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ISSUED FOR 1870.

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VOLUME XXIV.

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ISSUED FOR 1870.

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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 TO BE FOUND IN THE YEARLY VOLUMES.

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„ XV. „	1861	The Fossil Echinodermata, Vol. II, Part I (Oolitic Asteroidea), by Dr. Wright, 13 plates. Supplement to the Great Oolite Mollusca, by Dr. Lycett, 15 plates.
„ XVI. „	1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright, 11 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part I, by Mr. J. W. Salter, 6 plates. The Fossil Brachiopoda, Part VI, No. 1, Devonian, by Mr. Davidson, 9 plates. The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood, 7 plates. The Reptilia of the Cretaceous and Wealden Formations (Supplements), by Prof. Owen, 10 plates.
„ XVII. „	1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter, 8 plates. The Fossil Brachiopoda, Part VI, No. 2, Devonian, by Mr. Davidson, 11 plates. The Belemnitidæ, Part I, Introduction, by Prof. Phillips. The Reptilia of the Liassic Formations, Part I, by Prof. Owen, 16 plates.
„ XVIII. „	1864	The Fossil Echinodermata, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright, 6 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter, 11 plates. The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips, 7 plates. The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford, 5 plates. Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.

CATALOGUE OF WORKS—Continued.

Vol. XIX.* Issued for the Year	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. W. E. Binney, 6 plates. Supplement to the Fossil Corals, Part IV, No. 2, Liassic, by Dr. Duncan, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part II, by Dr. Wright, 14 plates. The Fishes of the Old Red Sandstone, Part I, by Messrs. J. Powrie and E. Ray Lankester, 5 plates. The Pleistocene Mammalia, Part II, Felis spelæa, continued, by Messrs. W. Boyd Dawkins and W. A. Sanford, 14 plates.
„ XXII.* „	1868	Supplement to the Fossil Corals, Part II, No. 1, Cretaceous, by Dr. Duncan, 9 plates. The Fossil Merostomata, Part II, Pterygotus, by Mr. H. Woodward, 6 plates. The Fossil Brachiopoda, Part VII, No. 3, Silurian, by Mr. Davidson, 15 plates. The 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, continued, 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. W. E. 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.

* 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.

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.

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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.

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.
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.
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.

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 Trigoniæ, by Dr. Lycett.
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.

† 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.

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JANUARY, 1871): *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* FIFTH *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 of Publication on the title-page of each part.	IV *n*. Dates of the Years *in which* the Monograph was published.	V. No. of Pages of Letterpress in each Monograph.	VI. No. of Plates in each Monograph.	VII. No. of Lithographed Figures and of Woodcuts.	VIII. No. of Species described in the Text.
The Flora of the Carboniferous Strata, by Mr. E. W. Binney, in course of completion	1867, 1870	1868, 1871	1868, 1871	62	12	82	13
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, in course of completion	1865	1866	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, 1854	1850, 1851, 1852, 1853, 1855	406	72	800	319*g*
Supplement to the Fossil Corals, by Dr. Duncan, in course of completion	1865, 1866, 1867, 1868, 1869	1866, 1867, 1868, 1869, 1870	1866, 1867, 1868, 1869, 1870	190	42	710	129
The Polyzoa of the Crag, by Mr. G. Busk, *complete*	1857	1859	1859	145	22	641	122
The Tertiary Echinodermata, by Prof. Forbes, *complete*	1852	1852	1852	39	4	144	44
The Oolitic Echinodermata, by Dr. Wright. Vol. I, *complete*	1855, 1856, 1857, 1858	1855, 1856, 1859, 1860	1857, 1558, 1859, 1861	474	43	724	109*h*
,, ,, Vol. II, in course of completion	1861, 1864	1862, 1866	1863, 1866	154	19	218	29
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, in course of completion	1862, 1867, 1869, 1870	1864, 1868, 1870, 1871	1864, 1868, 1870, 1871	160	45	603	46
The Fossil Cirripedes, by Mr. C. Darwin, *complete*	1851, 1854, 1858*a*	1851, 1854 *	1851, 1855, 1861	137	7	320	54
The Fossil Merostomata, by Mr. H. Woodward, in course of completion	1865, 1868	1866, 1869	1866, 1869	70	15	91	2
The Tertiary Entomostraca, by Prof. Rupert Jones, *complete*	1855	1856	1857	74	6	233	56
The Cretaceous Entomostraca, by Prof. Rupert Jones, *complete*	1849	1849	1850	41	7	176	27
The Fossil Estheriæ, by Prof. Rupert Jones, *complete*	1860	1862	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	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	1857, 1862	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, 1854	1851, 1852, 1853, 1855	409	42	1855	160
,, ,, Vol. II. The Permian and Carboniferous Brachiopoda, *complete*	1856*d*, 1857, 1858, 1859, 1860	1857, 1858, 1860, 1861 †	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	1864, 1865, 1866, 1867, 1869, 1871	528	70	2766	321
The Mollusca of the Crag, by Mr. S. V. Wood:—							
Vol. I. (Univalves), *complete*	1847, 1855*b*	1848	1848, 1857	216	21	581	244
Vol. II. (Bivalves), *complete*	1850, 1853, 1855, 1858*c*	1850, 1853, 1856, 1860	1851, 1853, 1857, 1861	344	31	691	253
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, in course of completion	1848, 1852, 1854, 1855, 1858	1849, 1852, 1854, 1856, 1860	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	1861, 1864, 1871	182	25	531	194
The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, *complete*	1850, 1853, 1854	1850, 1853, 1854	1850, 1853, 1855	282	30	846	419
,, ,, ,, Supplement by Dr. Lycett, *complete*	1861	1863	1863	129	15	337	194
The Belemnites, by Prof. Phillips, in course of completion	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	1865, 1866, 1867, 1869, 1870	128	36	622	69
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, *complete*	1853, 1854, 1855	1853, 1854, 1856	1853, 1855, 1857	67	27	319	79
The Fossils of the Permian Formation, by Prof. King, *complete*	1849, 1854*e*	1850 *	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	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 *	1849, 1850, 1859	150	58	304	39
The Reptilia of the Cretaceous Formations, by Prof. Owen, *complete*‡	1851, 1857, 1858, 1862	1851, 1859, 1860, 1864	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden and Purbeck Formations, by Prof. Owen, *complete*‡	1853, 1854, 1855, 1856, 1857, 1858, 1862	1853, 1854, 1856, 1857, 1859, 1860, 1864	1853, 1855, 1857, 1858, 1859, 1861, 1864	155	62	251	17
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, in course of completion	1859, 1860, 1868	1861, 1862, 1869	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, 1862, 1865, 1870	1861, 1863, 1865, 1870	121	37	177	8
The Crag Cetacea, by Prof. Owen, in course of completion	1869	1870	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	1866, 1868, 1869	1866, 1868, 1869	218	25	213	2
The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen, *complete*	1870	1871	1871	115	4	247	30
			TOTAL	6,769	1,044	19,547	3,718

a Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian, which is complete. *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 in binding up the parts. *n* Useful for establishing the dates of new species. * Dates not given. † Marked 1857—1862. ‡ 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—1870) *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
Crag	...	...	1865	1849	1852	1851, 1854	...	...	......	......	...	1857	1852	1847, 1850, 1853, 1855	...	...	......	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	1851, 1854	1849	...	......	......	1860	...	1852, 1854	......	1853, 1854, 1855	...	1851, 1857, 1858, 1862	
Wealden	...	...	...	...	......	......	...	1860	......	......	...	...	......	......	...	...	1853, 1854, 1855, 1856, 1857, 1862	
Oolitic	...	...	...	1851	1855, 1856, 1857, 1858, 1861	1851	...	1860	......	......	...	...	1850, 1852	1850, 1853, 1854	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	...	...	1852	......	......	...	1860	......	......	...	...	1856, 1857, 1858, 1859, 1860					
Devonian	...	...	...	1853	......	......	...	1860	1865, 1868	1862	...	...	1862, 1863	......	...	1867, 1869		
Silurian	...	...	...	1854	......	......	...	...	......	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 1870.

LONDON:

MDCCCLXXI.

OBSERVATIONS

ON THE

STRUCTURE OF FOSSIL PLANTS

FOUND IN THE

CARBONIFEROUS STRATA.

BY

E. W. BINNEY, F.R.S., F.G.S.

PART II.

LEPIDOSTROBUS AND SOME ALLIED CONES.

PAGES 33—62; PLATES VII—XII.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1871.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

CONTENTS.

PART II.

I. Introductory Remarks.

In this Monograph it was originally intended to have described a series of fossil Stems, showing structure, from the Coal-measures; and the genus *Calamodendron* was first taken as yielding, from specimens in my possession, more complete materials, not only for illustrating the structure of the stem, but also of the organs of fructification. Before proceeding to describe the structure of more stems, it has been considered desirable to bring before the Public some specimens showing Organs of Fructification. These are not very numerous, but their publication may be of use in indicating how small the amount of knowledge on the subject we really possess as yet, and in directing the attention of Collectors to the matter; for a great deal of labour is undoubtedly yet required before we shall be able thoroughly to understand the true nature of some of our commonest Coal Plants, so as to restore them in all their parts. One good specimen showing the organs of fructification connected with the stem and foliage of the plant is worth any number of detached fragments. It has been my good fortune to become possessed of a specimen showing such three portions of a plant; and, therefore, it has occurred to me that no time should be lost in describing it, although in due order, probably, it ought to have been delayed to a later portion of the Monograph.

II. Bibliographical History of *Lepidostrobus* and *Flemingites*, with Remarks on their Relationship with *Lepidodendron*, *Sigillaria*, &c.

§ 1. *General Remarks.*—The genera *Lepidodendron, Lepidostrobus,* and *Flemingites,* especially the two former, have been often described, in most works that have treated on Fossil Botany. The specimens figured have been for the most part mere casts and impressions, not showing any trace of internal structure. Those instances where the tissues of the plant happened to be well preserved, or where the organs of fructification distinctly showed their spores, have not been numerous and are soon given.

The specimen of *Lepidodendron Harcourtii* found by the Rev. C. G. W. Harcourt, Rector of Rothbury, and preserved by Professor John Phillips, afforded materials for the memoirs of Mr. Witham,[1] Messrs. Lindley and Hutton,[2] and M. Adolphe Brongniart,[3] on the structure of the stem.

Professor Morris[4] first described the capsules, so generally found in "splint" or "bone" coal, on which Mr. Carruthers[5] has established his genus *Flemingites.*

Dr. Hooker[6] collected materials which enabled him to show the anatomy of *Lepidostrobus.*

Dr. Robert Brown,[7] in a memoir read before the Linnean Society in 1847 and published in 1851, gave to the world a more perfect specimen of a portion of a cone than had been previously figured.

Mr. Carruthers[8] has shown what he considered to be the differences between *Lepidostrobus* and his new genus *Flemingites.*

And latterly M. Adolphe Brongniart[9] and Professor Schimper[10] have obtained specimens of the most perfect cones, exhibiting both microspores and macrospores in the same cone.

§ 2. *Stem.*—For many years the beautiful stems of *Lepidodendron* have attracted the attention of collectors of Coal-plants, on account of the elegant sculpture of the spots where the leaf proceeded from the stem. In the ordinary condition of the fossil plant, whether found in shales or sandstones, these have the appearance of scales, and hence the name. But this was not the original form of the scar of attachment, as Dr. Hooker[11] first showed; for the pitted knob, afterwards compressed into the so-called scale, projected originally from the stem one fourth to one third of an inch, as specimens in my cabinet prove. Different "species" have been named, owing to specimens being more or less compressed out of their original form. M. Ad. Brongniart has enumerated a great number of so-called species, which Professor Schimper has reduced to fifty-six. Doubtless these will have to be still further reduced, as in the case also of *Sigillaria,* when we become

1 'Observations on Fossil Vegetables,' by Henry Witham, 4to, Edinburgh, 1831; and On the Internal Structure of Fossil Vegetables found in the Carboniferous and Oolitic Deposits of Great Britain,' by H. T. Witham, of Lartington, 4to, Edinburgh, 1835.

2 'The Fossil Flora of Great Britain,' by Dr. Lindley and W. Hutton, 3 vols. 8vo, London, 1831-37.

3 'Histoire des Végétaux fossiles, ou Recherches Botaniques et Géologiques,' &c., 2 vols. 4to, Paris, 1828.

4 'Transact. Geol. Soc. London,' 2nd series, vol. v (explanation of plate xxxviii), 4to, London, 1840.

5 and 8 'Geological Magazine,' vol. ii, p. 433, 8vo, London, 1865; and ibid., vol. vi, pp. 151, &c., 1869.

6 'Memoirs of the Geological Survey of Great Britain,' vol. ii, part 2, pp. 440, &c., 8vo, London, 1848.

7 'Transact. Linnean Seciety,' vol. xx, 4to, London, 1851.

9 'Comptes Rendus,' vol. lxvii, pp. 421, &c., &c., 4to, Paris, 1868.

10 'Traité de Paléontologie végétale,' vol. ii, p. 69. Paris, 1870.

