, which led to errors in his definition of the section; he described it as without ornamentation, without tubercles or costæ, and resembling a large Unio. With some modification in the sectional characters it will be found to constitute a group sufficiently distinctive, not, indeed, devoid of ornamentation, for this appears to be a feature essential to the entire genus. The usual figure, as remarked by Agassiz, is somewhat inflated and ovate or ovately oblong, and the area is only slightly separated from the other portion of the valve, thus resembling Unio. Mesially, or immediately anterior to the position of the marginal carina, is a smooth space, which, commencing at the apex or near to it, gradually widens downwards to the lower border; most commonly this smooth space is more depressed than the other portions of the valve, it is also only very slightly impressed by the lines of growth; its breadth in two of the species (*T. Micheloti* and *T. Beesleyana*) is equal to all the remaining surface of the valve. The area is sufficiently defined and has usually the bi-partite character of the preceding sections, but for the most part it is destitute of carinæ or has only indications of them near to the umbones. The anteal portion of the valve has always costæ more or less prominent; usually they are much smaller and more closely arranged or less strongly defined than in other sections; they are either plain or tuberculated, and not unfrequently both kinds of costæ occur in the same specimen. The lines of growth are very conspicuous near to the lower border, and not uncommonly there are two or more arrests of development or transverse sulcations separating the surface into as many zones, and influencing the direction of the rows of costæ longitudinally. The interiors of the valves have the dividing siphonal ridge unusually prominent and forming a considerable indentation upon the internal moulds, the 'Horse Heads' of the Portland Oolite present good examples. Of the following seven species the last only belongs to the Cretaceous Rocks:—*T. gibbosa*, Sow., *T. Damoniana*, de Lor., *T. Micheloti*, de Lor., *T. Manselli*, Lyc., *T. tenui-texta*, Lyc., *T. Beesleyana*, Lyc., *T. excentrica*, Park.

The preceding species, although they possess certain sectional features in common, nevertheless appear to arrange themselves naturally into two groups, which may be termed respectively the *gibbosa* group and the *excentrica* group. If we place those two well-known species each at the head of a group, each of these series has in common the plain wide mesial space which passes downwards from the apex to the lower border, but in other important features the two groups appear to be sufficiently separated; thus, the *gibbosa* group, which is here illustrated by six species, has in the area and escutcheon a repetition of the characters which are seen also in the *Scaphoideæ*, the *Clavellatæ*, the *Undulatæ*, and the *Quadratæ;* both of these parts are well defined, and the area has the usual bi-partite form, with bounding carinæ more or less clearly developed. In the *excentrica* group, on the contrary, there is no distinct escutcheon, and the space representing the area is destitute both of ridges and depressions. Of this latter series we possess only two British species, excluding *T. sinuata*, Park., and *T. affinis*, Sow., which are only synonyms of *T. excentrica*, Park. *T. longa*, Ag., must also be referred to the same group. It is, therefore, not without some hesitation that I refrain from proposing to add another to the already numerous sectional forms of this genus, embracing *T. excentrica* and *T. Beesleyana,* and content myself with looking forward to the probability that the acquisition of additional forms will at some future period induce changes in the sectional arrangement in the direction now indicated.

5th.—Quadratæ.

The *Quadratæ* constitute a small section approximating to the *Clavellatæ,* but distinguished by the shorter figure, by the more quadrate outline, by the very large flattened and only slightly separated area, by the ornamented escutcheon, and by the great irregularity and excentricity in the arrangement of the rows of tubercles or varices upon the sides of the valves. *T. rudis,* Parkinson, may be taken for the best known British type of this section, which also includes *T. nodosa,* Sow., *T. dædalea,* Parkinson, *T. Orbigniana,* Lyc.; the latter, which has generally been mistaken for *T. dædalea,* presents in its sub-ovate figure, bi-partite area, and three nodose carinæ, an approximation to or connecting link with the *Clavellatæ.* The interiors of the valves have, as in the *Clavellatæ* and the *Glabræ,* a divisional siphonal ridge. All the British *Quadratæ* are Cretaceous.

6th.—Scabræ.

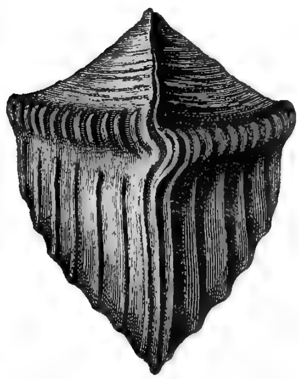
Unlike the Trigoniæ generally, the form is usually lunulate or crescentric rather than trigonal, but much inflated anteally; the umbones are produced and recurved more than usual; the superior or hinge-border is much excavated, the posterior extremity is produced, rostrated, and attenuated; the area has almost disappeared, excepting in the adult condition, which has indications of bounding carinæ towards the posteal portions of the valves; the large upper surface in these crescentric forms is occupied almost solely by a great concavity, which represents the escutcheon, and which is ornamented by transverse costellæ, similar in character to the costæ upon the sides of the valves. The costated portion has the rows for the most part ridge-like and imperfectly tuberculated, or they are scabrous or serrated. The interiors of the valves in the *Scabræ* have, towards their attenuated posteal portions, a lengthened divisional ridge, which separated the excurrent from the incurrent respiratory canal; there is also a lengthened series of small, regular, transverse, dental processes and alternate pits upon a narrow flattened plate that borders the escutcheon, its entire length in both the valves supporting an internal ligament or auxiliary portion of the hinge apparatus, and appears to be special to the present section in the Trigoniæ, reminding us of a similar feature in the genus Leda. Examples will be given in figures of the interiors of *T. aliformis.* All the British *Scabræ,* twelve in number, belong to the Cretaceous Rocks; they are *T. crenulata,* Lam., *T. aliformis,* Park., *T. caudata,* Ag., *T. Fittoni,* Desh., *T. Etheridgei,* Lyc., *T. spinosa,* Park., *T. ornata,* D'Orb., *T. Archiaciana,* D'Orb., *T. Picteti,* Coq., *T. tenui-sulcata,* Duj., *T. Pyrrha,* D'Orb., *T. Constantii,* D'Orb.

Of the foregoing, the first five only possess that remarkable elongation and attenuation of the posteal portion of the valves which tends to separate this section so prominently from all others of the genus. Agassiz placed *T. duplicata*, Sow., with the *Scabræ;* it is here placed with the *Scaphoideæ* for reasons which are given with the description of that species. The *Scabræ*, including the two sub-groups above indicated, constitute, perhaps, the most prominent and characteristic fossils of the Cretaceous formations; from whatever part of the world they are obtained both their natural history and geological position admit of no dispute, so nearly do the American and Asiatic species approach to the more well known of the European forms.

7th.—Costatæ.

In the preceding sections the opposite valves present no permanent or systematic differences either in their figure or ornamentation; in the present section, on the contrary, the difference of the valves in both particulars is universal and nearly uniform in their kind, varying chiefly in their degree of prominence or otherwise; separate descriptions of the valves, therefore, becomes necessary.

The Costatæ constitute a numerous and almost entirely Jurassic section recognized by longitudinal elevated plain costæ upon the sides of the valves; it also possesses other not less persistent and distinctive sectional features. The area is well separated from the costæ; it is bounded in each valve by two well marked dentated carinæ, and is divided into two nearly equal portions longitudinally. The superior portion is more depressed than the other; it is divided longitudinally by a small furrow, bordering upon which and placed upon the lower portion is usually a small indented median carina; these two inter-carinal spaces have small longitudinal indented costellæ, which take the same oblique direction as the carina. In the condition of advanced growth the entire ornamentation of the area is usually replaced by transverse irregular plications of growth. The escutcheon varies greatly in its relative size and figure in the outline of its upper border, and not less so in its ornamentation, so that it constitutes an important feature in the *Costatæ*, without which the definition of any of its species is incomplete and insufficient. The area in the two valves presents some well marked differences; the lower or carinal half of the *right* valve has the inter-carinal costellæ fewer and larger than those upon the other valve; they are also irregular and unequal, so that commonly the median carina only exists as one of these larger costellæ, of which there are usually from two to four. There is also a deeply excavated groove upon the area immediately *posterior* to the marginal carina and partly overlapped and concealed by it; this may be termed the *post-carinal sulcus;* in the other valve a similar sulcus exists immediately *anterior* to the marginal carina, which it separates from the extremities of the costæ. It is more conspicuous than the sulcus in the other valve, and is the *ante-carinal sulcus;* its use corresponds to that of the *post-carinal sulcus* in the other valve; the open extremities of the marginal carinæ when the valves were in opposition formed an aperture or incurrent orifice of the gills which admitted of being perfectly closed in the following manner:—The hinge allowed of a slight vertical or sliding motion to the valves by which the mollusk was enabled to bring the produced and internally convex lip, forming the extremity of the sulcus in the left valve, opposite to and in contiguity with the open extremity of the carina of the right valve, which it exactly fitted; in the same manner the sulcus of the right valve closed the extremity of the carina of the left valve, as seen in our engraving. By this exertion of muscular power, therefore, the valves were firmly locked at the will of the mollusk. Another result also followed this arrangement: the orifice for the excurrent aperture existed at the border of the depressed or superior half of the area; and, as that of the right valve is slightly lower than the corresponding portion of the other valve, the border forms a narrow orifice or undulation which became close-fitting when the incurrent aperture was also closed. Specimens, as in *T. elongata*, frequently occur with the apertures closed and locked; in other instances the extremities of the carinæ are rendered open by the relaxation of muscular force at the instant of death. In the *Clavellatæ* and other sections generally there were no open extremities of carinæ, and the excurrent and incurrent orifices were closed by simple muscular effort, but as the respiratory orifices of the *Costatæ* were not closed by simply shutting the valves, it became necessary to protect those organs by a special contrivance which is no less remarkable for its simplicity than its efficiency; it is, in fact, an exact reproduction of the same design as exhibited in the more ancient and allied genus Myophoria. From the foregoing statement it might be concluded that the *Costatæ* represent the most ancient or primordial portion of the genus Trigonia; but, judging from the present state of our knowledge of the organic contents of the Liassic and Triassic strata, such an inference is scarcely justifiable; certain it is that other sectional forms of Trigoniæ occur in Upper Liassic deposits, and that we are altogether unacquainted with the genus in the middle and lower subdivisions of that great formation.



In the left valve the extremities of costæ terminate abruptly posteally, and are separated from the carina by the *ante-carinal sulcus*. As there is no sulcus in that position in the right valve, the costæ touch the marginal carina, and sometimes pass over it as so many plications. The aperture formed by the extremities of the two marginal carinæ does not form a lengthened canal internally as in the genus Myophoria, the deposition of nacreous deposit went on simultaneously with the growth of the valves, so that whatever may be the stage of growth, the figure of an inner canal is preserved even in large species only for a length of about five or six lines.

The cardinal processes are unusually large and massive. In *T. sculpta* they occupy nearly a third part of the interior of the valves; thus it follows that the valves at their apical portions have always much convexity.

There is one other feature common to all the sections, but so much more strongly defined in the *Costatæ*, that it may here be adverted to, more especially as it has not previously been noticed. The oblique median furrow upon the area, forming the lower border of the superior or more depressed portion of the area, indicates the position of an internal rib; in the living mollusk this rib constituted a short process only, which, near to the outer border, served to separate the incurrent from the excurrent respiratory orifice; with progress of growth the process advanced continually, and its former position was obliterated by the deposition of new-formed shell-substance; the external furrow remained, and indicates the former position in growth of the internal divisional ridge.

With the exception of *Trigonia peninsularis, Coquand,* which occurs in the Cretaceous rocks of Spain, all the species of the *Costatæ* are Jurassic. The following thirteen species occur in British strata: *T. costata,* Sow., *T. denticulata,* Ag., *T. pulla,* Sow., *T. Meriani,* Ag., *T. elongata,* Sow., *T. augustata,* Lyc., *T. sculpta,* Lyc., *T. monilifera,* Ag., *T. Cassiope,* D'Orb., *T. Crucis,* Lyc., *T. gregarea,* Lyc., *T. hemisphærica,* Lyc., *T. tenuicosta,* Lyc.

8th.—Byssiferæ.

I propose to constitute this section to include *T. carinata,* Ag., from the Neocomian beds of France and England, a lengthened sub-cylindrical shell, which in general ornamentation resembles the *costatæ;* but in addition it acquired at the period of adult growth a byssal aperture, formed by a slight excavation of the anterior border of each valve; the condition of the area and of the shell generally at that stage of growth indicates that it became fixed or stationary. The elongated and almost cylindrical figure is very abnormal as regards the genus Trigonia, but we perceive a strong resemblance to Bysso-arca and to the relation which the latter holds to the genus Arca; the resemblance is much enhanced by a general worn appearance of the upper surface in adult forms in both these mollusks, which doubtless was the result of similar conditions of existence. The condition of the hinge has not been ascertained.

General Sketch of the Distribution of the Genus Trigonia *throughout the Geological Formations of Britain.*

The lowest geological position in which the genus occurs in Britain is in a single stratum about the middle of the Upper Lias, exposed upon the coast scars of Yorkshire, at the Peak, Robin Hood's Bay; here *T. litterata* occurs in all conditions of growth; it is one of the *Undulatæ.*

The Supra-liassic Sands of the Cotteswold Hills have produced four species very sparingly, and a fifth occurs in a similar position at the Peak; even thus early in the history of the genus these few species exemplify three of the sections into which the genus is divided. Three of these (*T. denticulata*, *T. spinulosa*, and *T. formosa*) pass upwards into the Inferior Oolite, in which they are more abundant. *T. Ramsayi*, and *T. Leckenbyi* are special to this stage.

In Britain the Inferior Oolite appears to have been the very metropolis of the Trigoniæ. Upwards of twenty-seven species have rewarded the industry of collectors; from its geographical position it forms four areas, severally from which the following species have been obtained:

1. *Area to the southward of the Mendip Hills, including the counties of Somerset and Dorset.*

T. costata, T. striata, T. formosa, T. duplicata, T. angulata, T. tenuicosta, T. signata.

2. *Area of the Cotteswold Hills.*

T. costata, T. sculpta, T. denticulata, T. hemisphærica, T. costatula, T. angulata, T. sub-globosa, T. producta, T. signata, T. Phillipsi, T. V-costata, T. pulla, T. tuberculosa, T. formosa, T. duplicata, T. gemmata, T. spinulosa, T. tenuicosta.

3. *Area of the Midland Counties and Lincoln.*

T. sculpta, T. denticulata, T. gregarea, T. hemisphærica, T. pulla, T. formosa, T. signata, T. Phillipsi, T. V-costata, T. Sharpiana, T. compta, T. minor, T. Beesleyana, T. producta.

4. *Area of Yorkshire.*

T. denticulata, T. gregarea, T. conjungens, T. spinulosa, T. V-costata, T. recticosta, T. signata.

From the foregoing lists it will be perceived that the areas of the Cotteswold Hills and of the Midland Counties have many species in common, but that the Somerset and Dorset area and that of Yorkshire have only a single species identical. Of these twenty-seven species two only (*T. denticulata* and *T. pulla*) have been found to pass into a higher formation.

The Bathonian formation has also a greatly varied but less numerous series, seventeen in number, as follows:

T. pulla, T. denticulata, T. Bathonica, T. arata, T. Moretoni, T. impressa, T. Painei, T. Crucis, T. Griesbachi, T. flecta, T. Clytia, T. imbricata; also the following, which appear to be special to the Cornbrash: *T. Scarburgensis, T. Cassiope, T. tripartita, T. angustata, T. bivirgata.* Of these I have been able to trace only *T. denticulata* into a higher formation.

Passing upwards we at once take leave of the numerous Trigoniæ that characterise the Lower Oolites; for, although some species occur in immense abundance at certain localities, the number of Jurassic species in any one stage are comparatively few, and in the Middle and Upper Oolites, from the Kelloway Rock to the Portland Oolite inclusive, only twenty-five additional species have been procured. The Oxfordian Trigoniæ are the following: *T. paucicosta, T. denticulata, T. complanata, T. Rupellensis, T. elongata, T. clavellata, T. irregularis, T. triquetra, T. corallina, T. composita, T. perlata, T. monilifera.*

The Portlandian series, including Kimmeridge Clay, Portland Sand, and Portland Oolite, have *T. irregularis, T. Juddiana, T. Pellati, T. muricata T. Carrei, T. gibbosa, T. Damoniana, T. Micheloti, T. Manselli, T. incurva, T. tenui-texta, T. Woodwardi, T. Voltzii.*

In the Cretaceous system of rocks, the species of the Neocomian formation are *T. nodosa, T. caudata, T. carinata, T. ornata, T. spinosa, T. Picteti, T. Pyrrha, T. Orbignyana, T. Etheridgei, T. ingens.*

The Gault has *T. Fittoni.*

In the Upper Green Sand are *T. tenuisulcata, T. Archiaciana, T. excentrica, T. spectabilis, T. crenulata, ? T. aliformis, T. dædalea, T. abrupta, T. ornata, T. Cunningtoni.*

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Mr. Cunnington, of Devizes, whose collection so well exemplifies the fossil faunas of the Upper Jurassic and Cretaceous rocks of that part of England, kindly forwarded everything calculated to illustrate that portion of the subject. The following gentlemen have also afforded material assistance either by the gift or the loan of specimens:—Rev. P. B. Brodie, of Rowington; Rev. J. E. Cross, of Appleby, Lincolnshire; Professor J. Buckman; Mr. J. Leckenby, of Scarborough; Mr. P. Hawkridge, of the same place; Mr. Beesley, of Banbury; Rev. C. L. Smith, of Canfield, Essex; Mr. J. Walker, of York; Mr. E. Witchell, of Stroud; Dr. T. Wright, of Cheltenham; Mr. R. Tate, of Camberwell; Mr. Samuel Sharp, of Northampton; Mr. Mansell, of Blandford, Dorset; also Dr. J. Lowe, of Lynn.

§ I. SCAPHOIDEÆ.

TRIGONIA DUPLICATA, *Sow.* Plate I, figs. 8, 9, 10.

TRIGONIA DUPLICATA, *Sow.* Min. Con., pl. 237, fig. 4.
— PROSERPINA, *D'Orb.* Prodr., 1, 10 Et., No. 315, p. 278.
— DUPLICATA. Ib., No. 317, p. 279.
— — *Morris.* Catal., 1854, p. 228.
— — *Morr.* and *Lyc.* Pal. Soc. Mon., 1854, pl. vi, fig. 2.

Shell ovately trigonal, moderately convex; umbones antero-mesial, elevated, obtuse, and somewhat recurved; anterior side much produced, its border curved elliptically with the lower border, posterior extremity more produced, attenuated, and rostrated; hinge-border concave, sloping obliquely downwards; area narrow, flattened, finely striated transversely, and bounded by two very small carinæ, each of which is minutely tuberculated; escutcheon narrow, depressed, and lengthened, forming an excavation at the superior border; it has delicate oblique costellæ, and at the apical extremity are a few transverse ridges, which also pass over the inner carinæ and the area. Costæ numerous (from 12 to 14), narrow, raised, delicately fringed with closely placed, minute, obtuse, rounded, or ovate tubercles; the first-formed three costæ are concentric, the fourth costa is directed downwards, and has anteally to it four or five short irregular horizontal or supplementary costæ, which are nearly at right angles with the fourth costa; the succeeding costæ—nine, ten, or more in number—pass from the carina downwards in a straight or slightly waved course perpendicularly to the pallial border; two, three, or four of the more anteal of these costæ divide near to the border or near to the middle of their course, each into several smaller costæ, but the few more posteal costæ are undivided. These small supplementary pallial costæ are never precisely alike in any two specimens, but are always small and numerous. The inner borders of the valves are crenulated.

Few Trigoniæ have so much variability as *T. duplicata*, both in the general figure and the arrangement of the rows of costæ; the number of the rows, their closeness or separation, and more especially the number of the small supplementary costæ, all are characterized by this diversity; usually the smaller specimens have the greater convexity, and have their apices more produced and recurved. D'Orbigny was misled by these differences, as exemplified by certain specimens, to separate his *T. Proserpina;* and for some time the larger and more depressed forms, with their closely placed costæ, induced me also to regard them as distinct; the figures now given will sufficiently illustrate this variability.