11 'Mem. Geol. Surv.,' vol. ii, part 2, p. 444.

better acquainted with their true original external character before the plants had been subjected to pressure. *Sigillaria,* instead of the flat surface and leaf-scars generally seen, had, in large specimens, strong ribs projecting fully an inch beyond the furrows, and divided by narrow furrows.

§ 3. *Internal Structure* (*Witham and others*).—For the first knowledge of the internal structure of the stem of *Lepidodendron* we are indebted to Mr. Witham,[1] Messrs. Lindley and Hutton,[2] and M. Adolphe Brongniart.[3] The branches dichotomised with great regularity, and at their extremities produced the cone so well known as *Lepidostrobus.* This latter fact had, for the most part, been inferred from the number of specimens of *Lepidostrobi* being found around and about the stems of *Lepidodendron,* rather than by any actual proofs of the cone being found actually attached to the stem itself.

§ 4. *Internal Structure and Cones* (*Hooker*).—Dr. Hooker, to whom we are indebted for most valuable information as to the nature of *Lepidodendron,* in his memoir previously quoted gives, at page 451, the following descriptions:

"1. Lepidodendron *elegans.* Cone slender, three quarters of an inch in diameter, four to ten inches long; sporangia eight in a whorl.

"2. Lepidodendron *Harcourtii?* Cone broad, one and a half inch in diameter; sporangia about sixteen in a whorl.

"If, now, these cones be examined with reference to the known contemporaneous fossils which accompany them, it will appear impossible to deny their having been the reproductive organs of *Lepidodendron,* not only from their association with the fragments of that genus, because the arrangement of the tissue in the axis of the cone entirely accords with that of the stem of *Lepidodendron,* just as we find in modern cones of *Lycopodiaceæ* and *Coniferæ* that the axis is a continuation of the branch which bears leaves, modified into organs adapted to support and protect the parts of fructification."

Now, although the author was quite right in his conclusion that *Lepidostrobus* was the fruit of *Lepidodendron,* in the beautiful plates which accompany his memoir there is no good transverse section given to prove the fact; and some writers, especially Mr. Carruthers, consider the evidence of the connection between a *Lepidodendron* and its own *Lepidostrobus* to be consequently of a very unsatisfactory nature.[4] Of course the occurrence of the cones in the insides of stems is by no means satisfactory, as any one knows who has examined the stems of *Sigillaria,* wherein are found plenty of Ferns, which certainly would not be admitted

[1] 'On the Internal Structure of Fossil Vegetables found in the Carboniferous and Oolitic Deposits of Great Britain,' by H. T. Witham, Edinburgh, 1833.

[2] 'Fossil Flora of Great Britain,' vol. ii, p. 46.

[3] 'Hist. Végét. foss.,' vol. ii, pp. 37 and following, plates x and xi.

[4] "On an Undescribed Cone from the Carboniferous Beds of Airdrie, Lanarkshire," by W. Carruthers, F.L.S.; 'Geol. Mag.,' vol. ii (No. xvi), p. 437.

to be the foliage of that plant merely from being found in the interior of its stem. The same may be said of *Stigmariæ* found in nodules in the Wigan Four Feet Coal, which are full of spores, but up to this time, to my knowledge, no one has clearly proved such spores to belong to *Sigillaria.*

In pl. v, figs. 10, 11, 12, and 13, of Dr. Hooker's memoir, there is, in my opinion, clear evidence to prove that the structure of the stem of *Lepidodendron* is identical with that of a *Lepidostrobus.* In this Monograph proof will be adduced in confirmation of Dr. Hooker's opinion, by showing that the stem of *Lepidodendron Harcourtii* is identical in structure with the axis of *Triplosporites* or *Lepidostrobus Brownii* of Carruthers, and that the stem of *Lepidodendron vasculare* had a cone resembling that of *Lepidodendron Harcourtii* in the form of its sporangia, with the bracts and leaves also similar, but was still different in the structure of its central column.

§ 5. *Roots* (*Bowman and Binney*).—As to the roots of *Lepidodendron,* we are not in possession of much definite information. In the remarkable fossil trees described by the late Mr. J. E. Bowman, F.G.S.,[1] and which I had the pleasure of visiting with my lamented friend, the specimens were clearly of two kinds, most of them being *Sigillaria,* but certainly one or two of them having markings on their exterior like those usually found on *Lepidodendron.* Around and at the bases of the stems were nodules of clay-ironstone, in the shales, all full of *Lepidostrobus,* chiefly *L. variabilis.* At that time both of us believed that such cones had been connected with, and in fact had constituted, the fruit of the stems, but of which of them we did not hazard an opinion.

§ 6. *Roots* (*Rd. Brown*).—Mr. Richard Brown, in his description[2] of an upright *Lepidodendron* with *Stigmarian* roots, in the roof of the Sydney Main Coal, in the Island of Cape Breton, gives very good evidence of the root of his specimen being *Stigmaria ;* but as to the stem being a *Lepidodendron,* it does not appear so certain from his published illustrations, at least the evidence adduced cannot by any means be considered conclusive as to whether the specimen belonged to *Lepidodendron* or to *Sigillaria.*

§ 7. *Roots* (*Hooker*).—Dr. Hooker, in his "Vegetation of the Carboniferous Period, as compared with that of the Present Day,"[3] says, "Of the stems, branches, leaves, and fructification [of *Lepidodendron*] we have thus a very satisfactory knowledge, but the nature of their roots is not ascertained. Mr. Dawes, of West Bromwich, to whom I am indebted for much information regarding the structural characters of Coal Fossils, is inclined to regard the species of *Halonia* as roots of *Lepidodendron,* on which opinion I have no remarks to offer."

[1] 'Transactions of the Manchester Geological Society,' vol. i, pp. 112—184, 8vo, 1841.
[2] 'Quarterly Journal of the Geological Society of London, vol. iv, pp. 46, &c., 1847.
[3] 'Mem. Geol. Surv.,' vol. ii, part 2, p. 422.

§ 8. *Roots* (*Carruthers*).—Mr. Carruthers, in his paper on the structure and affinities of *Lepidodendron* and *Calamites*, published[1] in 1867 (at page 5 of the excerpt), says, "Stigmarioid roots have been determined to belong to *Lepidodendron*, as well as to *Sigillaria*, and their whole structure supports this determination. I have satisfied myself that there is nothing that can be truly called a medullary ray in the woody cylinder of *Stigmaria*, but into the proof of this I will not now stay to enter. The base of the trunk was divided into a few principal roots, and these again divided dichotomously, but the ultimate divisions were never much attenuated. Throughout their whole course, and from every portion of their circumference, they gave off rootlets of considerable length, which, with the exception of a slender vascular bundle, were entirely composed of delicate hexagonal cells. They were articulated to flagon-shaped bodies, sunk in cavities, arranged in a quincuncial manner over the stem. The internal structure of *Stigmaria* corresponds to that of the trunk of a *Lepidodendron*. The axis was composed of fusiform barred cells, and this was surrounded by a woody cylinder, which was certainly penetrated by the vascular bundles that supported the rootlets. Beyond the woody cylinder came a great thickness of cellular tissue, almost always destroyed, but probably agreeing in its structure with the three zones of the stem."

§ 9. *Roots* (*Carruthers and Binney*).—As Mr. Carruthers' conclusions, which really go to the extent of proving that *Sigillaria* and *Lepidodendron* are the same plant, appear to be drawn mainly from my specimens of *Sigillaria vascularis* and *Lepidodendron vasculare*, described in the 'Quarterly Journal of the Geological Society,' vol. xviii, pp. 106—112, pls. iv, v, and vi, for May, 1862, it is desirable carefully to consider the subject. Of course the specimens had externally all the usual characters of *Lepidodendron*, but in the internal structure No. 3 differed considerably from Nos. 1 and 2, in possessing no internal radiating cylinder outside the medullary sheath, and it was, therefore, classed in the genus *Lepidodendron*. Up to the present time no evidence has come to my knowledge to show that the central axis of *Stigmaria ficoides* was the same as that of *Lepidodendron vasculare;* indeed, we are really ignorant of the structure of the medulla of *Stigmaria*, except so far as Professor Goeppert has made us acquainted with it, and as far as my own specimens of *Sigillaria* show; but it is no doubt the same as that of *Sigillaria vascularis*. This is probably not sufficient to warrant us in saying more at present than that *Sigillaria* and *Lepidodendron* were very much alike, and had similar habitats, and it is scarcely sufficient to prove that they were one and the same plant.

Unquestionably the medulla of the *Lepidodendron Harcourtii* of Witham and Lindley and Hutton, as well as a much more perfect specimen of the same species in my cabinet, presented to me by Mr. J. S. Dawes, and hereinafter described, is composed of cellular tissue, without any vascular bundles dispersed through it; whilst in my *Sigillaria vascularis*, both in the small specimens with rhomboidal scars and the large irregularly ribbed

[1] 'In the Journal of Botany,' 8vo, London, 1867.

and furrowed examples, as well as in my *Lepidodendron vasculare*, the medulla contains numerous scalariform tubes or utricles, called by Mr. Carruthers "fusiform barred cells." In addition, we must not forget that in *Lepidodendron Harcourtii* we find no trace of the internal radiating cylinder so characteristic of *Sigillaria vascularis*, although in both plants, as well as in *Lepidodendron vasculare*, there is evidence of an outer radiating cylinder composed of fusiform utricles. This external cylinder has been shown by me to occur in *Stigmaria*.[1]

In the present Monograph there will be described and figured two cones showing the internal composition of their columns; one of these exactly resembles in its structure that of *Lepidodendron Harcourtii*, and the other is similar to that of *Lepidodendron vasculare*; so for the present, probably, it will be desirable to keep the two genera distinct.

So far as my observations extend, plenty of both large and small specimens of *Lepidodendron* having rhomboidal scars are met with, whilst few ribbed and furrowed *Sigillariæ* of a small size are found, these fluted *Sigillariæ* being for the most part large specimens. In my memoir last quoted it was shown that, while the large stem of *Sigillaria* had small branches rhomboidally scarred and of a lepidodendroid character, the large stems, having the same internal structure as the branches, resembled the ordinary *Sigillaria* in its external appearance.

Hence, although *Lepidodendron* and *Sigillaria* are, no doubt, nearly allied, it appears to me desirable to retain them as distinct genera for the present, until more evidence of their perfect identity is furnished than my specimens figured and described in the 'Quarterly Geological Journal' and the 'Philosophical Transactions' have afforded.

Lepidostrobus.

§ 10. (*Lindley and others*).—From the earliest time that Carboniferous fossil Plants have been figured and described, the *Lepidostrobus* has appeared amongst them. Messrs. Lindley and Hutton, in their 'Fossil Flora,' give numerous figures of beautiful specimens, as also does M. Brongniart in his 'Histoire des Végéteaux fossiles;' but none of these appeared to show any internal structure, owing to their being simply casts, or carbonaceous impressions, in clay-ironstone or shale.

§ 11. (*Brown*).—Dr. Robert Brown read before the Linnean Society in 1847 a description of a cone (*Triplosporites*) which first showed the true structure of *Lepidostrobus*, so far, at least, as the upper part of the cone was concerned, but his paper was not published till 1851. In the mean time, namely in 1848, Dr. Hooker published his valuable researches on the structure of *Lepidostrobus*, showing the true nature of the cone, from a number of

[1] 'Philosophical Transactions,' vol. clv (1865), p. 593.

specimens, none of which were so perfect as that of Dr. Brown's, which exhibited the sporangia of the upper part of the cone, full of microspores, and attached to the central column, as well as the form of the microspores themselves. Both these authors came to the same conclusion from independent specimens—Dr. Brown from one in a perfect state of preservation, so far as the upper portion of the cone was concerned, and Dr. Hooker from several imperfect specimens, taking a little from one and a little from another. But neither of these observers was so fortunate as to see the lower part of *Lepidostrobus* containing sporangia with spores in them.

§ 12. (*Hooker*).—The genus *Lepidostrobus* has long been considered the fructification of *Lepidodendron.* This must of necessity have been the case as soon as *Lepidodendron* was supposed to be allied to *Lycopodium* by M. Brongniart and Dr. Lindley.

Dr. Hooker, in his excellent memoir on *Lepidostrobus,* published in the 'Memoirs of the Geological Society,'[1] notices numerous specimens of *Lepidostrobus* in the insides of stems of *Lepidodendron Harcourtii* and *L. elegans.* He says, at page 451, "The two cones from which the above general views have been deduced are apparently from different species, and I shall therefore characterise them as such. Further, as they seem to have belonged to the fossil *Lepidodendron* enclosing them, I shall for the future notice them as really the fruit of that genus." He then describes the cone of *Lepidodendron elegans* as slender, three quarters of an inch in diameter, four to ten inches long, with sporangia eight in a whorl; and the cone of *L. Harcourtii* (?) as broad, one inch and a half in diameter, with sporangia about sixteen in a whorl. He observes, "The most positive evidence that can be adduced of *Lepidostrobi* being a genus allied to *Lycopodium* is afforded by the spores, the presence of which not only removes them from *Cycadeæ*, *Coniferæ*, or any other order of flowering plants, but directly refers them to the family of *Lycopodiaceæ* and [not to?] *Coniferæ.* In both [*Lepidostrobus* and *Lycopodium*] the original spore divides into three or nearly [rarely?] four sporules, which are angular, and form the reproductive system of the plant. Not only do these groups coincide in the essential characters of their spores, but in many minor points the strongest similarity exists between them. The arrangement of the scales is the same in both, and so are the scales themselves in general features, especially towards their dilated apices. The situation of the sporangia, too, is alike, and their attachment by a very narrow surface to the scale."