Agassiz placed *T. duplicata* with the *Scabræ,* influenced, probably, by the examination of insufficient specimens; it is only necessary to direct attention to the characters of the area, with its tuberculated bounding carinæ and transverse striations, to perceive that it cannot be allowed to remain in that section.

Stratigraphical position and localities. This is a delicately ornamented species occurring not uncommonly in the Upper Trigonia-grit of the Inferior Oolite in the Cotteswolds at numerous localities; impressions in the hard ragstones are common, but it is difficult to separate a specimen in good preservation from the hard matrix. It also occurs in the Inferior Oolite of the Half-way House Quarry near to Yeovil. In France, Guéret is the locality for *T. Proserpina*, D'Orbigny.

TRIGONIA GEMMATA, *Lyc.* Plate I, fig. 7.

TRIGONIA GEMMATA, *Lycett.* Ann. and Mag. Nat. Hist., 1853, pl. ix, fig. 8, p. 425.
— — *Morris.* Catal., 1854, p. 228.

Shell ovately trigonal, moderately convex; umbones elevated, pointed, and slightly recurved; anterior border moderately produced, both it and the inferior border elliptically curved; hinge-border straight, lengthened, sloping obliquely. Area narrow, flattened, transversely delicately striated, but near to the apex costellated, having two distinct, delicately knotted, or cord-like carinæ which circumscribe it. The escutcheon is narrow, lengthened, and depressed, rendering that portion of the slope slightly concave. The costated surface has a dense and salient ornamentation; the first-formed series of costæ, about seven in number, occupy more than half of the valve. They have the rows very closely arranged, narrow, ridge-like, and concentric, each bearing a row of small, closely arranged tubercles; the succeeding rows of costæ, eight or nine in number, are similar, but they descend almost perpendicularly, or inclined somewhat forwards from the marginal carina to the pallial border. There is also a third series of short or supplementary costæ, which, originating at the anterior border, pass obliquely upwards to be united to the side of the last-formed costa of the first series, or concentric costæ, producing a singular unsymmetrical but not inelegant aspect to the anteal side of the valve. There are eight of these short costæ. The perpendicular costæ are undivided; one specimen only has a single intercalated rib; the tubercles upon the rows are irregular and unequal.

Length, 18 lines upon the carina; the diameter at right angles to it is 15 lines.

Trigonia duplicata, Sow., is allied to our species, and differs from it in the following particulars:—The species of Sowerby is less convex, and has the ornamentation smaller and more irregular; it commences with only two or three concentric or horizontal costæ, all the others are directed perpendicularly downwards from the carina; they are irregularly knotted, are frequently and sometimes alternately dichotomous; they are also fewer and more widely separated; the anterior side of the valve has also a few curved and very irregular and narrow costæ. The differences here indicated are very persistent.

T. gemmata is also allied to *Lyrodon sulcatum*, Goldf., from the White Chalk of Havre; but in that species the concentric costæ occupy the whole of the anterior border.

Stratigraphical position and localities. The bed called Upper Trigonia-grit of the Inferior Oolite in the vicinity of Stroud and of Cheltenham; it appears to be one of the most rare productions of that stratum.

TRIGONIA RECTICOSTA, *Lycett*, sp. nov. Plate I, figs. 4, 5, 6.

Shell ovately trigonal, moderately convex; umbones small, antero-mesial, scarcely recurved; anterior side short, truncated, its border slightly curved, lower border nearly straight; hinge-border straight, sloping obliquely downwards; area flattened, very wide, its breadth is equal to two fifths the entire breadth of the valve; it has a mesial furrow, is transversely irregularly plicated, and is bounded by two small tuberculated carinæ; the tubercles upon the marginal carina are regular, and nearly equal in size to those upon the side costæ; the inner carina consists of a row of minute, unequal, transverse, nodose varices. The costæ, nineteen or twenty in number, are moderately elevated, with regular, small, rounded tubercles; the first-formed eight or nine rows are slightly curved or oblique, and are directed towards the anterior border, where they are united to a series of short, ridge-like, narrow, sub-tuberculated, horizontal costæ, of which about nine occupy the anteal portion of the valve; the other costæ pass almost perpendicularly to the pallial border, increasing in size downwards without division or supplementary costæ; about twelve tubercles are in each row. The lines of growth are strongly defined; they form plications where they cross the perpendicular costæ. The general figure of the shell and the direction of the rows of costæ resemble *T. duplicata*, but the costæ are but little elevated or ridge-like; and, unlike that species, the tubercles are regular and symmetrical, the rows are more distantly arranged, and are not divided near to the pallial border into several smaller costæ.

From *T. gemmata*, the second of this group of Lower Oolite forms, it differs both in its figure and in the arrangement of the costæ, which are much fewer and more perpendicular, with wide interstitial spaces, and it has not the numerous first-formed large concentric rows of that species. It is also not without some general resemblance to a young *Trigonia navis*, both in its figure and the design of its ornamentation; for distinctive difference it is only necessary to refer to the numerous costæ and their minute tubercles in the British species.

Stratigraphical position and locality. The Inferior Oolite at Cloughton cliffs, to the northward of Scarborough. The Millepore bed (so called from the prevalence of *Cricopora straminea*) is there somewhat ferruginous; it has produced a few well-preserved specimens of our little Trigonia, and numerous others in an imperfect condition associated with

Trigonia conjungens, Phil., *Pygaster semisulcatus,* Phil., and a considerable series of Inferior Oolite Conchifera, some of the more common forms of which occur also in the Dogger and in the Grey Limestone upon the same coast and vicinity. The position of this marine deposit (from fifteen to twenty feet in thickness), about the middle of the great mass of Estuarine Sandstones and Shales, and between the Dogger and the Grey Limestone, is important as tending to connect the fauna of those two widely separated marine deposits, and as proving that the conditions of sea-bottom and the succession of molluscan life underwent no considerable change during the whole of the northern Inferior Oolite period as exemplified upon the coast of Yorkshire, undoubtedly less than is exhibited by beds of the same geological period at the southern localities. Two other less important marine beds also occur intercalated with the estuary deposits, one between the Dogger and the Millepore bed, the other between the latter deposit and the Grey Limestone; but as their marine testacea are few and ill-preserved, little interest attaches to their presence.

Specimens of *T. recticosta* from Cloughton are in the collection of Mr. Leckenby at Scarborough and in the cabinet of the author; others in a less perfect condition are in the Museum of the Yorkshire Philosophical Society at York. The British Museum has also a fine specimen in the Bean Collection.

TRIGONIA BATHONICA, *Lyc.* Plate I, fig. 3.

TRIGONIA BATHONICA, *Lycett.* Pal. Soc. Suppl. Monog., 1863, p. 52, pl. xl, fig. 3.

Shell sub-trigonal, short, depressed; umbones elevated, mesial and not recurved; anterior and posterior borders nearly straight, sloping obliquely downwards, the surface with numerous (about twenty-four) narrow, elevated, spinose, somewhat undulated and slightly radiating costæ, which are directed from the marginal carina anteally downwards, and all reach the pallial margin; the area is narrow and transversely striated; the marginal carina is very small and rather indistinct.

The narrow ridge-like costæ are very closely arranged, and have numerous minute obtuse spines, which impart roughness to the surface; the general aspect resembles *T. duplicata*, Sow., but it has no bifurcating or interstitial costæ near to the lower border, it is also without concentric costæ near to the apex; the absence of this latter feature will also distinguish it from *T. gemmata*, Lyc. The sole specimen at my disposal is imperfect at the posterior extremity; it has twenty costæ, and would require about four others to complete its surface. The figure is nearly an equilateral triangle, each of the sides having a length of about an inch.

Oppel, in his elaborate work 'Juraformation,' p. 486, makes incidental mention of a Trigonia which is regarded by Messrs. Rigaux and Sauvage as identical with our species.

It is from the Cornbrash of Marquise, and is named by him *T. Bouchardi;* unfortunately no figures of this and other new species incidentally and briefly mentioned in that work have been given, and, in the absence of any allusion to the difference of the costæ near to the apex, I consider that the species in question is not sufficiently characterised to constitute it an authority.

Stratigraphical position and locality. The only example at our disposal was obtained by Mr. Walton in the Great Oolite near to the Box Tunnel, Bath.

§ II. Clavellatæ.

Trigonia clavellata, *Sow.* Plate I, figs. 1, 2.

Curvirostra rugosa clavellata major, *Luid.* Litho., 1699, p. 36, pl. ix, fig. 700.
Trigonia clavellata, *Sow.* Min. Conch., 1815, pl. lxxxvii.
Lyrodon clavellatum, *Goldf.* Petref., 1834—1840, p. 200, pl. cxxxvi, fig. 6, *c*, *d*, *e*, and *f*, excl. fig. 6 *b*.
Trigonia clavellata, *Morris.* Catal., 1854, p. 228.
— — *Damon.* Geol. Weymouth, Suppl., 1860, pl. iv, fig. 2.

(Exclude the figures of *T. clavellata* in the works of Parkinson, Young and Bird, Bronn, Zeithen, Agassiz, Zwingen, Goldf., Petref., pl. cxxxvi, fig. 6, *b*; also of Hébert, "Trigonées clavellées," Jour. de Conchyl., 1861, pl. vii, fig. 1.)

Shell ovately trigonal, moderately elongated, convex; umbones large, obtuse and incurved, but rarely recurved; anterior side rounded, but not much produced, its lower extremity curved with the lower border; superior border straight, lengthened, sloping obliquely downwards; escutcheon flattened, its length is nearly equal to half the length of the marginal carina; the area is narrow, flattened or slightly convex, transversely irregularly plicated, having three carinæ, of which the mesial carina consists of a row of delicate, regular, small tubercles; the two bounding carinæ have the tubercles much larger, but depressed and closely arranged, those upon the inner carina form lengthened transverse varices; a well marked furrow borders upon the median carina, and in some specimens the furrow is bounded upon each side by a row of tubercles; more frequently, however, the second or upper row is very imperfectly indicated; the superior half of the area is more depressed than the other portion. The sides of the valves have the rows of tuberculated costæ at first oblique, but the later-formed few become more horizontal or more nearly accord with the direction of the lines of growth, so that the greater number of the rows reach the anterior border in the form of small attenuated or sub-tuberculated varices; the posteal extremities of the rows approach the carina at an angle which is somewhat greater than a right angle; the tubercles in the rows are large, not prominent, imperfectly rounded, closely arranged, and are rather unequal both in size and figure; eight tubercles are usually distinct in each row before they degenerate anteally into small varices; the last-formed one or two rows in specimens of advanced growth have the tubercles compressed into lamellar varices, or form almost continuous costæ. The shell in the Lower Calcareous Grit, which I regard as the type, has sixteen or seventeen rows of costæ in adult specimens; this form is special to the Lower Calcareous Grit and is the prevailing clavellated species of that rock both in Dorsetshire and Yorkshire. A clavellated Trigonia special to the Kimmeridge Clay, and very much resembling the typical *T. clavellata* of the Lower Calcareous Grit will, without due care, be placed with the latter species. For a comparison of these forms see the species next following.

Of the mistakes in the identification of species *T. clavellata* is a remarkable instance, the errors respecting it having been chiefly those of Continental authors, who have not had the advantage of comparing authentic English specimens, and have been misled or confused by the figure of Parkinson, which unfortunately has priority; this drawing is in every respect execrably bad, and undeserving of trust, so that after many unsatisfactory attempts at comparison with English Trigonias I have felt compelled to discard it altogether, and to regard the figure in the 'Mineral Conchology' as the typical example, as it is altogether free from doubt, and is readily identified with numerous Weymouth examples obtained in the Coralline Oolite formation or Lower Calcareous Grit of that vicinity. Nevertheless, this variety admits of some variability of figure, and we may regret that one or two additional specimens were not figured in the 'Mineral Conchology;' as an instance, refer to the figure in Mr. Damon's supplement to his 'Geology of Weymouth,' which accurately represents a specimen of abnormal form, with the anterior side very short, and the tubercles in the rows so large as to be partially confluent. Upon the whole, the larger figure of Goldfuss ('Petr.,' pl. 136, fig. *b*, *c*) is the best hitherto given of the adult form, but the locality (Inferior Oolite of Gundershofen) is unquestionably an error.

The *T. clavellata*, Agassiz, from the Oxford Clay of Dives, is remarkable for the great elevation and recurvature of the umbones, and the horizontal direction of the rows of costæ. D'Orbigny has justly separated this species under the name of *T. major;* it has not been recognized in Britain.

The *T. clavellata* of Zeithen is so very unlike the English species that we may be confident no true example of *T. clavellata* had come under his notice; it appears to coincide with *T. signata*, Ag. The *T. clavellata* figured by M. Hébert, from the Oxford Clay of Tronville, is also a different species, remarkable for the great breadth of the area, together with the shortness and prominence of the escutcheon. The *Trigonia Bronnii*, Ag., of which a single defective specimen was figured in the memoir by that author, has since been fully illustrated and described by M. Hébert in an interesting paper on the

"Trigoniæ of the Coral Rag;" he also states that he has seen specimens from the Calcareous Grit of Weymouth, and even expresses doubts as to the real type of *T. clavellata.* The specimens of *T. Bronnii* from Glos (Calvados) are much smaller than the *T. clavellata* of Weymouth; in all the specimens which I have examined the escutcheon has greater breadth and is shorter; the posterior extremity of the valve is broader and less pointed; adult specimens have the rows of tubercles less numerous, and their general direction is more horizontal; their irregularity in size and arrangement is also very conspicuous when compared with *T. clavellata.*

Another very large clavellated species from the Lower Calcareous Grit of Yorkshire and Oxfordshire has sometimes been mistaken for it; this is the *T. triquetra,* Seebach, for which the reader is referred to the description.

A near ally to *T. clavellata* is *T. perlata,* Ag., of which a great profusion of specimens have been obtained in the Coralline Oolite of Pickering, for which also see the description.

In Britain *T. clavellata* has occurred very abundantly in layers of the Lower Calcareous Grit formation in scars, and in the cliff at Sandyfoot Castle, near Weymouth; also in the same formation in Wiltshire and near to Filey Point, Yorkshire. Our figures represent its usual dimensions.

TRIGONIA VOLTZII, *Ag.* Plate X, figs. 1, 2.

TRIGONIA VOLTZII, *Agassiz.* Trigonées, 1840, p. 23, pl. ix, figs. 10—12.
— — *Oppel.* Juraformation, 1856—1858, p. 719, No. 88.
— CLAVELLATA, *Morris.* Catal., 1854, p. 228 (pro parte).

Few Trigoniæ have been the cause of so much perplexity and doubt as the present form, the result of the very unsatisfactory figure given by Agassiz, and also of the insufficiency of his description; so obscure, in fact, has this species appeared to be, that the greater number of authors have been contented to ignore it altogether. The figure in the memoir of Agassiz represents the internal mould of a clavellated Trigonia, some of the tubercles of which are impressed upon its surface, and the only distinctive character that can be ascertained from it is that the form is more elongated than *T. clavellata.*

D'Orbigny ('Prodrome,' 2, p. 51, makes *T. Voltzii* a synonym of *T. muricata,* Goldfuss.

Oppel ('Juraformation', p. 719) has a lengthened note upon *T. Voltzii,* which proves that he was well acquainted with our species, of which he had himself collected several specimens from the Kimmeridge Clay of Boulogne; but he does not appear to have been so certain with regard to the true type of *T. clavellata,* and he therefore gave no further comparison of the two forms than to state that the figure of *T. Voltzii* will readily be distinguished from the other by its greater length.

Having, after great delay, obtained perfect specimens of the Kimmeridge Clay *T. clavellata* (so called), I am enabled to affirm its specific distinctiveness from the typical or Calcareous Grit examples of *T. clavellata,* and to give its distinctive features with sufficient precision, figures of which will be given upon Plate X. Compared with that form, *T. Voltzii* is a larger, and also, in proportion, a more lengthened form, the umbones are somewhat more elevated and attenuated; the anterior side is short, but the posterior side is more produced; the test is also unusually thick; the convexity of the valves is somewhat less, consequently the surface of the area is more nearly upon the same plane with the other portion of the valve; the area in its other features offers but little that is distinctive, excepting that the transverse plications are unusually large, irregular, rugose, and wrinkled; they are united to the tubercles of the carinæ. The rows of tuberculated costæ upon the other portion of the valve are invariably less numerous, and much more widely separated, than in *T. clavellata;* adult examples of the latter shell have sixteen or seventeen rows; the larger, *T. Voltzii,* has only eleven or twelve rows; the tubercles also have some differences, their number in each row is nearly similar, but the Kimmeridge Clay shell has its tubercles compressed, or cuspidated and pointed, and, unlike the other, they are much impressed by the lines of growth, which are unusually large and conspicuous over the whole of the valve. The largest specimens have the anteal portions of the costæ attenuated and cord-like; the largest tubercles are near to the posteal extremities of the rows.

It may be a question of dispute how far the above-stated distinctions are of specific value, or what are the limits of variability possessed by each of these two clavellated Trigoniæ; without discussing the arguments which may be adduced for their distinctiveness or otherwise, it will be sufficient to remark that the peculiarities of each form are observable upon all the specimens in the geological formation where they occur, and are therefore of value in a stratigraphical point of view.

Separate valves of *T. Voltzii* occur in the Kimmeridge Clay of the coast of Dorsetshire, in the same formation at Wootton Basset, Wiltshire, and in Lincolnshire; examples with the valves united are rare. The localities given by Agassiz are Argentenay (Yonne), also Besançon; Oppel gives Boulogne: all in the Kimmeridge Clay.

TRIGONIA PERLATA, *Ag.* Plate III, figs. 1, 2, 3.

TRIGONIA CLAVELLATA, *Young* and *Bird.* Geol. Survey, 1828, pl. viii, fig. 18.
— PERLATA, *Agassiz.* Trigonies, 1840, p. 19. pl. iii, figs. 9—11.
— — *Hébert.* Trigonies clavellées, Jour. de Conchyliologie, 1861, pl. vii, fig. 2.

T. perlata, Ag., has not unfrequently been mistaken for *T. clavellata,* Sow., with which, indeed, it possesses some strong affinities. These errors are for the most part to be referred to the very imperfect single figure of the adult form given by Agassiz, and to his having mistaken the species of Sowerby, and figured another and very different form for his *T. clavellata ;* fortunately M. Hébert has given a good figure and precise description of *T. perlata* in the memoir above cited on some clavellated Trigonias of the Oxfordian Rocks. Although the features which distinguish the *T. clavellata* of Weymouth from the *T. perlata* of Pickering had long been present to my mind, it was the memoir of Hébert that enabled me to identify the latter with the species of Agassiz. Adult specimens of *T. perlata* agree in size with those of the other species. Young specimens are smaller than those of *T. clavellata,* and have their ornamentation much more minute, as exemplified in the rows of tuberculated costæ, and in the tubercles upon the carinæ ; the form also is much more pointed and produced, both at the apex and the opposite extremity of the valves, so that, even when comparing young specimens of both species, their distinctness is evident. Adult specimens of *T. perlata* have much variability in the number of costæ and in the relative size of tubercles ; occasionally the costæ form narrow sub-tuberculated ridges, and the angle at which they approach the carina differs, but the angle always exceeds that which occurs in *T. clavellata.* The apices are more produced, narrow, and more distinctly recurved. After making allowance for occasional variability, this latter feature is very persistent ; the opposite extremity is as constantly more attenuated and even rostrated. This figure is produced, not by an actual difference in the measurement across that part of the valve, but by the greater angle which that portion of the area forms with the costated portion of the valve, so that when the valve is viewed laterally, the posteal portion of the area is but little seen, and is not elevated as in *T. clavellata ;* an appearance of greater breadth and roundness is thus imparted to the posteal extremity of the latter species. The upper portion of the area is more depressed ; but there is never any distinct furrow, and never any indications of a second row of tubercles, as in *T. clavellata.* The three distinctive features, therefore, which are immediately evident are the smaller and more pointed tubercles, the more narrow and recurved apex, and the more produced and narrow posteal extremity in *T. perlata.* The more distinctly ridged specimens have the interior borders of the valves scalloped. The valves of Trigonia in the Coralline Oolite of Pickering occupy about a foot in thickness ; the specimens are of all periods of growth, and the valves are invariably disunited. Their surfaces have frequently been worn by attrition, but there is never any appearance of compression or distortion; many valves are broken, so that only a minority have the surface ornaments well preserved.[1]

Trigonia Bronnii, *Ag.* Plate IV, fig. 8.