§ 13. (*Carruthers*).—Mr. Carruthers, speaking of *Lepidodendron,* says,[2] "The fruit was a strobilus (pl. lvi, fig. 3) formed from a shortened branch, the leaves of which are converted into scales, that support on their upper surface a single large sporangium

[1] Vol. ii, part 2, 1848.

[2] "On the Structure and Affinities of Lepidodendron and Calamites," 'Journ. Botan.' vol. xiii, pp. 6 and 7.

(*Lepidostrobus*, pl. lvi, fig. 4), or perhaps several small ones (*Flemingites*, pl. lvi, fig. 6).

"There appear to be both macrospores (pl. lvi, fig. 5) and microspores in the same sporangium. I have examined at length the structure and affinities of these fruits, in a paper published in the 'Geological Magazine,' vol. ii, p. 433, to which I must refer, without here dwelling further on the subject. *Flemingites*, although the sporangia are enormously abundant in some coals, have not yet been found connected with any fossil; but specimens of *Lepidostrobus* attached to branches of *Lepidodendron* have been described by Dr. Paterson, Brongniart, and others, and I have noticed a fine specimen in the Museum of the Edinburgh Botanic Gardens, and others exist in the British Museum and elsewhere.

"In tracing the affinities of *Lepidodendron*, we have the safest guide in the organs of fructification, and fortunately these have been satisfactorily determined. The sporiferous strobilus shows that it is a true cryptogam, and in general appearance and arrangement of parts the strobilus can scarcely be distinguished from that of some living *Lycopodia*, except in the great difference of size. This affinity is strengthened by the character of the leaves and the structure of the stem. But the possession of both kinds of spores in the same sporangium exhibits stronger affinity to *Rhizocarpeæ* than to *Lycopodiaceæ*."

Flemingites.

§ 14. (*Morris*).—Probably ever since the Splint Coals of Scotland have been wrought the small disc-shaped bodies, of a chestnut colour, contained in them must have been observed, but until late years little attention has been devoted to them. They have been found in Cannel and Cherry as well as in Splint Coals, but in nothing like the same quantity. In some of the Fifeshire "Splints," near Methel, they occur in such abundance as to impart to the coal a chestnut tinge.

In Mr. Prestwich's memoir on the Coalbrookdale Coal-field, Professor Morris noticed these bodies in the following words:[1]—

"*Lycopodites*[2]? *longibracteatus*, n.s. Stem rounded, marked by the cicatrices of the fallen leaves, which are close, lozenge-shaped, and spirally disposed.

"Fructification in terminal imbricated spikes; thecæ reniform, minutely tuberculated, each attached by its centre to a base of a *long, lanceolate, foliaceous* bractea.

"The thecæ resemble in shape those of the recent genus *Stachygynandrum;* but as

[1] 'Transact. Geol. Soc. London,' 2nd ser., vol. v, part 3 (1840), explanation of plate xxxviii, figs. 8, 9, 10, and 11.

[2] Professor Morris, I believe, has since determined this plant to be a true *Lepidodendron*.

the capsules vary in form in different parts of the spike in that genus, it is difficult to assign its affinity to that division of the *Lycopodiaceæ*.

"The capsules (pl. xxxviii, figs. 8 and 8 *a*) of this species neither bituminized nor mineralized, but in a state of brown vegetable matter, are very abundant in some of the coarser sandstones of the Coal-measures."

§ 15. *Binney.*—In a paper of my own, published in 'The Quarterly Journal of the Geological Society'[1] for May, 1849, a description is given of some spores found imbedded in the roots of *Sigillaria*, from a coal-seam at Wigan. These bodies varied in size from one twenty-fifth to one twentieth of an inch in diameter, were of a nearly spherical form, and had a tri-radiate ridge on the under portion. On carefully comparing them with the spores of *Lepidostrobi*, figured in plates 5, 6, 8, and 10, of Vol. ii, Part 2, of the 'Memoirs of the Geological Survey of Great Britain' (Dr. Hooker's illustrations), I became acquainted with their true nature, and, from their resemblance, was led to believe them to be the spores of *Lepidostrobus ornatus*.

§ 16. *Balfour.*—Dr. Balfour, in a paper 'On certain Organisms found in Coal from Fordel,'[2] says, "Besides Sigillarias and Stigmarias, we also detect in the Fordel coal peculiar organisms, which have the appearance of seeds (pl. 11, figs. 12 and 13). Dr. Fleming informs me that similar bodies have been observed by him in coal, and that he exhibited them to Mr. Witham about twenty years ago. They have also been seen by Dr. Fleming in Lochgelly and Arniston parrot, and in the coal at Boghead; and, from having observed them in cherry, splint, and cannel coals, he is disposed to consider them as a somewhat common feature. I have seen them from coal at Miller Hill, near Dalkeith, as well as in the coal from Fife. They do not appear to have been fully described. The nearest approach to them is the *Lycopodites* figured by Mr. Morris in the 'Appendix to Mr. Prestwich's Paper on the Geology of Coalbrookdale.' They appear to be certainly allied to the fructification of the *Lycopodiaceæ* of the present day, more particularly to that form of it which consists of two valves placed in apposition, and containing what is called Lycopode powder, or minute cells having a glistening aspect, interspersed sometimes with matter of a dark wine-colour. These and like bodies I therefore consider to be the sporangia or spore-cases of some plant allied to *Lycopodium*, perhaps *Sigillaria*."

"Explanation of plate 11, figs. 5 to 18. Fig. 13. The same sporangia, magnified about eight diameters, imbedded in a mass of Fordel coal; some lying on the surface, others projecting from the broken edges of the coal. They seem to occur frequently in coal from different localities both in England and Scotland. Mr. Binney has seen them in Wigan coal."

[1] Vol. vi, p. 17, &c.; with woodcuts, figs. 2, 3, 4.

[2] 'Transactions of the Royal Society of Edinburgh,' vol. xxi, p. 187.

§ 17. *Goldenberg.*—Dr. Goldenberg[1] describes and figures such spherical bodies, some with the triradiate ridge, and others without that character, as the fruit of *Sigillaria, Stigmaria,* and fossil *Selagineæ.* These bodies, according to this author, appeared to be attached to the scales of the cones, and not contained in a sporangium; and in the figures they appear chiefly at the base of the specimen.

§ 18. *Binney.*—In 1864 a description of some spores of plants found in the splint coals of Methel, Fifeshire, was given by myself to the Literary and Philosophical Society of Manchester,[2] wherein it was stated that, when we consider the great abundance of these small fossils in all splint coals, and the immense number of the roots of *Sigillaria* found in the floors of such seams of coal, it is almost certain that they had some connection with that plant. This tended to confirm M. Adolphe Brongniart's opinion, expressed many years ago, that *Sigillaria* and *Lepidodendron* were plants very nearly allied to each other.

§ 19. *Carruthers.*—In October, 1865, Mr. Carruthers described[3] a fossil cone that had been discovered by Mr. James Russell, of Chapelhall, Airdrie, a diligent and intelligent collector of Carboniferous Fossils, and which showed the bodies described by Professor Morris, and noticed by myself and Dr. Balfour, as they occurred in the strobilus, and not detached, as they had been observed by me and Dr. Balfour. Mr. Carruthers describes at length the differences he considered to exist between *Lepidostrobus* and his new genus *Flemingites.* The two genera are thus contrasted (p. 438):

"*Lepidostrobus.*—Each scale of the cone supporting a single oblong sporangium.

"*Flemingites.*—Each scale of the cone supporting a double series of roundish sporangia.

"*F. gracilis.*—Cone slender, cylindrical, very slightly tapering at the base, composed of a solid axis and numerous imbricated scales, ten in a whorl. The apex of the scale long and slender. Sporangia attached by a tri-radiate ridge."

§ 20. *Brongniart.*—M. Adolphe Brongniart in a notice, "Sur un fruit de Lycopodiacées fossiles," in the 'Comptes Rendus' for August, 1868, gives a description of a cone very similar in its upper portion to that described by Dr. Robert Brown, which he names *Triplosporites Brownii* (*Lepidostrobus Brownii,* Carruthers).

This specimen shows sporangia containing microspores in the upper part of the cone, exactly like those in Dr. Brown's specimen; whilst in the lower portion of the same

[1] 'Flora Saræpontana fossilis;' plate B, figs. 18 to 25 (1855); plate X, figs. 1 and 2 (1857).

[2] 'Proceedings of the Literary and Philosophical Society of Manchester,' vol. iv, (for 1864), p. 45.

[3] "On an Undescribed Cone from the Carboniferous Beds of Airdrie, Lanarkshire," by W. Carruthers, F.L.S., of the British Museum; 'Geological Magazine,' vol. ii (No. xvi, October, 1865), pp. 433, &c.

cone there are macrospores in the sporangia, resembling those by Mr. Carruthers as the sporangia of *Flemingites.* This is the first instance that has come to my knowledge of a fossil cone containing both microspores and macrospores. It appears to have been found in the Drift deposits of the valley of Volpe, in Haute-Garonne, by M. Dabadie; but, if it is, as M. Brongniart asserts, identical in structure, so far as its upper part is concerned, with Dr. Brown's specimen, there is no doubt that it originally came from the Carboniferous strata.

The learned author says at page 424, "Cet épi présente donc, comme les Lycopodiacées des genres *Selaginella* et *Isoëtes,* des sporanges de deux natures, les uns, vers le sommet de l'épi, contenant des microspores, c'est à dire, des anthéridies; les autres, situés vers la base de l'épi, renfermant des macrospores ou spores germinatives.

"La forme et le mode d'insertion des sporanges, leur grand volume, le numbre considérable de macrospores qu'ils renferment, l'absence de toute trace de ligne de déhiscence régulière, font surtout ressembler ces organes à ceux des *Isoëtes;* mais dans ces plantes ces sporanges sont insérés sur la base même des feuilles qui naissent d'une tige très-courte et bulbiforme. Dans la plante fossile, au contraire, ces sporanges sont portés par des sortes de bractées, ou feuilles squamiformes, réunies en un épi, qui, comme ceux des *Selaginella,* terminait probablement les rameaux.

"Il y a donc là une combinaison particulière de caractères: sporanges analogues à ceux des *Isoëtes* réunis en un épi semblable à celui des Lycopodes et beaucoup plus grand."

M. Brongniart has been so kind as to forward to me a drawing of a sporangium and the macrospores contained in it, as well as of the microspores from his cone.

§ 21. *Schimper.*—Dr. Schimper[1] describes and figures the same fossil as M. Brongniart has treated of, and, terming it "*Lepidostrobus Dabadianus*, Sch., describes it as oblongo-cylindraceus, centim. $11\frac{1}{2}$ longus, in medio centim. 5 latus, extus cicatricibus tectus hexagonis millim. 6—8 latis, totidem altis, exacte contigiis, in medio tuberculo irregulari laminæ deciduæ residuo instructis, secundum ordinem $\frac{2}{27}$ dispositis; microsporis strobili dimidium superius occupantibus, illis præcedentis similibus; macrosporis sporangia dimidii inferioris tenentibus multo majoribus, sphæricis, tetraedri solum cacumen monstrantibus."

Dr. Schimper appears to distinguish the macrospores of his *Lepidostrobus Dabadianus* from the capsules described by Goldenberg; and he classes my Wigan specimens, which evidently are the uncompressed forms of the same fossil, found in splint coals, with that author's macrospore. Under the head of *Sigillaria* he says (p. 105):

[1] 'Traité de Paléontologie végétale, ou la Flore du Monde Primitif dans ses rapports avec les formations géologiques et la Flore du Monde actuel.' Part I, vol. ii, p. 69.

"B. *Spicæ fructificatonis.*

Sigillariostrobus, 'Sch. Atlas,' Plate LXVII, figs. 12, 24.

"Spicæ pedicellatæ strobiliformes oblongo et elongato-cylindraceæ, bracteis e basi ovato triangulari subito angustatæ, lanceolatæ, medio costatæ. Sporæ sporangio bracteæ basis lateri anteriori adfixo (incluso?) inclusæ, magnæ (macrosporæ?) et minores (microsporæ?) tetraedræ.

"Les épis que je rapporte avec M. Goldenberg aux *Sigillaria* se distinguent facilement de ceux des *Lepidodendron* par leurs bractées, dont la base sporangiophore est insérée presque verticalement, au lieu de l'être horizontalement, comme dans ces dernièr. Le sporange occupe toute la largeur de la base de la bractée, et parait avoir été d'une consistance très tendre. Les spores sont de grandeur differente, des macrospores et des microspores; les premières offrant un diamètre de 1, $1\frac{1}{2}$, à 2 millimètres, les autres à peine celui de 1 millimètre (voy. notre planche, figs. 16, 20, 23). Les macrospores se rencontrent souvent en très-grande quantité dans les couches à *Sigillaria* et *Stigmaria* et quelquefois dans l'intérieur de ces troncs.