Lyrodon clavellatum, *Bronn.* Lethæa Geognostica, 1834—1838, pl. xx, fig. 3.
Trigonia Bronnii, *Agassiz.* Trigonées, 1840, p. 18, pl. v, fig. 19.
— — *D'Orbigny.* Prodr. de Paléont., ii, 1850, p. 16, No. 259.
— — *Hébert.* Jour. de Conchyl., 1861, pl. vii, figs. 4, 6, et pl. viii, figs. 1, 2, 3; Note sur les Trigonies clavellées de l'Oxford Clay et du Coral Rag.

Compared with *T. clavellata,* Sow., and *T. perlata,* Ag., the chief distinguishing feature consists in the straightness or horizontal directions of the rows of costæ which approach the marginal carina nearly at right angles, and the costæ last formed take nearly the direction of the lower border. The irregularity and inequality in the tubercles is also remarkable; usually the second and third tubercles from the carina are larger than the others, and the last-formed one or two rows are smaller, irregularly knotted, and cord-like; their general direction is nearly horizontal, so that all the rows have their extremities upon the anterior border. Near to the apices the rows are nearly plain, or only slightly crenulated. The escutcheon nearly resembles that of *T. clavellata,* excepting that it is somewhat larger, and has also greater length; the area and its ornamentation do not offer anything remarkable, its posteal truncation is usually greater than in our figure. The lines of growth are less conspicuous than in the allied species. Measurements of the dimensions are of little utility in a species whose figure varies considerably. More commonly the tubercles upon the costæ are fewer and larger, and sometimes more scabrous, than in either *T. clavellata* or *T. perlata.* The usual figure of the shell is also less elevated or more oblong; in a multitude of examples which I have examined from the Coral Rag of Glos these distinguishing features are persistent.

Stratigraphical position and localities. In the vicinity of Weymouth it has occurred

[1] The following section in descending order shows the position of the Trigonia bed at Pickering in the Coralline Oolite:

1. Rubbly coarse limestone with large coralline masses.
2. Thick bed of oolitic building-stone.
3. Hard band, one foot thick, full of shelly fragments, and of disunited valves of *Trigonia perlata.*
4. Thick bed of oolitic building-stone.
5. Flaggy, thin-bedded, hard oolite, full of small mollusca, Cerithium and Nerinæa (basement bed of the Coral Rag.)
6. Yellow, hard, subsiliceous sandstones of the Lower Calcareous Grit.

rarely, and does not usually much exceed the size of our figured specimen; it is found in the Calcareous Grit at Osmington Hill; the same formation at Filey Point, Yorkshire, has also produced it rarely, and not well preserved. In Normandy it is very abundant in the Coral Rag of Glos and of Hennequeville.

TRIGONIA INGENS, *Lycett*, sp. nov. Plate VIII, figs. 1, 2, 3.

Shell sub-ovate or ovately oblong, convex anteally; umbones obtuse, moderately produced; anterior border short, curved arcuately with the lower border; posterior border nearly straight, sloping obliquely, and terminating in a rounded, wide, posteal extremity; escutcheon large, lengthened, concave, its superior border raised; area moderately large, slightly convex, with a mesial divisional furrow, bordering a small medium tuberculated carina; the area is also bounded by two small minutely tuberculated carinæ; its surface has small transverse striations, which over its posteal half become irregular rugose plications, the carinæ at the same position also disappear. The other portion of the shell has about fourteen rows of large, oblique, tuberculated costæ; the tubercles, six or seven to each row, are large and rounded, but sometimes compressed at their upper sides; they are nearly equal in size, but become suddenly small at the anteal curvature of the valve, where the costæ become cord-like and bend upwards. The last formed two or three costæ are smaller, more depressed, and cord-like, or without distinct tubercles, and in this degenerated condition they proceed anteally in the direction of the lines of growth, or nearly parallel to the lower border. Specimens of adult growth have the lengthened anteal slope occupied by a series of short, narrow, ridge-like, sub-tuberculated costæ, which pass upwards almost perpendicularly to the extremities of the larger costæ; there are about twelve of these supplementary costæ, they gradually disappear at the curvature which unites the anterior and lower borders.

The lines of growth are strongly defined over the whole of the valves.

This is the only British species of the *Clavellatæ* known in the Cretaceous Rocks. Compared with the numerous Jurassic clavellated species, it does not appear to possess any *sectional* distinctive features; its nearest ally is *T. Voltzii*, which it closely resembles in the characters of the tuberculated costæ, excepting that the rows are somewhat more elevated or ridge-like, and that the largest tubercles are those nearest to the marginal carina; the general figure also is less lengthened; the umbones are more obtuse, or less produced, less attenuated, and have not the curvature of the Kimmeridge Clay species; the posterior side is of greater breadth, and is without attenuation or flattening; the short anteal supplementary series of costæ is also another distinctive feature.

The internal mould is inflated anteally, compressed posteally; the apices are widely separated; the posteal muscular scar is unusually large. The height is equal to four fifths of the length; the diameter through the united valves is equal to half the length.

Stratigraphical position and locality. The Neocomian formation of Downham, Norfolk; the rock is a coarse, brownish, or sometimes greyish-brown, incoherent sandstone, locally called Carstone; various specimens, for the most part ill-preserved, and also external casts, have been liberally forwarded to me from the Museum of the Lynn Philosophical Society, through the kindness of Dr. Lowe of that place. Our figures are taken from moulds of gutta-percha pressed into the external casts, and also an indifferently preserved internal cast.

TRIGONIA JUDDIANA, *Lycett*, sp. nov. Plate II, figs. 6, *a, b, c*; Plate IV, figs. 5, 7.

Shell gibbose, ovately oblong, short and truncated anteally, posteally flattened and angulated; umbones antero-mesial, elevated, much incurved but scarcely recurved; lower border curved elliptically; superior border of moderate length, slightly concave, terminating posteally in a considerable angle with the wide posterior border of the area. Escutcheon large and slightly depressed; its superior border is not raised. Area wide, mesial furrow conspicuous; the superior half of the area is depressed concave; marginal carina small, but well marked, with a row of regular, small, distinct tubercles; transverse plications upon the area very irregular, often wrinkled; they frequently unite to form varices at the median and inner carinæ; near to the apex they become regular, plain, narrow, transverse costellæ. The other portion of the valve has about twelve or thirteen rows of clavellated costæ, which curve obliquely downwards and forwards from the marginal carina, and form short, abruptly attenuated varices upon the curvature of the anteal smooth, flattened space; the rows terminate posteally at a smooth, slightly depressed space, which widens downwards and separates the rows from the marginal carina. The tubercles, from six to eight in each row, are prominent, pointed, and somewhat ovate; they are nearly of equal size, and the rows are symmetrical, excepting the two last formed, which are rendered squamous by the large plications of growth near to the lower border.

The diameter through the united valves is equal to half the length of the marginal carina.

This is one of the most convex, and also short or sub-quadrate, forms of the *Clavellatæ;* it will readily be distinguished by the general shortness of the figure, and the truncated outline, both anteally and posteally, the smooth post-costal space, the general gibbosity, and the short oblique rows of prominent pointed tubercles. It is allied to, but I believe distinct from, a clavellated species found in the Kimmeridge Clay of Boulogne

(*T. Rigauxiana,* Mun.-Ch.[1]); in the latter species the comparatively narrow area and the long oblique slope of the hinge-border are essentially different, and also the absence of the wide, smooth, ante-carinal space. Another allied species from the same formation in North-Western Germany is *T. verrucosa,* Credner,[2] but the latter is more erect, its convexity is much greater; the rows of tubercles are much more concentric, smaller, and more numerous; they become very small and attenuated as they approach to the position of the carina; this latter is also apparently destitute of tubercles; it is, therefore, clearly distinct. A clavellated species still shorter has also been figured in the same work under the name of *T. clivosa;* it has the rows of costæ almost horizontal or sub-concentric, and appears to be destitute both of the smooth ante-carinal space and of tubercles upon the marginal carina; it is, therefore, more remotely allied to our species.

Some specimens obtained from the same bed in Lincolnshire, and at the same locality, are more gibbose, with more numerous rows of costæ, each of which has smaller and more numerous tubercles; the posteal extremities of the costæ curve upwards, and form small faintly defined varices upon the smooth ante-carinal space; these are exemplified by Plate IV, figs. 6, and 7, which afford a marked contrast to fig. 5. In both varieties the lines of growth are strongly defined over the entire surface. As the test has undergone considerable change, no portion of the granulated tegument remains.

Stratigraphical position and locality. The Kimmeridge Clay of Market Rasen, Lincolnshire. The name is intended as a slight recognition of services to Jurassic Geology rendered by Mr. John W. Judd in Lincolnshire and the adjacent counties, during his labours as an officer of the National Geological Survey.

TRIGONIA TRIQUETRA, *Seeb.* Plate VI, figs. 1, *a*, *b*, 2.

TRIGONIA TRIQUETRA, *Seebach.* Der Hannoversche Jura, 1864, p. 117, pl. ii, fig. 5.

Shell sub-trigonal, depressed; umbones elevated, pointed, and slightly recurved; anterior side very short, its border abruptly truncated; lower and posterior borders slightly curved, giving to the general form, with its pointed posterior and apical extremities, an unusual trigonal appearance.

The escutcheon is large, slightly depressed, flattened; its length is equal to half of that of the marginal carina and to more than twice its breadth; the area is narrow, slightly convex; the posteal half is more depresssd than the other; the sides of the valves are flattened; they have rows of large varices, or in other instances tubercles, which pass

[1] "Note sur quelques espèces nouvelles du genre Trigonia," par M. Munier-Chalmas, 'Bull. de la Société Linnéenne du Normandie,' vol. ix, 1863–4, (Caen, 1865), pl. iv, fig. 2.

[2] 'Ueber die Gliederung der obern Juraformation, &c.,' Heinrich Credner, Prag, 1863, pl. viii, figs. 23, *a*, *b*, *c*.

downwards to the lower border at right angles to the carina; they are straight or occasionally waved. The other specific features may be conveniently given under two separate descriptions of individual specimens, the originals of our figures; of these the Yorkshire shell appears to be of more advanced growth than the other.

From Lower Calcareous Grit of Cumnor, Oxfordshire.

The median and inner carinæ are represented each by a row of regular rounded tubercles the marginal carina is distinctly elevated, and for two thirds of its length has a row of well separated rounded tubercles; towards the posteal extremity these become large plications. The costæ consist of fifteen rows of large and moderately elevated rounded tubercles, which, towards the border, become continuous rope-like varices; the last three rows are altogether continuous and rope-like; the lines of growth are distinct upon the lower portion of the valve, and are more conspicuous where they cross the area.

From Lower Calcareous Grit of Filey Point, Yorkshire.

The median and inner carinæ are slightly elevated; each consists of an irregular series of unequal transverse varices, which are continuations of the large irregular plications that cross the area; the marginal carina is elevated, consisting of squamous varices or large plications, which are continued across the area. The costæ consist of about fourteen or fifteen rows of oblique, but straight or somewhat waved, broad, depressed ridges, each of which has about thirteen narrow, oblong or slightly rounded varices, which are much impressed by the large, irregular, longitudinal plications upon the sides of the valves; the varices are compressed obliquely from the direction of the carina, and therefore not in the direction of the lines of growth.

Apparently these specimens exhibit the extremes of variability to which the species is liable in the surface-ornaments, and also in the figure; the Cumnor shell is unusually convex, and is also very short compared with the height; the other has the length greater than usual in proportion to the height.

From *T. clavellata*, and not less so from other of the *Clavellatæ*, it is readily distinguished by the sub-trigonal depressed figure, and large, nearly perpendicular, nodulous varices upon the sides of the valves. It has some resemblance to *T. Suevica*, Quenst., but is much shorter, and the apex more elevated, with fewer oblique varices.

Large blocks of stone, detached by marine action from adjacent beds of Lower Calcareous Grit, at Filey Point and at the Castle of Scarborough, contain rough and usually ill-preserved specimens of this Trigonia, of a size comparable to the largest known examples of the genus. In common with other insufficiently known clavellated forms it has been assigned to *T. clavellata*, Sow. Upon the coast of Yorkshire the valves are seldom found disunited; they are in contact, or spread open; originally held together by the ligament, or in the worst-preserved specimens the calcareous spar into which the test was transmuted has disappeared, and the rough, brown, grit-stones still show the ornamentation of the valves more or less imperfectly. The foregoing remarks are founded upon eight examples of various dimensions, two of which are from the same formation at Cumnor, Oxfordshire; three have the valves in contact, the others are in a less satisfactory condition; the largest has a length of six inches upon the marginal carina; the opposite measurement is four and a half inches; but, judging from other imperfect specimens, these are not the largest dimensions attained by the species.

M. Seebach states that *T. triquetra* occurs in the Coralline Oolite of Malton and Pickering, but of this I know of no example; in Hanover he gives as its locality the Hersum beds of the Tönnjesberg, in true Coral Rag. Specimens are in the Museum of Practical Geology, in the Museum of the Philosophical Society, Scarborough, and in the cabinet of the author.

For the larger of the specimens figured (Plate VI, fig. 2) I am indebted to the generosity of Mr. Hawkridge, of Scarborough.

TRIGONIA RUPELLENSIS, *D'Orb.* Plate VIII, fig. 4.

TRIGONIA RUPELLENSIS, *D'Orbigny.* Prodrome de Paléont., 1850, tome ii, p. 17, No. 261.
— CLAVELLATA, var. *Leckenby.* Quart. Jour. Geol. Soc., 1859, vol. xv, p. 8.

Shell ovately trigonal, moderately convex; umbones elevated, pointed, and slightly recurved, placed within the anterior third of the valves; anterior side short, both it and the inferior border elliptically curved; posterior side moderately produced, its border somewhat concave. Escutcheon lengthened, narrow, depressed, and flattened; its length is equal to two thirds of that of the marginal carina; the area is narrow and flattened, delicately transversely plicated, with three very small minutely knotted carinæ, which become evanescent posteally; the posteal extremity of the area forms an obtuse angle, both with the escutcheon and with the inferior border; the apical portion of the area has a few transverse costellæ. The costated portion of the shell has about thirteen rows of tuberculated costæ, of which the four or five rows first formed are simply sub-concentric and ridge-like or sub-tuberculated; all the remaining costæ have distinct rounded tubercles, but their direction is very irregular; posteally they are curved upwards to the carina at a considerable angle, and the last three or four costæ have their superior extremities with the tubercles confluent or forming small depressed varices; anteally there are two or three short additional or supplementary rows of tubercles, which form a very irregular and confused ornamentation over a large portion of the valve; nevertheless, the anteal extremities of the rows pass to the border in regular order and attenuated form.

The plications of growth are strongly defined; they impress the three last-formed rows of costæ. The length of the marginal carina is about one fourth greater than the height; the diameter through the united valves is equal to half the height.

Only a few specimens have been procured, and these vary much from each other in the number, character of, and description of the rows of costæ; with a single exception, also, the condition of preservation assumed by these Kelloway Rock Trigonias is very indifferent, and renders the task of description difficult and deficient in definition.

The description of *T. Rupellensis* in the 'Prodrome' of D'Orbigny is very brief, but appears to be sufficient to characterize the species. It was also briefly alluded to, and its more prominent features indicated, by Mr. Leckenby, in his 'Memoir on the Kelloway Rock of the Yorkshire Coast.' It has occurred very rarely; the original of our figure, from Mr. Leckenby's cabinet, is the only perfect example with which I am acquainted.

Geological position and locality. The Kelloway Rock of Red Cliff, near Scarborough, associated with *T. paucicosta* and numerous other fossils characteristic of that formation.

The French specimens are from the Coral Rag of La Rochelle and Nantua.

TRIGONIA SIGNATA, *Ag.* Plate II, figs. 1, 2, 3.

TRIGONIA CLAVELLATA, *Ziethen.* Petref. Würtemburg, 1830, pl. lviii, fig. 3.
— SIGNATA, *Agassiz.* Trigonées, 1840, pl. iii, fig. 8; pl. ix, fig. 5; p. 18.
— — *D'Orbigny.* Prodrome, 1850, tome i, p. 278.
— DECORATA, *Lyc.* Ann. & Mag. Nat. Hist., 1850, vol. xii, pl. xi, fig. 1.
— — *Morris* and *Lyc.* Gr. Ool. Monog. Pal. Soc., 1853, pl. xv, fig. 1.
— — *Morris.* Catal., 1854, p. 228.
— CLAVO-COSTATA, *Lyc.* Ann. Nat. Hist., 1850, pl. xi, fig. 6 (variety).
— SIGNATA, *Oppel.* Juraformation, 1856, p. 408.
— CLAVELLATA, *Quenstedt.* Der Jura, 1856, pl. lx, fig. 13.
— SIGNATA, *Dewalque* and *Chapuis.* Pal. Luxemb., 1857, p. 172, pl. xxvi, fig. 1.

Shell ovately elongated, sub-trigonal, depressed; umbones antero-mesial, small, and not prominent nor recurved, but rarely they are more erect and recurved; the anterior side is moderately produced and rounded; both this and the lengthened lower border are curved elliptically; superior border straight and lengthened, or, more rarely, somewhat concave; area wide, flattened; its posterior extremity is compressed and somewhat truncated, bounded by two delicate, minutely tuberculated carinæ, and traversed longitudinally by a mesial furrow, and sometimes by a minutely tuberculated carina for about the half of its length; it is also transversely plicated, either coarsely or delicately; in the former case the tubercles of the inner carina forms varices or continuations of the transverse plications; the whole surface of the area measured transversely is upon the same plane.

The escutcheon is depressed, lengthened, and narrow; its superior border is somewhat raised.

The costated portion of the shell has a numerous series (about twenty) of oblique rows of tuberculated costæ, of which the first-formed four or five are slightly curved, but are nearly horizontal, delicate, and sub-tuberculated; the rows which succeed are also raised;

they have the tubercles small, separate, rounded, regular, and nearly of equal size, excepting near to the anterior border, where the costæ are attenuated and their tubercles small and cord-like or indistinct; the last-formed six or seven rows pass upwards nearly perpendicularly to the marginal carina, with which they form a considerable angle; these portions of the last-formed costæ are cord-like or imperfectly tuberculated; there are thirteen or fourteen tubercles in each row.

Most commonly the rows of tubercles are symmetrical and continuous across the entire valve, but occasionally the anteal portions of the valves have the tubercles confused and irregular; in such instances the tubercles continue rounded and separate.

The examples upon our plate, which are only of medium size, indicate that the species possessed variability both in the general figure and in the ornamentation. Some specimens obtained near Chipping Norton are remarkable for the raised ridge-like figure of all the costæ, the indistinctness of their tubercles, the coarseness of the plications across the area, the great convexity of the valves, and the recurvature of the umbones. A specimen with the valves spread open, now in the National Museum, Jermyn Street, is remarkable for these peculiarities. The largest example I have seen is in the collection of Professor Buckman, of Bradford Abbas; its length is four and three quarter inches, and is from the Upper Trigonia-grit of Rodborough Hill; the area has coarse plications which render the carinæ obscure. The figure given by Messrs. Dewalque and Chapuis is very distinctive in the characters of its costæ, but the three large cord-like carinæ upon the area differ altogether from the numerous examples that have been brought under my notice.