"Les épis eux-mêmes étaient fixes au tronc entre les coussinets foliaires, soit en suivant les séries droites (orthostiques, voy. notre planche, fig. 2*a*), soit en suivant les lignes obliques ou la spire fondamentale. Nons avons donné plus haut la description des cicatrices que ces épis ont laissées sur les troncs."

III. Remarks on Macrospores and Microspores.

Professor Morris many years ago remarked of the capsules from the Coalbrookdale Coal-field that they are neither mineralized nor bituminized (see above, p. 41), but in a state of brown vegetable matter. On finding similar bodies in some of the Low Moor Coals, he attributed the excellent qualities of those beds for the manufacture of iron to the presence of the spores. It is well known that the soft caking coal of Low Moor, called the "Better Bed," as well as the celebrated hard coal of Elsicar, Yorkshire, and all the Scotch splint coals, have been long prized for their iron-making qualities; but the goodness of the latter may have arisen from their great power of sustaining weight in the furnace, and their freedom from sulphur, as well as from their containing any peculiar hydrocarbon derived from the spores. In the rich Boghead and Methel Cannels the spore is found, but not in such quantity by any means as in the splint coals. On making a section of either of these last-named coals for microscopic observation, and examining it under a three-quarters power, it appears as a dark-coloured vesicular mass, having its vesicles filled with a yellowish matter. In the celebrated Boghead Trial these were mistaken, by some of the witnesses, for the cellular structure of plants, and all the evidence of the chemical witnesses went to show that they had not been able to dissolve such yellow matter out of the coal by the most powerful solvents. When, however, the coal is subjected to distillation at a low temperature, this matter goes off as a yellowish vapour, which, on being condensed, forms crude paraffine oil. On afterwards examining the coke, it is found to be a black pulverulent mass, very porous, and containing numerous vesicles, from which the yellow matter, first seen under the microscope, had been expelled by the heat. Now, although at present we cannot account for the rich oil-producing qualities of these coals by the macrospores found in them, it is possible that the microspores of some cones, not far removed from *Flemingites* or *Lepidostrobus*, may have largely entered into their composition and produced it. These smaller bodies appear to have been preserved in coal, like the larger ones, without having undergone much alteration; but, owing to their smaller size, they have generally not attracted much notice.

As might have been anticipated from their great power of resisting decomposition, the organs of fructification of recent plants would be most likely to be preserved at the present day, so we find that such also are the portions of plants most completely preserved in the coal beds. This is most probably owing to the fatty oils and waxy substances which protect them, as well as to the presence of tannin. Baron Reichenbach first discovered paraffine in the wood of the Beech, whose leaves have on their outsides a thick coating of waxy matter; and the great quantity of paraffine found in brown cannel coals, such as those of Boghead and Methel, may be partly due to the waxy matter of the organs of fructification and leaves of the ancient plants, with which they were enabled then to resist moisture, as is now found to be the case in the Cabbage, Nasturtium, and other plants; the paraffine now found in the coal being in much the same state as it existed in the old plants, and very little altered.

The microspores contained in the upper sporangia of *Lepidostrobus Brownii* (Carruthers), which may now probably be regarded as the fructification of *Lepidodendron Harcourtii*, are very little altered, and appear like crude paraffine, and different in composition from the sporangia in which they are enclosed, and the column to which they are attached, both these being chiefly composed of carbonate of lime.

In Mr. Carruther's specimens of the genus *Flemingites*, the small round bodies which he terms sporangia (see above, p. 42), but which some of the first living authorities now consider to be macrospores, appear to consist so far as their outer covering is concerned, of paraffine or some similar hydrocarbon, whilst their insides contain bisulphide of iron or carbonate of lime, according to the nature of the matrix in which the fossil occurs. Generally the scale which supported them, according to Mr. Carruthers, or the sporangium that contained them, as well as the column of the cone to which they were attached, have been converted into coal, and lost all their structure. In other cases the last-named portions of the plant have been converted into carbonate of lime, while the sporangia or macrospores consist of paraffine. In my cabinet is a mass of macrospores, near a cone with sporangia, and these bodies, on light being transmitted through them, show in their interior granular bodies, in appearance like the coriaceous envelope of the macrospore in which they are enclosed.

Mr. Carruthers, in his Memoir, appears to class all the spore-like bodies found in coals and ironstones, whether they have a rough or smooth outside, or are furnished with a tri-radiate ridge on the lower part or not, as sporangia, under his new genus *Flemingites*. This appears to me to be going probably rather too far, in the present state of our knowledge. These bodies, be they sporangia or macrospores, appear to have been a common form of the organs of fructification during the Carboniferous Epoch; and, although doubtless some of the sporangia containing them were arranged spirally round the column of the cone, as in *Lepidostrobus,* others were arranged verticillately in whorls around the axis, as in the organs of fructification of *Calamodendron commune.* As to the latter, Mr. Carruthers appears to think, according to his statement in the 'Geological Magazine'[1] (vol. vi, p. 155), that none of them have been found so arranged. A specimen, however, will be described in this Monograph, not only showing this verticillate arrangement, but the connection of the cone with a stem bearing branches and leaves, hence the genus *Flemingites,* if it remain, will scarcely suffice to hold all the disc-shaped bodies described by Professor Morris, myself, Goldenberg, Balfour, and others. As to their all being macrospores, it appears to me there can be little doubt but there are macrospores not of one plant, but of many distinct plants.

IV. Description of the Specimens.

§ 1. The Specimens (*Lepidodendron Harcourtii* and *Lepidodendron vasculare*), Nos. 17, 18, 19, *and* 20. Plates VII and VIII.

Specimen No. 17, *Lepidodendron Harcourtii* (Plate VII, figs. 1—5, 7—10).

Fig. 1 is a fragment of a cone, one and a half inches in length, one and a quarter inches across its major, and one inch across its minor axis. Although doubtless originally cylindrical, it has now somewhat of an oval section. The outside of the fossil, which is deprived of the upper portions of its scales or bracts, exhibits rhomboidal scars in every respect similar to those usually found on *Lepidostrobus ornatus;* and is most probably either the middle or the upper part of such a cone, It was found in a calcareous nodule from the Upper Foot Coal, near Oldham (marked with three asterisks in the section previously

[1] In this paper Mr. Carruthers states that *Lepidostrobus variabilis* is really a specimen of *Flemingites gracilis.*

given at p. 12), by Mr. James Whitaker, of Watershedding Bar, near Oldham, who has kindly allowed me to slice the specimen and examine it.

Figure 2 is a transverse section of the specimen, of the natural size, showing the central axis and sixteen irregularly pear-shaped sporangia, each about half an inch in length, radiating from it.