The very indifferent examples figured by Agassiz, especially that of his Plate III, fig. 8, induced me at first to regard the British forms as a distinct species. The attenuations of the carinal extremities of the costæ, and their increase of size towards the anterior and the lower border, as depicted in the example above quoted, are altogether unlike British specimens, from whatever locality they may be obtained; it is, therefore, just possible that the first figure of Agassiz may really represent another species, even if we allow some latitude for variability in the ornamentation.

Additional examples of *T. clavo-costata*, Lyc., indicate that it is the immature condition of a large variety of *T. signata*, in which both the tubercles upon the costæ and those also upon the marginal carina participate in general increase of the dimensions; the figure is also less lengthened posteally than in the typical form. The few specimens which I have examined are from white limestone in the vicinity of Stroud.

Affinities and differences. From *T. clavellata*, Sow., and *T. perlata*, Ag., *T. signata* is sufficiently separated by the more depressed form, the more numerous rows of costæ, the smaller and more numerous tubercles, together with the considerable angle at which they approach the marginal carina: others of the *Clavellatæ* are more remotely allied.

Stratigraphical position and localities. *T. signata* appears to be limited to the Inferior Oolite, in which it has occurred at numerous localities, both British and Continental, but it is not a common species. In Dorsetshire it appears to be present, judging from the matrix of two specimens which have come under my notice. In the Cotteswold Hills the upper hard ragstones, or Upper Trigonia-grit, yield many impressions of its outer surface; but examples with the test preserved are more rare. Rodborough Hill, near Stroud, and other localities of the same vicinity, have produced good examples; similar conditions apply to the uppermost bed of the same rock in Oxfordshire, near Chipping Norton. In the same county the ferruginous Inferior Oolite Sands at Rollwright Heath and Hook Norton have yielded numerous specimens in a beautiful condition of preservation as regards the test, both externally and internally. Examples of these are in the collection of Mr. Stuttard, of Banbury; and also in the Museum of the National Geological Survey, Jermyn Street.

Following the course of the Inferior Oolite northwards, Mr. Sharp has failed to discover our shell in the Sands of Northamptonshire; and it appears to be equally absent in Rutlandshire and in Lincolnshire, although the fossils of the Inferior Oolite throughout its long course in the latter county have received considerable attention. In the North Riding of Yorkshire, at Cloughton, near Scarborough, the hard grey limestone has yielded it rarely; specimens are in the collection of Mr. Leckenby of that place, and in my own cabinet. Foreign localities are Longwy and St. Pancre, Luxembourg; Guéret and Moutiers, France; also various localities in the Cantons of Soleure and Basle, Switzerland: all in the Inferior Oolite.

TRIGONIA SCARBURGENSIS, *Lyc.* Plate IV, figs. 1, 2, 3, 4.

TRIGONIA SCARBURGENSIS, *Lycett.* Mon. Pal. Soc., 1863, p. 48, pl. xxxvii, fig. 1.

Shell ovately oblong, elongated, somewhat depressed; umbones antero-mesial, pointed, but not conspicuous, much incurved, and somewhat recurved; anterior side moderately produced, but with little convexity; its border curved elliptically with the lower border; posterior border lengthened and straight, or sometimes slightly concave; its extremity attenuated and rounded. The escutcheon is very large, and but little depressed; its length is considerable, or equal to the height of the valves and to nearly three fourths of the length of the marginal carina; its superior border is raised, which renders the superior border of the valve nearly straight. The area is narrow, lengthened, and flattened, delicately transversely plicated, divided by a faintly traced tuberculated median carina and slight furrow; it is bounded by two small carinæ, which, in the young state, are minutely tuberculated; subsequently they form small elevated plications, and in the most advanced stage of growth even these disappear, and the flattened surface of the area has only the usual folds of growth. The costated portion of the shell has the rows, for the first five or six, regular, sub-concentric, and delicately sub-tuberculated; those which succeed are in proportion much more widely separated, very irregular and oblique; they approach the marginal carina at a right angle. Anteally the costæ become attenuated and sub-tuberculated, their direction is more irregular and variable; not unfrequently they form a kind of undulation, and have the tubercles indistinct or cord-like; in other instances their direction anteally is nearly straight or horizontal, and invariably there is a supplementary rib formed upon that side. The posteal extremities of the costæ never reach to the marginal carina; it is separated from them by a smooth diagonal space for the lower three fourths of its length, but this space is neither considerable nor altogether uniform upon each valve in all specimens. The number of costæ are usually about thirteen, but occasionally sixteen; the tubercles upon the few later-formed costæ are large and obtuse posteally, but their number upon each row and their figure are very variable, some costæ having only eight and others about thirteen tubercles.

This is one of the most elongated and irregular of the *Clavellatæ;* it is the Cornbrash shell attributed to *T. clavellata* in the lists of Cornbrash fossils given by Phillips, Williamson, and Bean. In irregularity of the costæ it quite equals *T. irregularis*, Seebach, that beautiful Oxford Clay shell so long and well known at Weymouth; but a comparison of adult forms in the two species will at once show their distinctness. It approaches in figure more nearly to *T. Voltzii*; but in commencing our comparison with the umbones we find that in *T. Scarburgensis* they are less produced and recurved; the anteal side is more produced, and has much less convexity; the superior border is much straighter, resulting from the more raised superior border of the escutcheon; the rows of costæ are much more irregular, the tubercles are smaller and less raised; they do not terminate abruptly anteally, but become gradually attenuated and sub-tuberculated.

Young specimens having only eight or nine rows of costæ have not any strongly defined specific characters: they sometimes have portions of the granulated tegument preserved. The left valve is not unfrequently found with its ornamentation imperfectly developed, as in our specimen Plate IV, figs. 2, 3. The latter figure, which has been exceeded in its irregularity, appears to have resulted from an atrophized condition of the mantle upon that side; a defect which is equally conspicuous upon the left valve of the young specimen, fig. 4 upon the same plate, and is not, therefore, a concomitant of advanced growth.

Stratigraphical position and localities. It is not uncommon in the Cornbrash upon the northern side of Scarborough Castle Hill and in Cayton Bay. The late Dr. Porter obtained it in the same formation near to Peterborough. The officers of the National Geological Survey state that it is an abundant fossil at several localities in the South Lincolnshire district.

TRIGONIA TUBERCULOSA, *Lyc.* Plate V, figs. 9, 10.

TRIGONIA TUBERCULOSA, *Lycett.* Ann. and Mag. Nat. Hist., 1850, pl. xi, f. 9.
— — *Morris.* Catal., 1854, p. 228.
— — *Lycett.* Cotteswold Hills Handbook, 1857, pl. iii, f. 4.
— CLAVELLATA, *Quenstedt.* Der Jura., 1857, t. 60, f. 14 ?.
— TUBERCULOSA, *Rigaux* and *Sauvage.* Descr. de esp. nouv. de L'Etage Bathon du Bas-Boulonnois, 1868, p. 19.

Shell ovately trigonal, depressed; umbones small, mesial, and recurved; anterior border produced, curved elliptically with the lower border; superior border sloping and nearly straight; area narrow, with two small delicately tuberculated bounding carinæ, traversed transversely by plain costellæ, which become posteally somewhat rugose and less conspicuous. The sides of the valves have a numerous series (from eighteen to twenty) of rows of curved and delicately tuberculated costæ. The tubercles are regular, very closely arranged, slightly compressed laterally, obtuse and produced downwards, so that their bases almost touch the next succeeding row; they are of equal size, excepting near to the carina, when the rows become smaller.

It is allied to *T. Griesbachi*, Lyc., to which the reader is referred, and also to *T. clavulosa*, Rigaux, and Sauvage, Mem. de la Soc. Acad. de Boulogne, 1867, vol. 3. The latter species appears to differ from it solely in having delicate transverse striations upon the area in lieu of the costellæ upon our *T. tuberculosa.*

Geological position and locality. The Inferior Oolite shelly freestone at Leckhampton Hill, near Cheltenham, where it has occurred rarely. Specimens are in the National Museum, Jermyn Street, in the cabinet of Dr. Wright, of Cheltenham, and of the Rev. P. B. Brodie, of Rowington; for the smaller specimen figured I am indebted to the kindness of the latter gentleman. Our figures do not clearly show the downward prolongation of the little tubercles in each row.

TRIGONIA IMBRICATA, *Sow.* Plate VI, fig. 5 *a*, *b*.

TRIGONIA IMBRICATA, *Sowerby.* Mineral Conchology, 1826, t. 507, figs. 2, 3.
— — *Morris* and *Lycett.* Gr. Ool. Monog. Pal. Soc., 1853, p. 63, t. 6, figs. 8, 8A.
— — *Morris.* Catal., 1854, p. 228.
— — *Oppel.* Juraformation, 1857, p. 485.

Under the above name Mr. Sowerby figured a minute Trigonia, which appears to be in an immature or young condition, and of which adult specimens have not been recognised; the peculiar imbrication of the costæ noticed by Mr. Sowerby appears to arise from the erosion of their rounded tubercles.

In the 'Mineral Conchology' it is described as "transversely oblong, depressed, with five or six concentric, dentated, sub-imbricated keels upon the rounded anterior side; the posterior side obliquely truncated, ribbed. The carinæ upon the surface of this little shell resemble terraces, one above the other; each is divided into four or five angular lobes."

The little specimen herewith figured is larger than the type in the 'Mineral Conchology;' it has seven rows of regular, concentric, tuberculated costæ, each of which has five or six distinct tubercles; anteally the rows become attenuated and only slightly tuberculated; posteally they are well separated from the marginal carina, which consists of a row of somewhat smaller tubercles, corresponding in number to the rows of costæ; the area has transverse, plain costellæ, each of which is united to one of the carinal tubercles. Our specimen is slightly broken posteally.

The few minute specimens hitherto examined differ from the young condition of all the known Clavellated Trigonias of the Lower Oolites, and are believed to constitute a distinct species.

Geological position and localities. Ancliff and Bath in the shelly Great Oolite.

TRIGONIA GRIESBACHI, *Lyc.* Plate III, fig. 10, *a*, *b*.

TRIGONIA TUBERCULOSA, *Lycett.* Pal. Soc. Suppl. Monog., 1863, p. 47, pl. xl, fig. 6; not *T. tuberculosa*, Lyc., Ann. and Mag. Nat. Hist., 1850, t. ii, fig. 9.

The little *T. Griesbachi* is only known by a single specimen, which fortunately is in so excellent a condition of preservation that its entire specific characters are fully exposed, and have been faithfully delineated in the magnified figure above cited, and published by the Palæontographical Society in 1863. At that period a single specimen of *T. tuberculosa* was all that remained at my disposal for comparison, and its condition was by no means in so satisfactory a state; it was, without doubt, nearly allied to the Cornbrash Shell, and making some allowance for difference of mineral character, and of geological position, I was induced to regard the two as not specifically distinct or differing only within the limits that might possibly be induced by altered conditions of geological habitat and of fossilisation. The examination of additional specimens of the Inferior Oolite shell have convinced me of the real distinctness of the two little Trigonias, and that their distinctive characters are as follows:

T. Griesbachi has nearly the general outline of its ally, but is more depressed, so that its area is much more nearly upon the same plane as the other portion of the surface; its marginal carina is, therefore, more remote from the superior border of the valve. The rows of tuberculated costæ are much more numerous, and their tubercles are also smaller, so that when viewed in certain directions the rows appear to take a different direction, and to be nearly vertical. The tubercles in their figure accord with those of the Inferior Oolite species; their bases are compressed laterally, and touch the row of tubercles next in succession; but it is only in *T. Griesbachi* that their close proximity produces this deceptive appearance of a vertical arrangement in the rows.

The area is flattened, narrow, with two very small tuberculated, bounding carinæ, and with acute, transverse costellæ, every alternate one of which forms a small varix upon the inner carina, and is prolonged somewhat upon the escutcheon.

Stratigraphical position and locality. The late Rev. A. W. Griesbach obtained this remarkable little species in the Cornbrash of Rushden, Northamptonshire. It has also occurred in the upper zone of the Great Oolite, near to Cirencester.

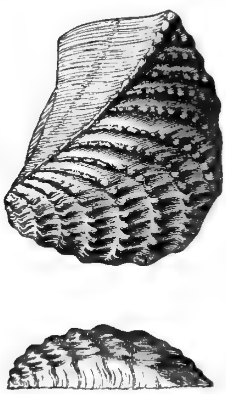
TRIGONIA FORMOSA, *Lyc.* Plate V, figs. 4, 5, 6.

TRIGONIA STRIATA, *Quenstedt.* Jura., 1857, tab. 46, fig. 2.
— FORMOSA, *Lycett.* Jour. Geol. Soc., 1859, note in Memoir of Wright on the Inferior Oolite formation.

Shell ovately trigonal, depressed; umbones elevated, pointed, and recurved; anterior side moderately produced; both it and the lower border elliptically curved; superior border lengthened and concave; area rather narrow, flattened, with closely arranged acute, transverse striations; a faintly marked oblique, mesial furrow, and bounded by two small densely and minutely dentated carinæ; the escutcheon is concave, smooth, and lengthened, sloping obliquely downwards, forming a considerable angle posteally with the posterior extremity of the area. The costated portion of the shell has very numerous narrow, oblique, knotted ridges, which are small at the carina, but increase in size anteally, where they also curve more or less horizontally, even to the anterior border; the last-formed five or six ridges arrive at the pallial border almost without curvature.

The umbonal extremity of the area has costellæ in lieu of transverse striations. This well-characterised species was long confounded with *T. striata,* Miller, owing probably to the bad figures originally given of the latter species; as a contrast to these the *Trigonia Montierensis* figured by Goldfuss under the name of *T. striata* is excellent. Upon comparing examples of equal size it will at once be observed that the general figure is very different; *T. striata* is by no means depressed like the other; its superior border is short, straight, and nearly horizontal, so that its posteal extremity is at less than half the distance from the umbo to the lower extremity of the shell; the less conspicuous umbones, and great comparative breadth of the area, are also so remarkable that they impart a sub-quadrate aspect to the whole, and a wide truncation to the posterior side; the fringing tubercles of the costæ are also more dense and delicate than in *T. formosa.* Length of an adult specimen of *T. formosa* 29 lines; height 24 lines.

Stratigraphical position and localities. T. formosa has occurred in the Inferior Oolite at Dundry Hill, but probably not at any more southward locality in Somersetshire or Dorsetshire, where it is replaced by *T. striata.* In the Cotteswold Hills it has occurred in the Supra-liassic Sands at Frocester Hill, and also in several beds in the Inferior Oolite, beneath the upper Trigonia Grit, at various localities, more especially at Cold Comfort, near Cheltenham, and at Rodborough Hill, near Stroud; it appears to be altogether absent in the Inferior Oolite, in its extension through the counties of Oxford, Northampton, Lincoln, and York. Another and nearly allied species from the red Inferior Oolite of Moutiers, Normandy, has the general figure and ornamentation nearly resembling *T. formosa,* excepting that the Moutiers form has greater convexity, and the escutcheon has greater breadth; the rows of costæ increase in size anteally, and the tubercles have each a small pillar, which descends perpendicularly to the costæ next in succession. The space between the anteal extremities of the costæ and the border has a numerous series of small transverse supplementary costæ. All the examples which have come under my notice are smaller than average specimens of *T. striata* or *T. formosa.* The British Museum has a fine series. I propose for it the name *Trigonia Moutierensis.*



TRIGONIA STRIATA, *Miller.* Plate V, figs. 6′, 7, 8.

TRIGONIA STRIATA, *Sow.* Min. Chol., 1819, t. 237, figs. 1, 2.
— — *Morris.* Catal., 1854, p. 229.
— — *Oppel.* Juraformation, 1857, p. 407.

Shell subquadrate, short, moderately convex; umbones small, erect, only slightly recurved, antero-mesial; anterior side short, somewhat truncated, lower border curved elliptically; superior border short, horizontal, forming a considerable angle with the wide truncated extremity of the area; the length of this truncated border exceeds that of the superior border. Area very wide and flattened, traversed mesially by an obscure furrow which slightly bends the transverse striations; these are very regular and minute, even to the apex. There is no mesial carina, and almost no inner carina, as the transverse striations are cut off abruptly at that border. The marginal carina is always clearly defined; it is very narrow, ridge-like, minutely tuberculated, and has only a slight curvature.

The escutcheon is narrow, lengthened, and much depressed; its superior border is considerably raised. The other portion of the surface has about twenty-two narrow, obliquely curved, and elevated costæ; they are small towards the carina, which they touch, and descend almost perpendicularly ere they curve towards the anterior border. The last-formed six or seven costæ attain the lower border; each costa is fringed with a densely-arranged row of small, elevated, obtuse tubercles, which are frequently somewhat compressed laterally. The interiors of the valves have the lower border prominently dentated.

The most remarkable features in this species are the short sub-quadrate figure and the large size of the area; the height is equal to, or even slightly exceeds, the length, and the surface of the area is equal to two fifths of the entire valve. Its general aspect is so peculiar that it will not readily be mistaken for any other species; but the only authentic figures are those in the 'Mineral Conchology,' which can only be described as bad specimens badly drawn, and this will account for the fact that both Goldfuss and Agassiz have fallen into error respecting it; each of them has figured for *T. striata* a different species.

Another allied species is *T. spinulosa,* described but not figured by Messrs. Young and Bird in their 'Geology of the Yorkshire Coast,' and soon afterwards figured but not described by Professor Phillips, in his 'Geology of Yorkshire,' as *T. striata,* and subsequently by Agassiz as *T. tuberculata.* In this species the much more lengthened area and the different costæ with their larger tubercles will serve to distinguish it. The name chosen by Miller refers to the transverse striations upon the area. The little shell figured by Agassiz for *T. striata,* Miller ('Trigonies,' tab. 4, fig. 12), is not that species but the single small figure, and insufficient description renders it difficult to be assigned to any one of the allied Inferior Oolite forms. The characters of the rows of tuberculated costæ differ equally from *T. Moutierensis, T. formosa,* and *T. Phillipsi;* the general figure has no resemblance to *T. striata.*

Stratigraphical position and localities. The zone of Ammonites Humphriesianus in the Inferior Oolite at various localities in the Counties of Somerset and Dorset. It appears to be altogether absent in the more northern extension of the Inferior Oolite in its course through the Cotteswold Hills, and is also absent in Oxfordshire, Northamptonshire, Lincolnshire, and Yorkshire; it appears, therefore, that the Mendip Hills presented a dividing barrier at the period of the deposition of the Inferior Oolite formation, and thus had an important influence upon the distribution of its testaceous mollusca.

Trigonia Phillipsi, *Mor.* and *Lyc.* Plate VI, figs. 3, 4.

Trigonia striata, *Agassiz.* Trigonies, 1840, pl. iv, fig. 12 (not figs. 10, 11).
— Phillipsi, *Mor.* and *Lyc.* Pal. Soc. Gr. Ool. Monog., 1853, tab. 6, fig. 1, p. 62.
— — *Morris.* Catal., 1854, p. 228.

Shell sub-ovate, convex; umbones obtuse, moderately elevated, and scarcely recurved; anterior side produced, its border elliptically curved with the lower border; superior border nearly straight, of moderate length, sloping obliquely; area flattened, transversely lineated, divided by an oblique furrow, and bounded by two very small, minutely tuberculated carinæ; escutcheon excavated, wide, its length is equal to half of that of the marginal carina; the costated portion of the shell has very numerous closely arranged concentric, raised, and minutely tuberculated costæ. About thirty rows may be counted in a specimen fifteen lines in length; the first few costæ appear to be destitute of tubercles; all the rows are nearly of equal size throughout their course, and are very closely arranged, bordering upon the carina; they do not quite reach the anterior border, but form a slight undulation upon the anteal slope; their posteal extremities rise nearly perpendicularly towards the marginal carina.

T. striata, Miller, and *T. formosa,* Lycett, are allied to it. From the first it is separated by the smallness and obliquity of the area, and by the length of the superior border, which offers a marked contrast to the short sub-quadrate figure of Miller's species.

From *T. formosa* it is distinguished by the greater convexity, by the absence of the acute recurved umbones, and by the concentric in lieu of the oblique costæ of that species; the tubercles, also, are much more minute both upon the costæ and the carinæ, and, contrary to *T. formosa,* the few first costæ are plain.

The height is about one sixth less than the length, but specimens differ in their proportions; no example with the valves united has been obtained.

The figure given in the Monograph of the Great Oolite Mollusca (Palæont. Soc., 1853) is unusually short posteally, which may have resulted from the position in which the specimen was placed before the artist.

Stratigraphical positions and localities. It has occurred in several distinct beds of the Inferior Oolite near to Stroud very rarely, in cream-coloured, nearly hard limestone; at Desborough, Northamptonshire, in brown ferruginous oolite; in white oolite at Stamford, Lincolnshire, and in a similar rock at Stoke, near Grantham; at Appleby, North Lincolnshire, in the lowest bed of Inferior Oolite, a hard, brownish oolite. Our specimens figured are from the latter locality, and were presented to me by the Rev. J. E. Cross; the larger one is more lengthened than is usual; at neither of these localities is it common.

It is not certain that the species has been obtained at any foreign locality. Fine specimens are in both of our great national museums, in the collection of the Rev. J. E. Cross, of Appleby, and in that of the author at Scarborough.

TRIGONIA IRREGULARIS, *Seeb.* Plate V, figs. 1, *a*, *b*, 2; Pl. VII, fig. 6.

TRIGONIA, *Damon.* Geol. Weymouth, Suppl., 1860, pl. ii, fig. 3.
— *Seebach.* Der Hannoversche Jura. See his obs. on *T. triguetra.*

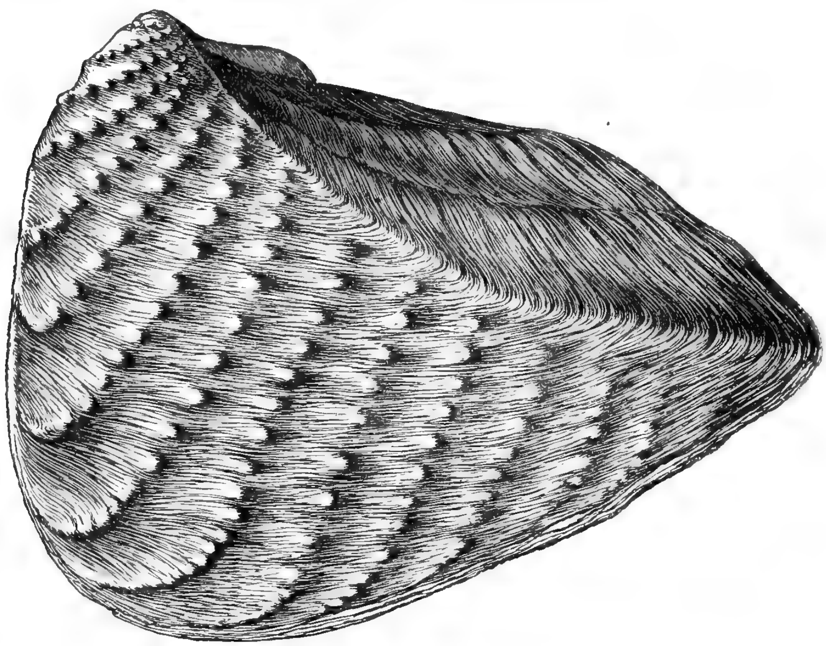
Shell ovately trigonal or oblong; umbones antero-mesial, prominent, and recurved; anterior side short, moderately convex, slightly truncated; its lower portion curved with the lengthened lower border, which is slightly sinuated near to its posteal extremity; the posterior or superior side has its border concave and terminally rostrated.

The escutcheon is very large and depressed; its length exceeds the half of the entire length of the shell; its superior border is only slightly raised. The area is narrow, having three tuberculated carinæ; the inner and median carinæ have each a row of small, transverse, nodose varices rather distantly arranged; these are ultimately lost in the large posteal plications of growth; the marginal carina is small, consisting, for about a third of its length, of a narrow, elevated, finely-indented ridge; subsequently it acquires small transverse nodose varices similar to those of the median and inner carinæ. The transverse plications upon the area are for the most part small excepting near to the apex, where its surface is occupied by about eight regular, narrow, transverse costellæ. The superior half of the area is the more depressed, and has sometimes a minute line of tubercles bordering upon the mesial furrow, and parallel to the median carina. The other portion of the valve has about fourteen rows of slightly elevated costæ decked with distinct, elevated, conical, pointed, and unequal tubercles; the first-formed six or seven rows are regular and concentric; those which succeed are more or less irregular both in their direction and in the size and arrangement of the tubercles; the anteal portions of the rows become broken and confused; the tubercles adjacent to the border are the smaller, and are often compressed laterally. The posteal extremities of the rows are separated from the marginal carina by a smooth and slightly-depressed space which widens downwards, and terminates at the lower border in a well-marked undulation of the border; the number of tubercles in the rows varies from eight to ten. The figure in Mr. Damon's 'Supplement' is an extreme example of that general irregularity in the arrangement of the tubercles which Seebach has adopted as a name for the species. The large imperfect specimen which we have figured (Plate V, fig. 2) exhibits the greatest irregularity observed; the small specimen (Plate VII, fig. 6) is an example of the forms in which the irregularity in the rows of tubercles is so slight as to be quite inconspicuous. The smooth ante-carinal space is always present but varies in its size.

Stratigraphical positions and localities. In the Oxford Clay of Weymouth it is moderately abundant. It has occurred, also, less frequently in the Kimmeridge Clay of Wootton Basset, Wilts.

TRIGONIA WOODWARDI, *Lycett*, sp. nov.

Shell large, ovately trigonal, depressed; umbones elevated, pointed, recurved, placed at about the anterior third of the valves; anterior side produced, its border curved elliptically with the lower border, which is lengthened and nearly straight posteally; the superior border is nearly straight, it slopes downwards obliquely, and forms only a slight angle with the posteal border of the area, the lower extremity of which is pointed. The escutcheon is narrow, lengthened, and concave; its superior border is raised. The area is narrow, its superior or umbonal portion forms a considerable angle with the costated



surface of the shell; it has three small tuberculated carinæ, which become evanescent posteally, and transverse irregular plications, which form near to the umbo, acute, regular, small costellæ. The other portion of the shell has the rows of costæ small, widely separated, nearly straight or oblique, sometimes somewhat undulated; the tubercles in the rows are numerous, rounded, closely placed, and unequal; they become smaller, crowded in the rows, cord-like and attenuated near to the anteal and lower borders; the few last-formed rows are smaller, their pallial portions curve much forwards; about twelve distinct rounded tubercles occur in each row. The lines of growth are strongly defined over the whole of the shell.

Length $4\frac{1}{4}$ inches, height $3\frac{1}{4}$ inches, diameter through the united valves $1\frac{3}{4}$ inch.

It is distinguished from *T. clavellata* and also from *T. perlata* by its more depressed figure, by the more produced anterior side, by the straightness of the lower border, by the unusually narrow area, by the straight, equal, or slightly undulated rows of costæ, which also have the tubercles smaller, more numerous, and more equal in size, so that the surface of that portion is remarkably wide, flattened, and uniform in its aspect. The costæ approach the small marginal carina nearly at right angles to it.

Compared with *T. Pellati,* it is less lengthened, and its rows of costæ are more numerous and less curved.

T. Woodwardi has occurred rarely in the Kimmeridge Clay of Dorsetshire and of Wootton Basset, Wilts. Two specimens from the latter locality are in the British Museum, numbered 66, 126, but their state of preservation is only indifferent. Fine examples from the same formation at Villersville, near to Honfleur, are also in the Museum collection.

TRIGONIA PELLATI, *Mun. Chal.* Plate VII, figs. 1, 2, *a, b;* Pl, XI, fig. 1.

TRIGONIA PELLATI, *Munier Chalmas.* Bull. Soc. Linn. de Normandie, 1865, tom. ix, pl. iv, fig. 4.
— — *Hebert.* Bull. de la Soc. Geol. de France, 2nd ser., 1865, tom. xxiii, p. 216.
— — *De Loriol* et *Pellat.* Monogr. Paléont. et Geol. de l'Etage Portlandien des envir. de Boulogne-sur-Mer, 1866, tab. viii, fig. 4.

Shell oblong, inordinately elongated, wide upon the superior, depressed or wedge-shaped towards the inferior border; umbones near to the anteal extremity of the valves, obtuse, much incurved and depressed, anterior side very short, truncated, with considerable convexity, its border curved elliptically with the lower border which is very long and straight; the superior border is also very long, its border is slightly concave, its posteal extremity forms an obtuse angle with the posteal border of the area, and terminates with its extremity somewhat pointed and much produced. The area has great length, and slightly convex, with a well-marked mesial furrow bordering a line of minute tubercles and bounded by two delicately traced and minutely tuberculated carinæ, which posteally become transverse, irregular plications. The escutcheon is flattened, of moderate breadth, and unusually lengthened; the ligamental fossa also partakes of the general lengthening of the superior border; the area has transverse, irregular plications, which become large posteally. The sides of the valves are very narrow, and have a few rows of very distantly arranged, oblique, tuberculated costæ; three or four of the tubercles near to the carina are large, rounded, pointed, and much elevated; those upon the lower half of the valve become rapidly smaller and more depressed; their rows curve anteally almost in the direction of the lower border. The first formed five or six costæ are more straight and oblique; each has its upper terminal tubercle unusually large and elevated.

The height is equal to two fifths of the length, and is one fifth greater than the diameter across the superior border.

This is the most elongated of the *clavellatæ;* the great length and horizontal direction of the superior border readily separates it from *T. Voltzii* and from *T. incurva;* others of the section are more remotely allied.

Stratigraphical position and localities. Both the specimens figured upon Plate VII were obtained by Mr. Mansell in the Kimmeridge Clay of Kimmeridge Bay, Dorset. The broken specimen has the area somewhat compressed or spread upwards; it has also occurred in the same formation near to Ely, and in the vicinity of Westbury, Wilts. France, Boulogne-sur-Mer.

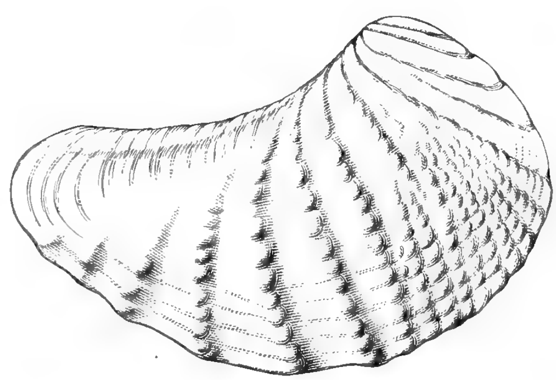
TRIGONIA INCURVA, *Benett.* Plate IX, figs. 2, 3, 4, 5, 6.

TRIGONIA INCURVA, *Etherelda Benett.* Catalogue of Organic Remains of Wilts., 1831, pl. xviii, fig. 2.
— — *Sowerby.* In Fitton. Geol. Trans., 2nd ser., 4, 1836, tab. xxii, fig. 14 (internal mould).
— — *Bronn.* Index Paleontologie, 1848, p. 1280.
— — *D'Orbigny.* Prodrome de Paléont., 2, p. 60.
— — *Morris.* Catalogue, 1854, p. 228.
— — *Cotteau.* Etud. sur les Moll. Foss. de la Yonne, fasc. 1, Prodrome, 1853-7, p. 76.
— — *Oppel.* Juraformation, p. 721, 722, No. 145.
— — *Damon.* Geol. of Weymouth Suppl., 1860, pl. vii, fig. 1 (internal mould).
— HÉBERTI, *Munier Chalmas.* Bull. de la Soc. Linn. de Normandie, vol. ix, 1863—4, pl. iv, fig. 5.
— INCURVA, *Hébert.* Note sur la Terr. Jurassique du Boulonnais; Bull. Soc. Geol. Fr., 2nd ser., t. xxiii, p. 214, 1865, p. 220.
— — *Pellat.* Bull. Soc. Geol. de Fr., 3rd ser., 1866, t. xxiii, p. 226.
— — *P. de Loriol* et *E. Pellat.* Monogr. Paleont. et Geol. de l'Etage Portlandien des environs de Boulogne-sur-Mer, 1866, pl. viii, fig. 3.

Shell elongated, curved at the two extremities or sublunate; anterior side convex; posterior side lengthened, curved, depressed; umbones large, obtuse, elevated, somewhat recurved, and placed near to the anterior border, which is curved elliptically with the lower border. Escutcheon concave, lengthened; its superior border is somewhat raised.

Area narrow, distinctly bipartite with three delicate tuberculated carinæ and irregular transverse plications; there are also some irregular varices near to the posteal portions of the median and inner carinæ; those of the latter extend a little upon the escutcheon, The ornamentation upon the other portion of the valve varies much in accordance with the development in the growth of the shell. A specimen two and a half inches in length has twelve rows of tuberculated varices, which rise nearly perpendicularly to the carina; anteally they curve much forwards, and are continued in an attenuated condition almost to the anterior border; the superior portions of the varices have the tubercles large, rounded, but somewhat unequal and irregular; anteally they rapidly become small and cord-like; the lines of growth are strongly marked over the whole of the shell. A specimen three and a half inches in length figured by Messieurs de Loriol and Pellat has the costæ more broken near to the anterior border; they lose all distinctness and form an irregular assemblage of small tubercles. The original figure given by Miss Benett represents a condition of growth still more advanced, the anteal gibbosity has much increased, and its border is almost destitute of tubercles; the plications of growth have also become more conspicuous. A specimen greatly larger and still more inflated from Niangle, Boulogne, is No. 36913 in the British Museum; the anteal folds of growth have here replaced all ornamentation.

In the Portland Oolite at Swindon and at the Isle of Portland internal moulds are common, but it rarely happens that any considerable portion of the test is adherent; the characters of the surface may, however, be ascertained upon the adherent portions. The examples figured 5 and 6, Plate IX, represent the more frequent condition of such specimens. Figs. 4 and 5, upon the same plate, may be regarded as a distinct variety from the Kimmeridge Clay, with the anteal portions of the varices curved and unbroken. No. 2 has suffered somewhat from vertical pressure, its umbo is more than usually produced and pointed.



In the Portland Oolite of Boulogne it has occurred in a better condition of preservation and of much larger dimensions; the original of our wood engraving is from the latter locality, and represents an example of adult growth, but not of the largest dimensions, the size is reduced one half; the small anteal supplementary varices are unusually numerous and strongly defined.

TRIGONIA SPINULOSA, *Young* and *Bird*. Plate III, figs. 4, 5, 6.

TRIGONIA SPINULOSA, *Young* and *Bird*. Geol. Survey, 1828, p. 225.
— STRIATA. Phil. Geol. York., 1829, 1, pl. xi, fig. 38 (not *T. striata*, Miller).
— TUBERCULATA, *Agassiz*. Trigonies, 1842, p. 20, t. ii, fig. 17, et tab. ix, figs. 6—8.
— — *Oppel*. Juraformation, 1856, p. 407.
— STRIATA, *D'Orbigny*. Prodrome, vol. i, 1850, p. 278, No. 312 (supposed by him to be young examples of *T. striata*).

Shell ovately trigonal, moderately convex, umbones not prominent, much incurved, obtuse but only slightly recurved, antero-mesial; anterior side short, curved elliptically, with the lower border, posterior side, produced and compressed. Area moderately large, transversely irregularly plicated, divided by a delicately tuberculated carina bordering a furrow; the two bounding carinæ are large, with prominent rounded tubercles; the superior half of the area is more depressed than the other. The escutcheon is very large and depressed, but its upper border is moderately raised throughout its length. The other portion of the surface has about fifteen rows of large, raised, tuberculated costæ, of which the first formed seven are simply concentric; all the rows are small, ridge-like, and only subtuberculated anteally; the tubercles in the rows are distinct, but slightly compressed laterally, and increase in size posteally; the general direction of the rows is nearly horizontal anteally, or slightly directed downwards; posteally they curve upwards rather suddenly and are united to the carina at a considerable angle; they therefore most frequently form a kind of slight undulation posteally at the part where the tubercles are the largest.

The three tuberculated carinæ and median groove are usually well defined, but occasionally, as in the second specimen figured by Agassiz, there is no median row of tubercles bordering the groove.

No figure of this species is given in the work of Messrs. Young and Bird, but their description is sufficiently precise and comprehensive to leave no doubt of the species intended. The figure given in the 'Geology of Yorkshire' is very characteristic and must have been named *striata* from mistaken recollection, as it is impossible that it could have resulted from comparing the species of Miller with that from Blue Wyke; the first figure of *T. tuberculata*, Ag. ('Trig.,' t. ii, fig. 17), has been drawn from a specimen distorted by compression. Specimens differ considerably in the proportions of their length and height.

D'Orbigny ('Prodrome,' i, p. 278) has fallen into the same mistake as Phillips in regarding *T. tuberculata* as the young of *T. striata;* the very coarsely drawn and indifferent figures in the 'Mineral Conchology' of *T. striata* will perhaps account for these errors. *T. spinulosa* is more nearly allied to *T. formosa*, Lyc., but comparison will show that the former is more convex and much more produced posteally; the figure of the rows of costæ is different, the greater size of the posteal tubercles and their separation in the rows are also distinctive. The escutcheon in *T. spinulosa* is larger, the three tuberculated carinæ upon the area also distinguishes that portion of the shell.

Geological positions and localities. T. spinulosa occurs not uncommonly in the shelly bed of the Dogger at Blue Wyke, also in the Ironstone of Glaizedale, associated with *T. denticulata*, Ag., and *T. V. costata*, Lyc. Specimens more or less imperfect also occur rarely in the Supra-Liassic Sands at Frocester Hill, Gloucestershire. The localities mentioned by Agassiz for his *T. tuberculata* do not define its geological position clearly in Southern Germany, but, from its association with *T. costellata* and *T. pulchella*, we may infer that its position nearly agrees with that at Blue Wyke.

TRIGONIA CORALLINA, *D'Orb.* Plate III, figs. 7, 8, 9, 11; Plate VIII, fig. 3.

TRIGONIA CORALLINA, *D'Orbigny.* Prodrome de Paléont., vol. ii, 14th et., 1850, p. 16, No. 260.
— CLAVELLATA, var. JURENSIS, *Grewingk.* Gest. u. Geolog. Livonia und Courland, Dorpat, 1864.

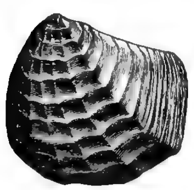
" *Espèce voisine pour les petits tubercles rapprochés du côtes du T. concentrica, mais avec les côtes bien plus serrèes, moins arquées, l'area anale striee en travers.*"—*D'Orbigny.*

Shell ovately trigonal, convex; umbones antero-mesial, not much elevated, incurved, and somewhat obtuse, anterior side short and curved elliptically with the lower border, posterior slope lengthened, its outline rather convex, its junction with the area is obtusely angulated or somewhat rounded. The escutcheon is lengthened and depressed, its upper border raised; the area of moderate breadth, flattened, with three small imperfectly developed tuberculated carinæ; it has irregular rugose plications posteally, which, near to the umbones, become transverse narrow costellæ. The other portion of the surface has numerous rows of narrow, ridged, curved, costæ; their tubercles are small, irregular, and unequal, closely arranged, becoming attenuated and imperfectly developed towards the anteal extremities of the rows, which, at that portion of the valve, have but little regularity and are but slightly curved. The young examples (Plate III, figs. 8, 9, 11) are from the Coralline Oolite of Wiltshire, and were collected by the officers of the National Geological Survey. The larger examples (Plate III, fig. 7, and Plate VIII, fig. 5) are from the Coralline Oolite at Pickering. As a species it is distinguished from *T. concentrica*, Ag. ('Trigon.,' p. 20, pl. 6, fig. 10), by its shorter figure, its ridge-like sub-serrated costæ, which have less curvature; the area also with its anteal ridge-like costellæ and rugose middle and posteal portions is equally distinctive.

Stratigraphical position and localities. It occurs very sparingly in the Coralline Oolite of Pickering associated with *T. perlata*, Ag., from which it is distinguished by its small dimensions, by the much greater number of the rows of costæ, by their more horizontal direction and more close arrangement. The tubercles are also smaller and much more numerous. The three smaller immature examples are from the Coralline Oolite of Wiltshire. A specimen larger than these latter, but also of immature growth, was forwarded by Professor Grewingk, of Dorpat, to Mr. Leckenby, together with a series of Livonian Oxfordian testacea. The Trigonia was named *T. clavellata,* var. *Jurensis,* obtained in the vicinity of Popilacny, Province of Kowno, associated with a young example of *T. monilifera,* Ag. France, Tonnere (Yonne).

Trigonia parcinoda, *Lycett,* sp. nov.

Shell small, moderately convex, ovately subquadrate, the length slightly exceeding the height; umbones small, antero-mesial; area large, flattened, or slightly concave, traversed transversely by large regular costellæ; there is no mesial furrow; the marginal carina is small but distinct; its sub-umbonal portion has several minute tubercles, there is no distinct inner carina and the escutcheon is small and inconspicuous; the posteal border of the area descends abruptly from the extremity of the escutcheon. The other portion of the surface has about ten rows of small horizontal and gently curved costæ, each of which is crossed perpendicularly by about six small regular varices; these are of moderate size and are distantly arranged about the middle of the valve, becoming small and indistinct towards the anteal border; the costellæ upon the area form continuations of the costæ, but near to the posterior border the former become smaller and more numerous.



Magnified twice.

Height, 4 lines; length, 5 lines; the surface of the area is equal to two fifths of the entire valve.

A pretty little sub-quadrate species remarkable for the few small, widely separated perpendicular varices upon the costated portion of the valves; it does not possess any striking affinities to other of the *Clavellatæ,* and is known only by the sole specimen here figured, which is now in the British Museum, numbered 67,272.

Stratigraphical position and locality. It was collected many years since by Mr. Etheridge in the Inferior Oolite of the Halfway House Quarry near Yeovil.

Trigonia impressa, *Sow.* Plate VII, figs. 4, 5.

Trigonia impressa, *Sowerby.* Jour. Zool., vol. 3, tab. xi.
— — *Prevost.* Ann. Scient. Nat., vol. 4, tab. xviii, figs. 22, 23.
— — *Morris* and *Lycett.* Pal. Soc., 1853, p. 61, tab. v, fig. 14.
— — *Morris.* Catal., 1854, p. 228.
— — *Lycett.* Cotteswold Hills Handbook, 1857, pl. vii, fig. 5.

Shell ovately oblong, depressed, umbones antero-mesial, small, pointed and slightly recurved, anterior and posterior borders curved elliptically; posterior border lengthened, its superior portion straight, and slightly sloping; escutcheon lengthened, narrow, slightly excavated, its outer border raised; area moderately wide, flattened, transversely irregularly striated, but usually delicately impressed, with a slight median furrow, and bounded by two small, minutely tuberculated carinæ. The other portion of the shell has a numerous series (14 posteally) of regular curved and nearly horizontal small tuberculated costæ, which are very delicate and minutely knotted anteally, directed from the border slightly downwards to the middle of the valve; posteally the costæ are somewhat larger, and more distinctly tuberculated; the tubercles enlarge towards the carina, which they meet at a right angle in the few last formed costæ; all the tubercles are depressed, and very few are separated in the rows; anteally there are one or two supplementary or intercalated costæ, the posteal terminations of which are about the middle of the valve.

The aspect of this little species is peculiar, and its several features, although minute, are very persistent; few specimens exceed thirteen lines in length, and the greater number do not exceed ten lines; they were very gregarious, the disunited valves are profusely scattered in a thin layer over the slabs of Stonesfield Slate at numerous localities in Oxfordshire and Gloucestershire; the shell substance is rarely preserved, but the impressions in the soft sandy shale exhibit perfectly all the more delicate features of the species. It appears to be entirely absent in the shelly beds of the Great Oolite.

Its figure is more lengthened than *T. Moretoni*, its costa are more numerous, the area has never the coarse rugose aspect of that species, and the entire ornamentation is much more minute and delicate; other Trigoniæ are more remotely allied. A large example has the height $10\frac{1}{2}$ lines, length 14 lines.

TRIGONIA MORETONI, *Mor.* and *Lyc.* Plate II, figs. 4, 5, 7, 8; Plate IV, fig. 6.

TRIGONIA MORETONI, *Mor.* and *Lyc.* Gr. Ool. Monogr. Pal. Soc., 1853, p. 57, tab. v, figs. 19, 19 *a*.
— — *Morris.* Catal., 1854, p. 228.
— — *Rigaux* et *Sauvage.* Descr. de Quelq. Esp. Nouv. de l'Etage Bathonien, extr. du vol. iii, Mem. de la Soc. Académ. de Boulogne, 1867, p. 19.
— — *Sharp.* Oolites of Northamptonshire, p. 383; Quart. Jour. Geol. Soc., August, 1870.
— CLAPENSIS, *O. Terquem et E. Jourdy.* Monog. de l'Etage Bathonien dans le Depart. de la Mozelle, Mem. Soc. Geol. de France, 2 ser., 1869, tom. 9, Pl. II, figs. 1, 2, 3, 4.

Shell ovately trigonal, rather depressed, umbones antero-mesial, elevated and only slightly recurved; anterior border moderately produced and curved elliptically with the lower border; hinge border lengthened and nearly straight, sloping obliquely, and forming an obtuse angle with the posteal extremity of the area; escutcheon depressed, moderately lengthened, its upper border raised; area narrow, flattened, transversely plicated; the plications are usually large and irregular, there is a faintly marked, mesial oblique furrow, and a minutely tuberculated median carina which disappears towards the posteal extremity, the marginal and inner carinæ are well marked; the inner carina has elevated squamous tubercles. The marginal carina is at first a narrow elevated plain ridge, which soon changes to transversely compressed elevated tubercles, from which originate the transverse plications upon the area; the carina ultimately degenerates into these plications. The other portion of the valve has about fourteen or fifteen rows of clavellated but always elevated and sometimes subtuberculated costæ; the first three of these are plain, acute, and concentric, they are interrupted by the marginal carina, but pass unchanged in character across the area; the succeeding costæ are subtuberculated, and pass obliquely downwards with little curvature, both anteally and posteally, the posteal portions are much the larger and more distinctly clavellated, their junction with the anteal portions form so many undulations or angles about the middle of the valve, and the anteal series has one, two, or even more rows than the other series, so that the rows are sometimes rather crowded anteally; all are, however, tuberculated or subtuberculated.

The Trigonia which most nearly approximates to our species is *T. arata,* one of the *undulatæ* from the upper zone of the Great Oolite, to which the reader is referred. *T. Moretoni* varies much in its length, as will be seen from our illustrations; occasionally it exhibits a crowding of the narrow anteal portions of the costæ, which imparts an apparent confusion to the ornamentation of the shell.

Our figures exhibit much of the variability which occurs both in the proportions of the general figure and the ornamentation; not uncommonly the costæ are nearly plain, or are only very slightly knotted. Neither of these several variable features appears to be special to any locality or stratum.

Stratigraphical positions and localities. *T. Moretoni* appears to range throughout the whole of the Great Oolite formation, it occurs commonly in all the shelly beds of the Minchinhampton district, and attains to its full dimensions, but the far greater number are immature forms from ten to fifteen lines in length. Mr. Whiteaves has obtained it in Oxfordshire, Mr. S. Sharp in Northamptonshire, the officers of the Geological Survey in the South Lincolnshire district, and in North Lincolnshire the upper zone of the Great Oolite has produced a profusion of beautifully preserved specimens, which are the originals of our figures; for these I am indebted to the liberality of the Rev. J. E. Cross, of Appleby, who has assiduously developed the fossil fauna of a district rich in the testacea of the Lower Oolites.

France, Bas-Boulonnais. See examples in the British Museum.

TRIGONIA COMPLANATA, *Lycett*, sp. nov. Plate VII, fig. 3.

Shell ovately oblong, depressed; umbones small, pointed, anterior; anterior side very short, curved elliptically with the lower border; posteal extremity produced and pointed; area very large, flattened, its surface is equal to two fifths of the entire valve; hinge-border lengthened, and nearly horizontal; bounding carinæ small, impressed by irregular, small, transverse plications, which also extend across the area; there is also a slight mesial furrow, but the two portions of the area are upon the same plane. Escutcheon large and flattened, its superior border is raised; the other portion of the surface has about thirteen rows of small, tuberculated, oblique, and nearly straight costæ, each of which has about seven small depressed tubercles.

The length is one third greater than the height; it is also nearly equal to three times the diameter through the united valves.

The lines of growth are strongly marked, they modify both the figures of the tubercles and the surface of the area.

This clavellated species is remarkable for the unusual depression of the valves, for the very short, wedge-like, anterior side, for the lengthened figure posteally, for the unusually large size of the flattened area, and for the small depressed tubercles upon the straight rows of costæ which approach the carina at a right angle. These several characteristic features also separate it from *T. clavellata*, *T. perlata*, *T. Voltzii*, and *T. corallina*; other examples of the section are more remotely allied.

Stratigraphical positions and localities. A few specimens, for the most part deprived of the test, have been obtained in the Kelloway Rock of Scarborough. The British Museum has finely preserved examples from the Oxford Clay of Normandy.

TRIGONIA RAMSAYI, *Wright*. Plate VI, fig. 6.

TRIGONIA RAMSAYI, *Wright*. On Upper Lias Sands, Quart. Jour. Geol. Soc., 1856, vol. xii, p. 323.
— — *Lycett*. Cotteswold Hills Handbook, 1857, p. 26, pl. i, fig. 8.

Shell ovately oblong, convex, short anteally, lengthened, and somewhat attenuated posteally; umbones small, obtuse, erect, placed nearly upon the line of the anterior border, so that the superior border represents almost the entire length of the shell; the lengthened lower border has only a slight curvature, and the superior border is slightly concave. The area is narrow, and slightly convex; it is bounded by two very small, but distinct and minutely tuberculated carinæ, and traversed longitudinally by an inconspicuous mesial furrow; the transverse plications of the area are small and closely arranged, excepting upon its posteal third, where they become large, rugose, irregular, forming some varices at the inner carina. The escutcheon is depressed, of moderate breadth and great length; its upper or inner border is raised.

The other portion of the shell is occupied by a series of numerous and closely arranged costæ, twenty-two in number; they are nearly of equal size, rounded, more or less knobbed or transversely plicated, and are only slightly attenuated near to the marginal carina; their general direction is oblique, or at right angles to the marginal carina, but the seven last formed or posteal costæ are nearly perpendicular; for the most part they are somewhat undulated, or even wrinkled, and there is one supplementary or intercalated costa upon the anterior side. The lines of growth are distinct over the greater portion of the valve. The small tubercles upon the costæ are more distinctly traced upon the few umbonal or more concentric ones, upon the succeeding costæ they are very unequal and frequently indistinct.

The length of the marginal carina is equal to nearly twice the height and to three times the diameter through both the valves; the general aspect is sufficiently distinctive, and does not approximate very nearly to any other species of the Lower Oolites. *T. signata* is more produced anteally and more truncated posteally; the upper portions of its costæ are more attenuated, they also approach the carina at a much greater angle.

Geological position and locality. This rare *Trigonia* has only been obtained in the Ammonite-bed of the Supra-Liassic Sands[1] at Frocester Hill. The specimen in the National Museum, Jermyn Street, and another in the cabinet of Dr. Wright at Cheltenham, are the only examples with which I am acquainted.

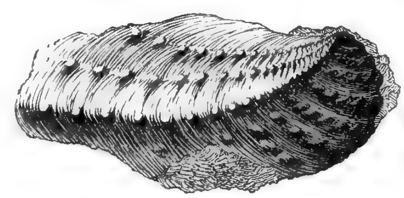
TRIGONIA MURICATA, *Goldf.* Plate IX, fig. 1.

LYRODON MURICATUM, *Goldfuss.* Petref. German., 1836, tab. 137, fig. 1, p. 201.
TRIGONIA MURICATA, *Roemer.* Nordd. Ool. Nachtrag., 1839, p. 75.
— — *Agassiz.* Trigonies, 1840, pp. 7 and 51.
— — *D'Orbigny.* Prodrome de Paléont., 1850, vol. ii, p. 51, No. 120.
— — *Oppel.* Juraformation, 1857, p. 719, No. 89.

[1] I prefer provisionally to employ this term to designate the sands or marly sandstones which separate the Inferior Oolite from the Upper Lias (*Am. communis* Zone) over such distant areas in England, France, and Germany. After collecting for many years and comparing the faunas of these several zones, the conclusion has long been present to my mind that the fossils of these sands, viewed as a whole, are clearly separable from those of the beds both anterior and posterior to them in chronological order; the boundary lines of this stage, both lower and upper, are neither abrupt lithologically nor palæontologically, each has its species of testacea whose limits vertically may extend to one or both sides of our convenient, but somewhat arbitrary, divisional lines; nevertheless its fauna, viewed as a whole, is well marked and characteristic of the stage.

Several examples of this species have been placed at my disposal from the Portland strata of Wilts and Dorset, collected by the officers of the National Geological Survey, and also by Mr. Cunnington; neither of these, unfortunately, are altogether satisfactory. The Survey specimens are deprived of their tests, as that of Plate IX, fig. 1, which does not exhibit the characters of the area. The specimens of Mr. Cunnington consist of portions only with the test preserved; fortunately the latter gentleman has also made a good gutta-percha pressing, which exhibits the characters of the area as in the adjoining woodcut; together they afford sufficient materials to characterise the species.

The present figure exhibits the entire area and escutcheon, together with the posteal portions of the tuberculated costæ. *T. muricata* has a lengthened oblong figure, the length measuring 48 lines, the height 28 lines; the anterior side is very short; the posterior side is much lengthened and attenuated; the anterior and lower borders are curved elliptically; the convexity of the valves is only inconsiderable; the umbones have but little elevation, but are distinctly recurved; the area is large and flattened, or is slightly convex posteally; it has three tuberculated carinæ, of which the tubercles upon the marginal carina are regular, rounded, and rather distantly arranged; the transverse lineations upon the area are delicate and obscure, excepting the sub-umbonal portion, where they become regular, ridge-like, and closely arranged, but are also small and delicate; the lateral costæ have but little elevation; they are very numerous (about twenty-four), obliquely curved, and are nearly of equal size; their anteal portions curve nearly in the direction of the plications of growth, and become evanescent near to the pallial border; their tubercles are small, numerous, regular, and slightly compressed laterally; the larger tubercles occupy the middle and posteal portions of the rows; they are everywhere well separated.

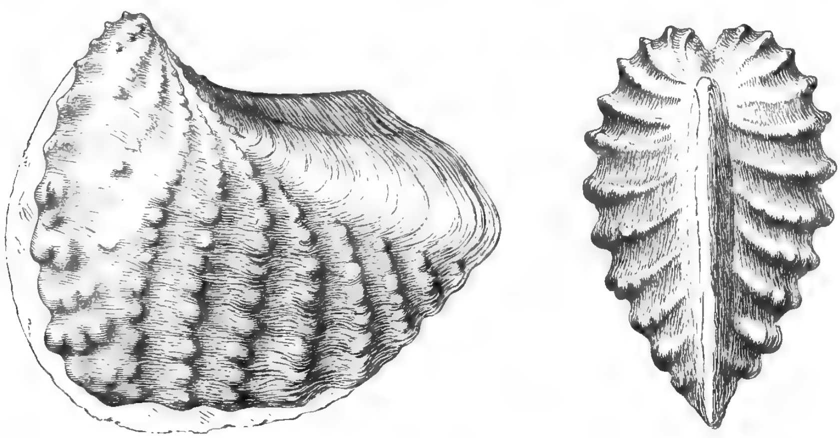


The more prominent features, as exemplified in the depressed, lengthened, oblong figure, the very numerous rows of curved costæ with their inconspicuous tubercles, together with the delicate features of the area, separate it readily from other of the British *Clavellatæ*. In Portugal it also occurs in the Upper Jurassic Limestone at Torres Vedras.

PLATE I.

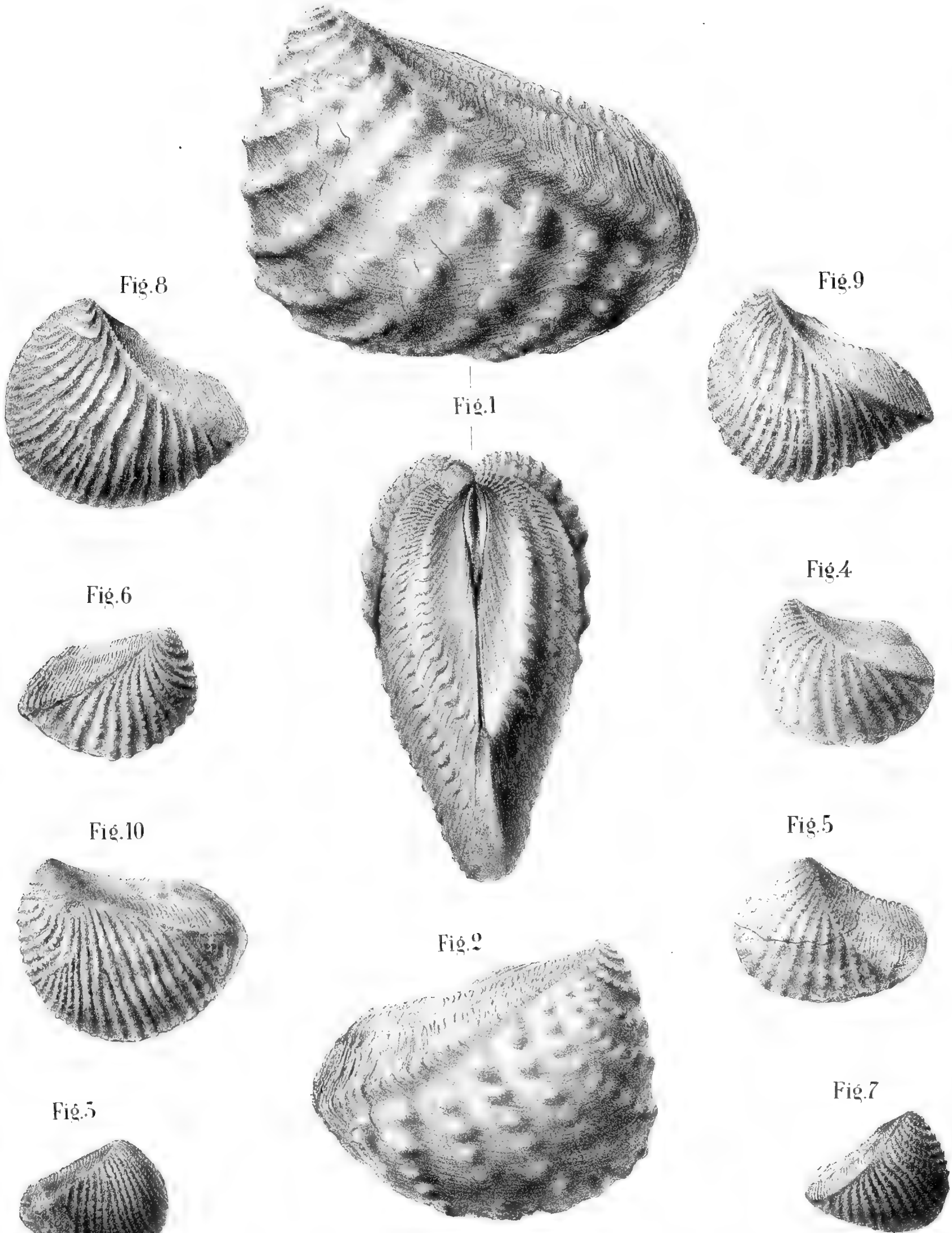
Fig.		
1, *a*, *b*.	*Trigonia clavellata*, Sow.	Specimen of adult growth from the Lower Calcareous Grit of Weymouth. (Page 18.)
2.	,, ,,	A smaller example from the same locality.
3.	,, *Bathonica*, Lyc.	Great Oolite Box, near Bath. (Page 17.)
4, 5, 6.	,, *recticosta*, Lyc.	Inferior Oolite, Cloughton, near Scarborough. (Page 16.)
7.	,, *gemmata*, Lyc.	Inferior Oolite, Cheltenham. (Page 15.)
8 and 10.	,, *duplicata*, Sow.	Inferior Oolite, near Stroud. (Page 14.)
9.	,, ,,	Inferior Oolite, near Yeovil. (Page 14.)

The small dimensions of British examples of the *Scaphoideæ* (figs. 3 to 9 inclusive) have induced me to subjoin a wood engraving of *Trigonia navis*, Lam., which is the typical species of that section, and which exemplifies its peculiar features much more prominently than is seen in the British species. Our



specimen, which is of adult growth, but not of the largest dimensions, is from the thick deposit of dark clays at Gundershofen (Haut Rhin), which Professor Quenstedt has shown to belong to the lowest zone of the Inferior Oolite in Southern Germany. Other localities for this species are Metz (Mozelle), Günsberg (Solothurn). For numerous figures, see Agassiz, 'Trigonies,' tab. i; also, Quenstedt, 'Der Jura,' tab. xliv, fig. 13.

Pl.I



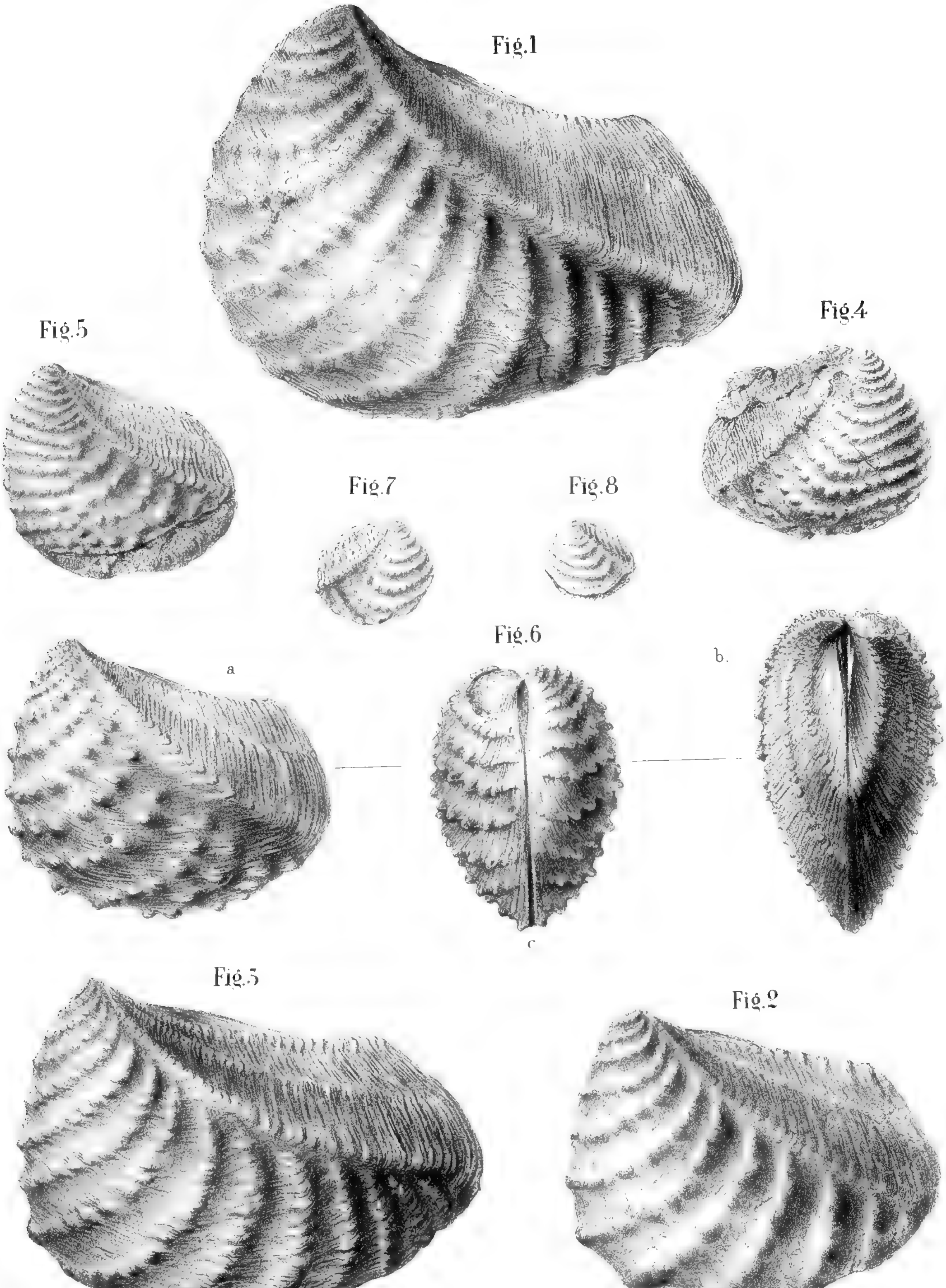
P. Lackerbauer ad nat. in lap. del.

Imp. Becquet à Paris.

PLATE II.

Fig.			
1.	*Trigonia signata*, Ag.		Inferior Oolite, Rodborough Hill, near Stroud. (Page 29.)
2.	,,	,,	A small specimen with large costæ. Inferior Oolite, Cold Comfort, near Cheltenham.
3.	,,	,,	Inferior Oolite (grey limestone), Cloughton, near Scarborough.
4, 5.	,,	*Moretoni*, Mor. and Lyc.	Cornbrash, Appleby, Lincolnshire. (Page 47.)
7.	,,	,,	Young example from the same locality.
8.	,,	,,	Young example, Great Oolite, Bisley Common, near Stroud.
6, *a*, *b*, *c*.		*Juddiana*, Lyc.	Adult specimen from the Kimmeridge Clay of Market Rasen, Lincolnshire. (Page 25.)

Pl.II



P. Lackerbauer ad nat in lap. del

Imp Becquet à Paris.

PLATE III.

FIG.

1. *Trigonia perlata,* Ag. Coral Rag, Pickering; the rows of costæ are fewer than is usual. (Page 22.)

2. ,, ,, The same formation and locality; the largest specimen known.

3. ,, ,, Young specimen from the same locality.

4, 5 *a,* 5 *b,* 6. *spinulosa,* Y. and B. Inferior Oolite (Dogger), Blue Wyke, Yorkshire. (Page 44.)

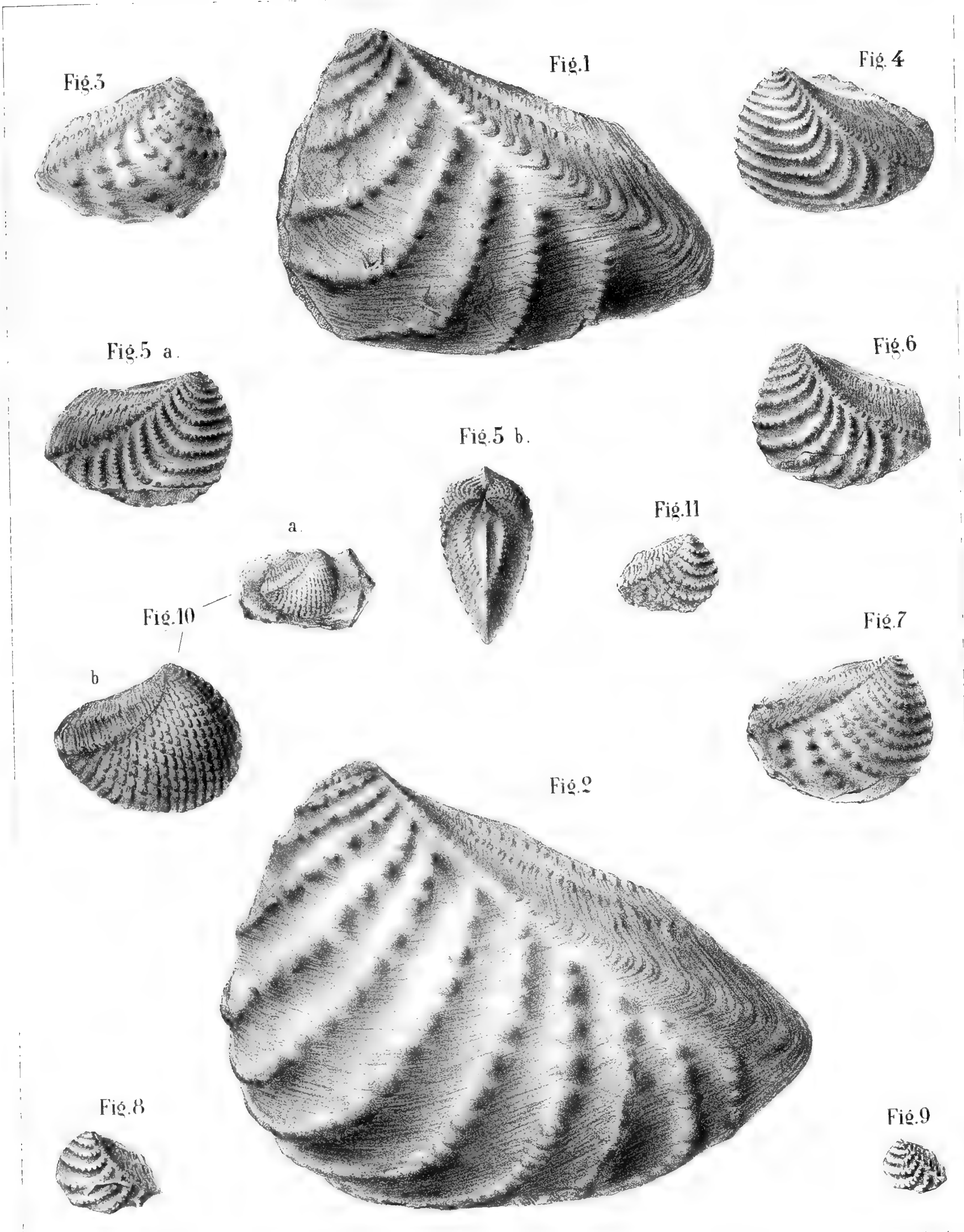
7. ,, *corallina,* D'Orb. Coralline Oolite, Pickering. (Page 45.)

8, 9, 11. ,, Young specimens, Coral Rag, Steeple Ashton, Wilts.

10, *a.* ,, *Griesbachi,* Lyc. Cornbrash, Rushden, Northamptonshire; natural size. (Page 34.)

10, *b.* ,, ,, The same specimen magnified.

Pl.III



P. Lackerbauer ad nat. in lap. del.

Imp. Becquet à Paris.

PLATE IV.

Fig.			
1.	*Trigonia Scarburgensis*, Lyc.		Left valve, Cornbrash, Scarborough. (Page 31.)
2, 3.	,,	,,	Opposite valves of the same specimen.
4.	,,	,,	Young example.
5.	,,	*Juddiana*, Lyc.	Kimmeridge Clay, Market Rasen; example with few costæ and large tubercles. (Page 25.)
7.	,,	,,	Example with more numerous costæ and smaller tubercles.
6.	,,	*Moretoni*, Mor. and Lyc.	Cornbrash, Appleby, Lincolnshire; adult specimen. (Page 47.)
8.	,,	*Bronnii*, Ag.	A variety from the Lower Calcareous Grit of Weymouth. (Page 23.)

Fig.1

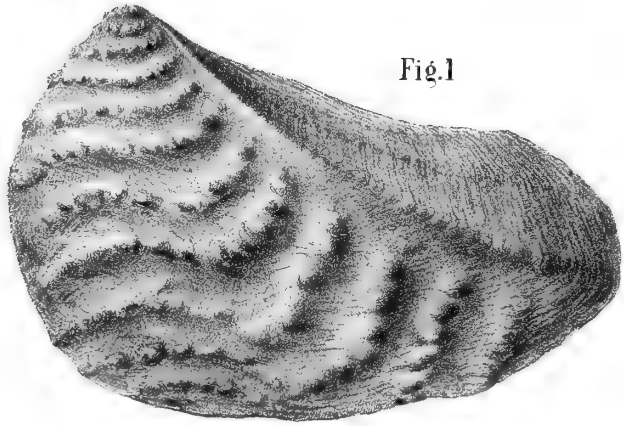


Fig.5

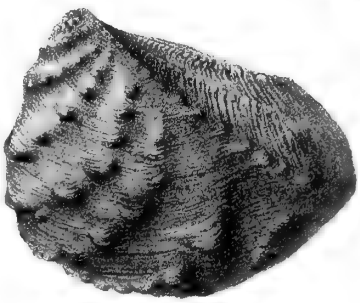


Fig.4

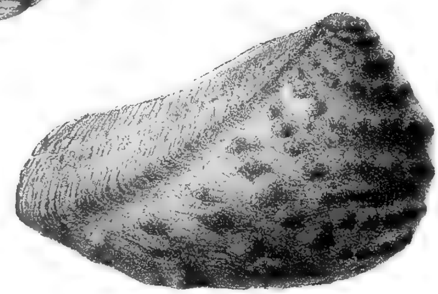


Fig.6

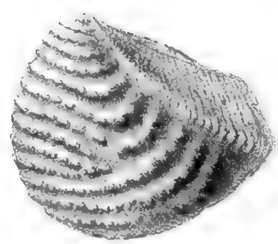


Fig.2

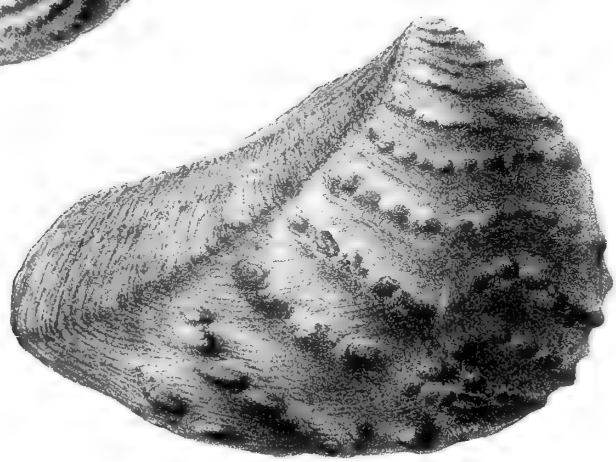


Fig.7

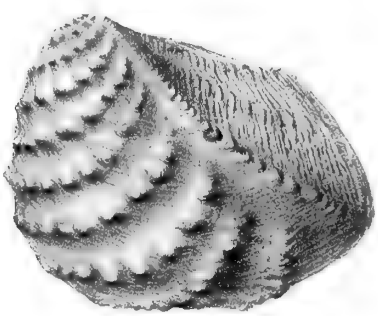


Fig.3

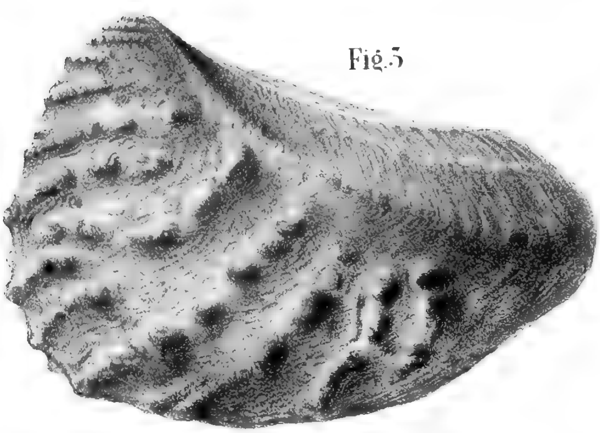
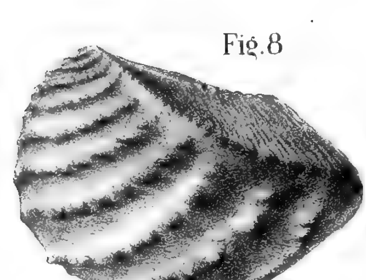


Fig.8



P. Lackerbauer ad nat. in lap. del.

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PLATE V.

FIG.

1, *a*, *b*. *Trigonia irregularis*, Seebach. Specimen of adult growth, Oxford Clay, Weymouth. (Page 39.)

2. ,, ,, Imperfect specimen with the rows of costæ more than usually numerous and irregular.

4. ,, *formosa*, Lyc. Young example, Inferior Oolite, Cold Comfort, near Cheltenham. (Page 35.)

5. ,, ,, Young example, Rodborough Hill, near Stroud.

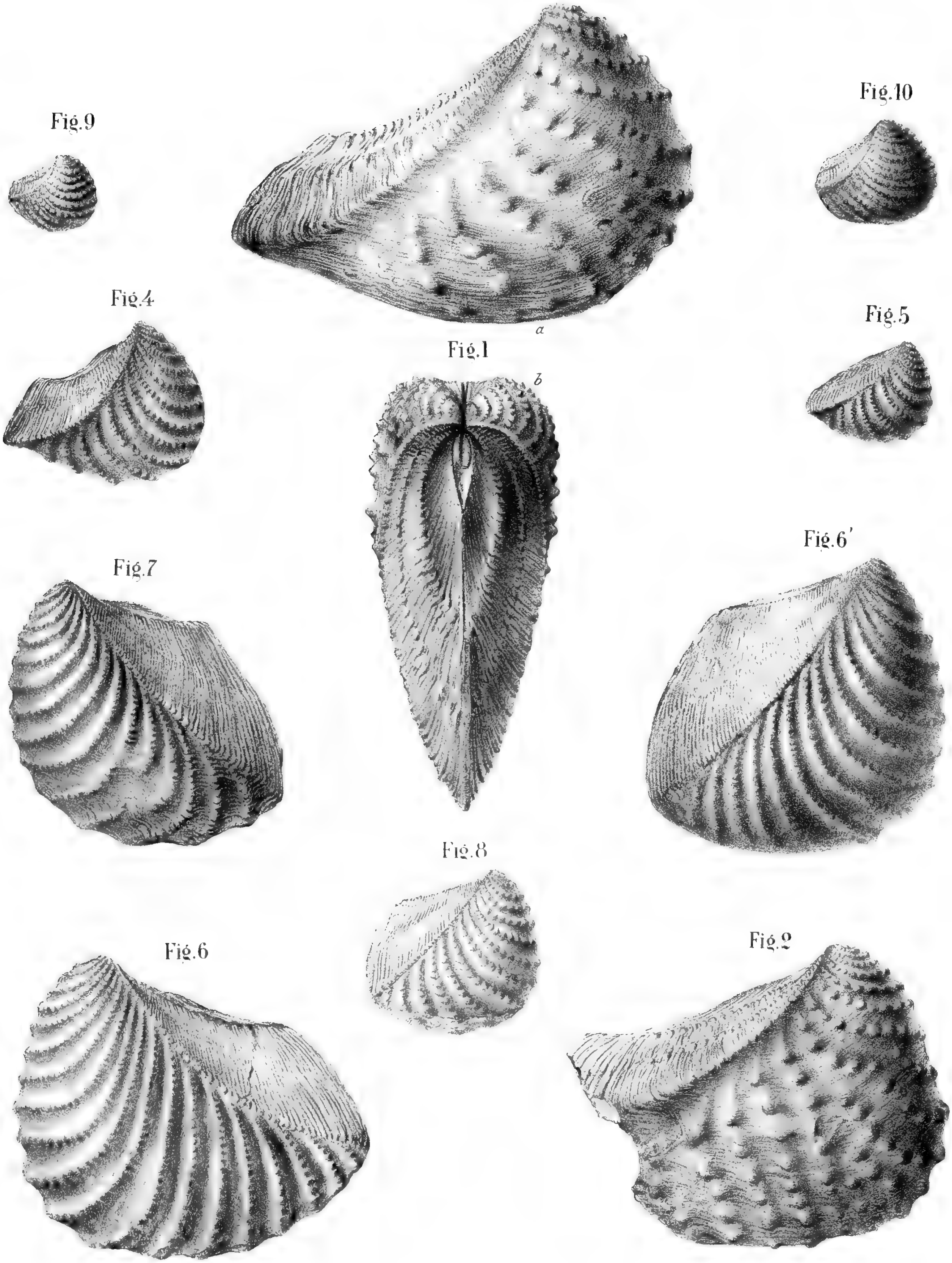
6. ,, ,, Specimen of adult growth, Rodborough Hill, near Stroud.

3 and 7. ,, *striata*, Miller. Adult examples, Inferior Oolite, Bradford Abbas, Dorset. (Page 36.)

8. ,, ,, Young example from the same locality.

9, 10. ,, *tuberculosa*, Lyc. Inferior Oolite, Leckhampton Hill, near Cheltenham. (Page 33.) The perpendicular continuations downwards of the little tubercles are not sufficiently distinct.

Pl.V



P. Lackerbauer ad nat. in lap. del

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PLATE VI.

Fig.		
1, *a*, *b*.	*Trigonia triquetra*, Seebach.	Calcareous Grit, Cumnor, Oxfordshire. (Page 26.)
2.	,, ,,	Lower Calcareous Grit, Filey Point, Yorkshire. Specimen with fewer and larger tuberculated varices.
3, 4.	,, *Phillipsii*, Mor. and Lyc.	Inferior Oolite, Appleby, Lincolnshire. (Page 38.)
5 *a*.	,, *imbricata*, Sow.	Great Oolite, Bath. (Page 33.)
5 *b*.	,, ,,	The same specimen magnified.
6.	,, *Ramsayi*, Wright.	Supra-Liassic Sands, Frocester Hill, Gloucestershire. (Page 49.)

Pl.VI

Fig.2

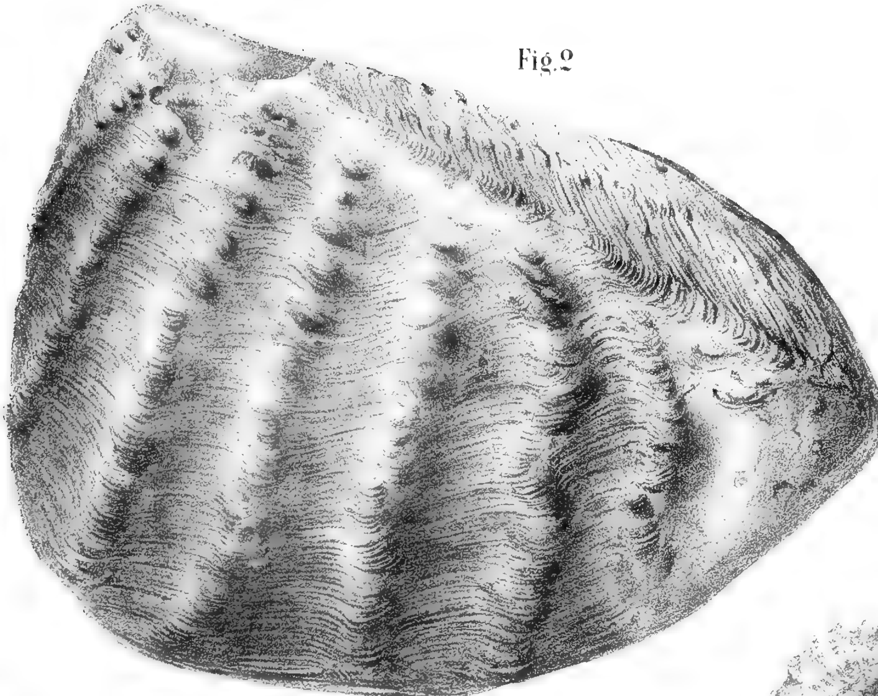

Fig.1

Fig.6

a

Fig.5

b

Fig.1

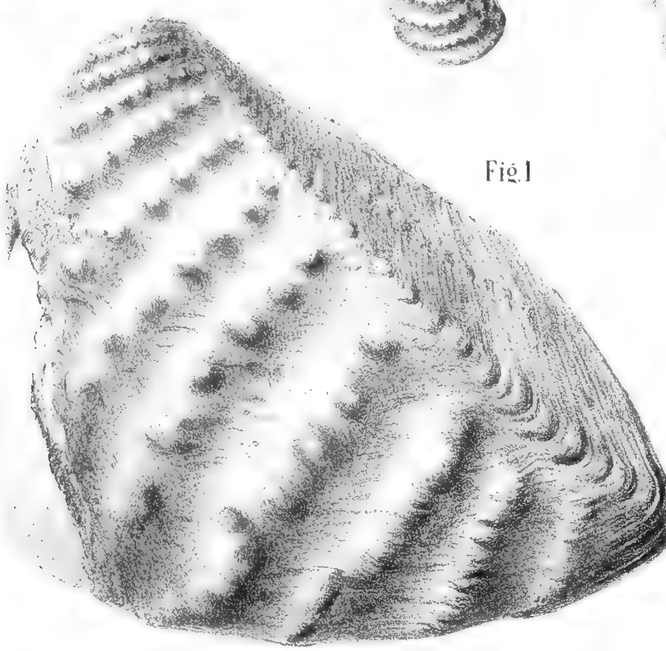

Fig.3

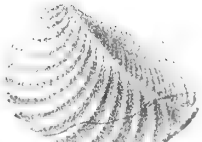

Fig.4

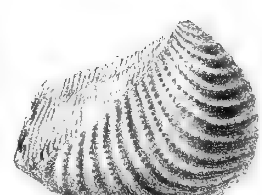

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PLATE VII.

Fig.

1. *Trigonia* ***Pellati,*** Mun. Ch. Adult example, Osmington Bay, near Weymouth. Kimmeridge Clay. (Page 41.)

2. ,, ,, Another example from the same locality and formation.

3. ,, *complanata,* Lyc. Killoway Rock, Cayton Bay, near Scarborough. (Page 49.)

4, 5. ,, *impressa,* Sow. Slate, Stonesfield, Oxfordshire. (Page 46.)

6. ,, *irregularis,* Seeb. Young specimen, Oxford Clay, Weymouth. (Page 39.)

Fig.1

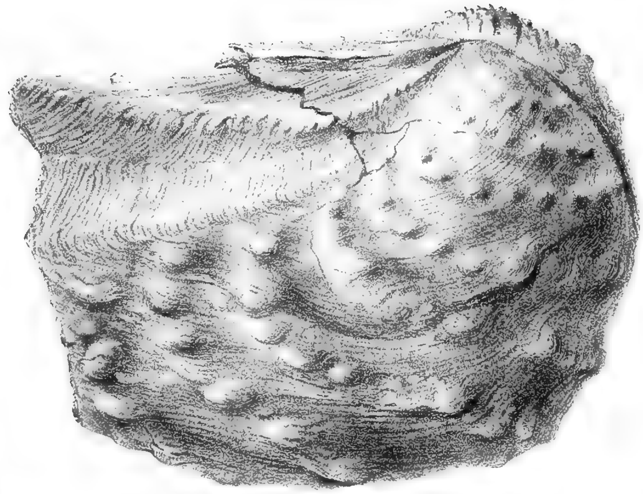


Fig.2

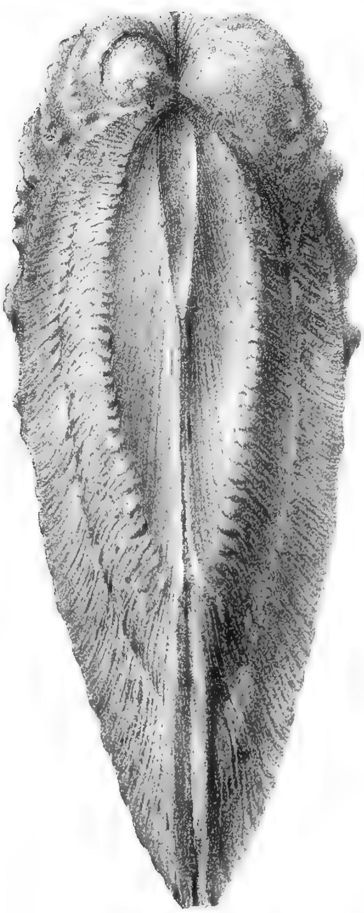


Fig.3

Fig.4

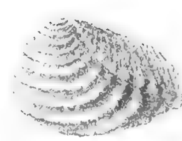


Fig.5

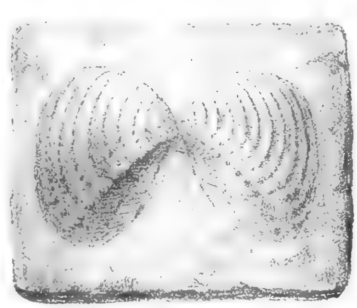


Fig. 6

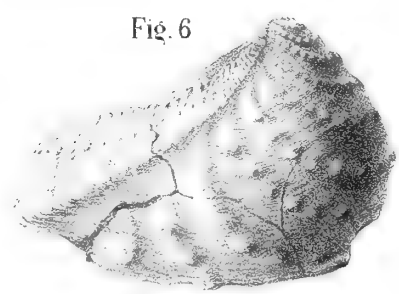
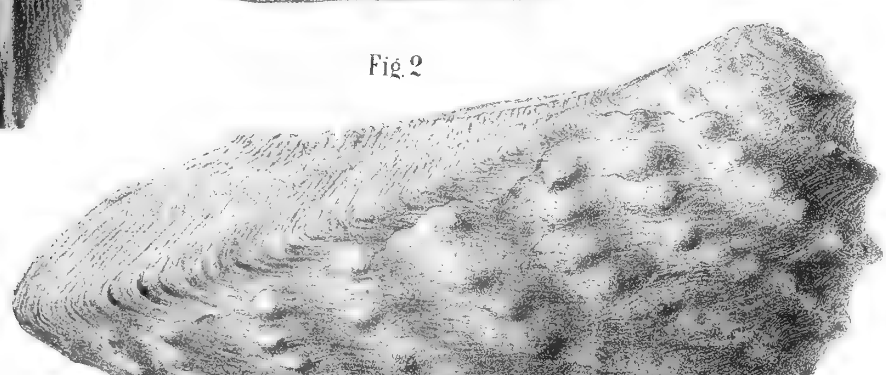


Fig.2



P. Lackerbauer ad nat. in lap. del.

Imp. Becquet à Paris.

PLATE VIII.

FIG.

1. *Trigonia ingens,* Lyc. Neocomian formation, Downham, Norfolk. Adult example; impression from an external cast, in coarse sandstone. (Page 24.)

2, *a, b.* ,, ,, Internal mould, size somewhat reduced, Downham, Norfolk.

3. ,, ,, Young example, with the test preserved, Downham, Norfolk.

4. ,, *Rupellensis,* D'Orb. Kelloway Rock, Cayton Bay, near Scarborough. (Page 28.)

5. ,, *corallina,* D'Orb. Adult example, Coral Rag, Pickering. (Page 45.)

Pl.VIII

Fig.1

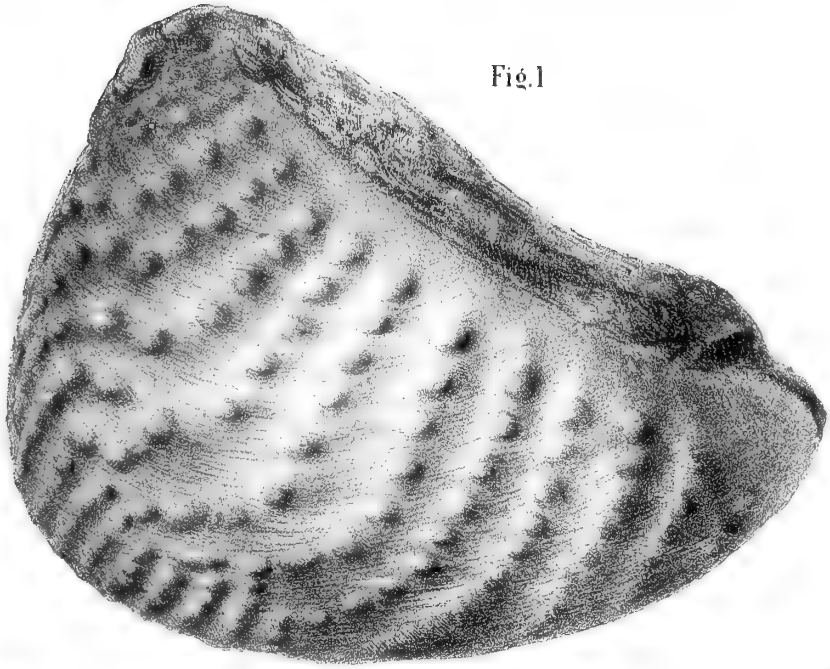


Fig.5

Fig.4

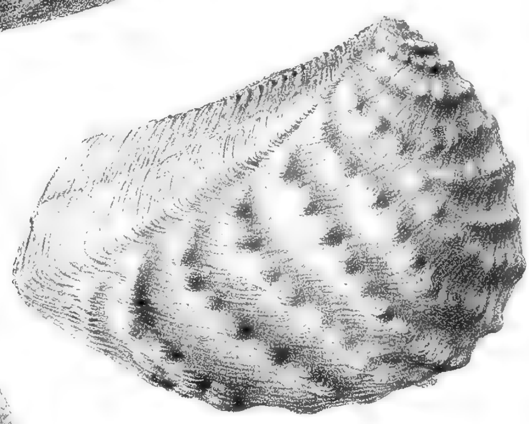


Fig.2

Fig.3

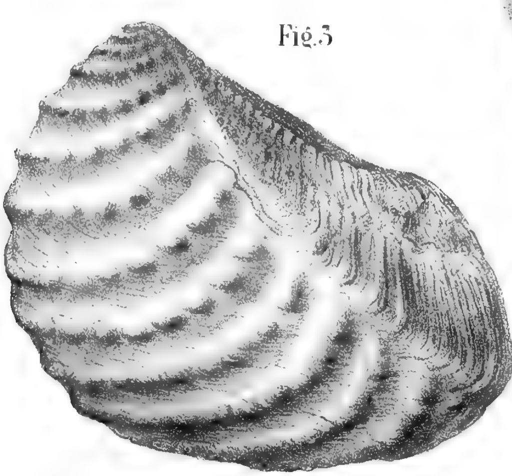
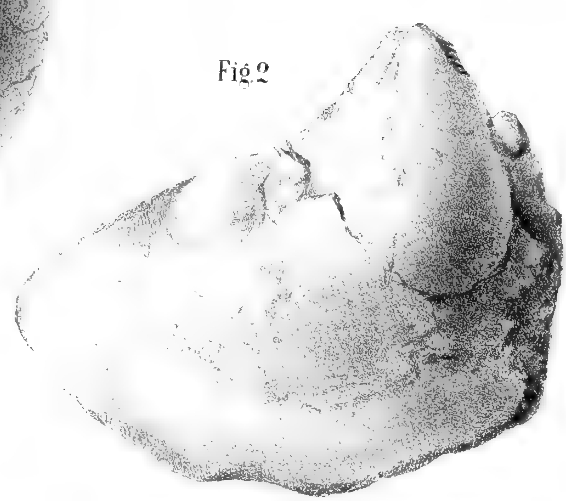


Fig.2



P. Lackerbauer ad nat. in lap. del.

Imp. Becquet à Paris.

PLATE IX.

Fig.

1. *Trigonia muricata,* Goldf. Portland Limestone, Wilts. (Page 50.) The test has disappeared.

2. ,, *incurva,* Benett (a variety). Kimmeridge Clay, Dorsetshire. (Page 42.) It is somewhat flattened from vertical pressure.

3. ,, ,, Internal mould, Portland Oolite, Swindon. (Page 42.)

4. ,, ,, Small specimen, Kimmeridge Clay, Wotton Basset, Wilts.

5. ,, ,, Portland Oolite, Isle of Portland.

6. ,, ,, Portland Oolite, Crookwood, near Devizes, Wilts.

Fig.1

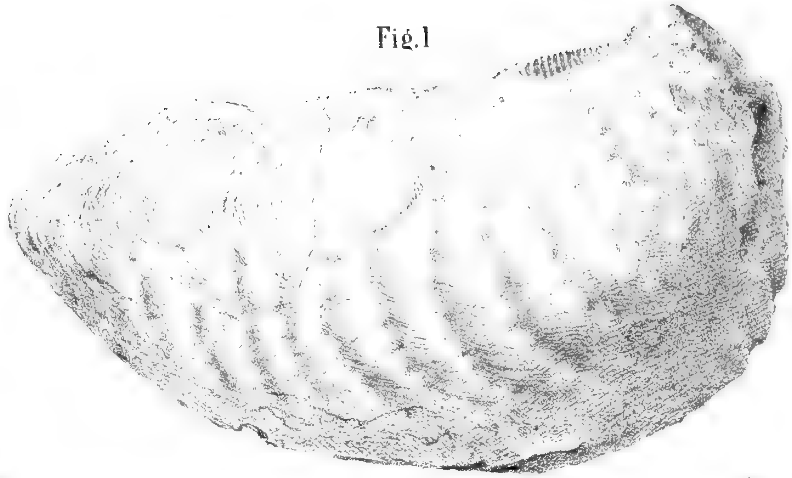


Fig.3

Fig.5

Fig.4

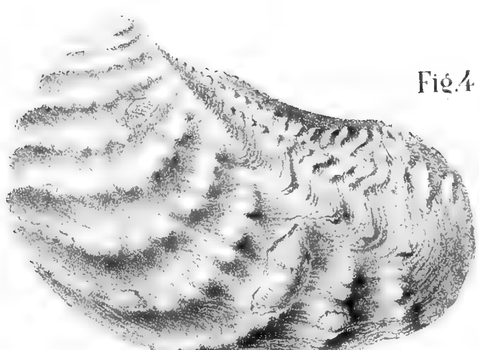


Fig.6

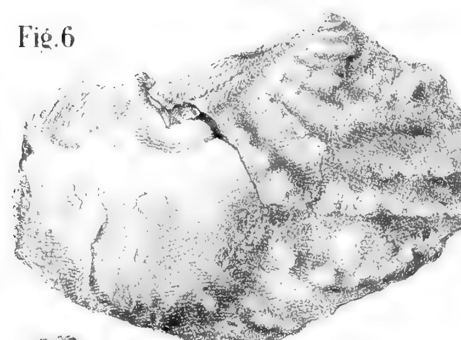
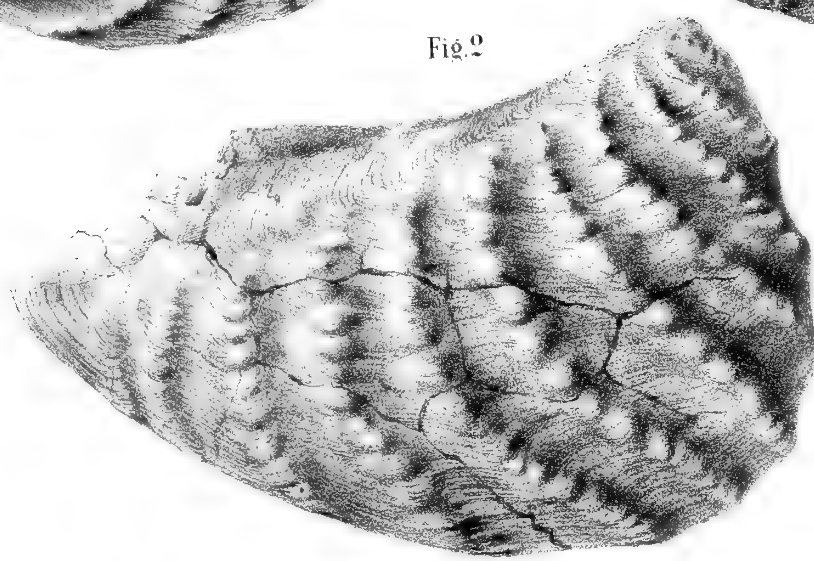


Fig.2



P. Lackerbauer ad nat in lap.

Imp Becquet a Paris.