Figure 3 represents a longitudinal section (natural size) of the central axis and the scales or bracts, which have a spiral arrangement and support sporangia, on each side of it.

Figure 4 is the transverse section of the cone, magnified two diameters, showing its internal structure. The centre, originally composed of cellular tissue, and for the most part destroyed, has been replaced with carbonate of lime. It is surrounded by a zone of hexagonal tubes, having their sides barred by transverse striæ. This is bounded on the outside by a sinuous dark line, from which are seen to spring the bundles of barred vessels that communicate with the scales or bracts. These vessels traverse, in a highly inclined curve upwards, a band of cellular tissue which has been mostly removed and replaced by mineral matter. The outside of the axis shows elongated cells or utricles arranged in radiating series, similar to what are usually found on the outside of stems of *Lepidodendron Harcourtii*, and described at length by Messrs. Witham, Lindley and Hutton, and Adolphe Brongniart.

Fig. 5 is a transverse section of the same part of the axis last described, magnified forty-five diameters.

Fig. 7 is a horizontal section of a single sporangium (magnified five diameters), showing its irregular pear-shaped form. The wall is composed of one line of transversely elongated cells; and the inside is a mass of microspores, many of which divide into three, some into four, and others into five sporules, all composed of a yellowish-brown hydrocarbon, resembling crude paraffine in appearance. In every respect this sporangium and its contents so closely resemble that of the cone described by the late Dr. Robert Brown that a description of one would nearly do for the other.

Fig. 8 is a vertical section (magnified four and a quarter diameters) of the pedicel and apex of a scale or bract, and of its underlying sporangium, that has an elongated oval form. The scale or bract is chiefly formed of cellular tissue, enclosing in its centre a bundle of vascular tissue, which is seen in the specimen to proceed from the axis and traverse the scale to its apex. The apex is broad, dilated at right angles to the pedicel, produced upwards into a triangular acute point, and downwards into a blunt lobe, as described by Dr. Hooker.[1] This sporangium was probably of an elongated oval form, and the notch shown in the lower part of this sporangium towards the axis is due to some disturbing cause, as it is not seen in the other sporangia of the cone.

Fig. 9 is a longitudinal section of the central axis of the cone, magnified forty-five diameters, showing the place of the pith (most probably composed of cellular tissue, but

[1] 'Mem. Geol. Surv.,' vol. ii, part 2, p. 450.

destroyed in the specimen), and the vascular cylinder of seven barred vessels on each side. Those next the pith being considerably larger than those on the outside.

Fig. 10 represents a longitudinal section of a portion of the wall of the sporangium, composed of a single line of transversely elongated cells, and a group of microspores, composed of crude paraffine, and dividing into three, four, and five sporules, but far more frequently into three; magnified fifty diameters.

This specimen in all its parts resembles Dr. R. Brown's Cone; and the only additional information that it affords is the structure of the central axis wanting in his specimen. The structure of the central axis in the Oldham specimen in all its parts, except the medulla of cellular tissue, is so closely identical with that of the stem of *Lepidodendron Harcourtii* (see Specimen No. 18, fig. 6, next described), that there can be little doubt as to its having been the fructification of that plant; and most probably Dr. Brown's specimen belonged to it also, as it exactly resembles my specimen, except that the central axis has been destroyed so far as structure is concerned. Now M. Brongniart is of opinion that Dr. Brown's *Triplosporites* is identical with his specimen. If this be so, the last-named genus has to be merged into *Lepidostrobus*,[1] if not to *Lepidodendron Harcourtii.*

Specimen No. 18, *Lepidodendron Harcourtii* (Plate VII, fig. 6).

Fig. 6 is the transverse section of the inner portion of a stem of *Lepidodendron Harcourtii*, magnified ten diameters, showing the central axis or pith composed of fine cellular tissue, surrounded by a zone of fine vascular tubes (of a hexagonal form, and having their sides barred with transverse striæ) and a sinuous boundary-line, of a dark colour, from which spring the vascular bundles that communicate with the leaves. The outer portion of the specimen clearly shows the band of lax cellular tissue, traversed by vascular bundles, and the outer radiating zone so usually found in stems of *Lepidodendron* exhibiting structure.

This specimen was presented to me by Mr. J. S. Dawes, F.G.S., and was found by him in the Dudley Coal-field. It is described and figured for the purpose of showing the identity of the structure of the stem of *Lepidodendron Harcourtii* with that of the axis of the Cone above described. If similarity of structure is of any value in proving the connection of organs of fructification with a stem, the Oldham Cone must be held to belong to *Lepidodendron Harcourtii.*

[1] As Dr. Brown himself and Mr. Carruthers also have shown; see 'Geol. Mag.,' vol. ii, p. 437.

Specimen No. 19, *Lepidodendron vasculare*. Plate VIII, figs. 1—5, 7—9.

Fig. 1 is a fragment of a Cone, one and eight tenths of an inch in length, one and one tenth of an inch across its major, and one inch across its minor axis. This Cone is somewhat compressed out of its original cylindrical form, but not so much as is the Specimen No. 17. The fossil has lost the upper portions of the scales or bracts, in shelling out of its matrix, but it shows the rhomboidal scars of *Lepidostrobus*. They are not so broad as those of the last-described specimen. It also came from the Upper Foot Coal, near Oldham, and was found by Mr. John Butterworth, who has liberally allowed me to slice and describe it.

Fig. 2 is a transverse section of the specimen (natural size), showing the central axis of the Cone in a fair state of preservation; but the Sporangia connected with it are much disarranged, so that it is impossible to say how many there were in its original state.

Fig. 3 is a longitudinal section (natural size) of a portion of the Cone, showing the central axis and the scales or bracts, arranged in spiral order, and supporting Sporangia on each side of it.

Fig. 4 is a transverse section of the Cone, magnified two and a quarter diameters, showing the arrangement of the central axis, composed of hexagonal barred tubes, the smallest being towards the outside, where there is a dark line, nearly circular, and not so sinuous as in the last-described specimen. From this boundary-line spring bundles of barred vessels, that pass through the zone of cellular tissue, and communicate with the scales or bracts. These vessels traverse, in a highly inclined curve, a band of lax cellular tissue, which has for the most part been replaced by carbonate of lime. The outside of the axis exhibits elongated cells or utricles, arranged in radiating series, resembling those found in *Lepidodendron Harcourtii*. In the inner portion of the axis appear two circular bodies; one (in the upper part of the figure on the right hand side) having a white space, is the central axis of the plant, magnified in fig. 5; and the other (in the lower part on the left hand side) shows one of the vascular bundles which communicated with the scales or bracts.

Fig. 5 is also a transverse section of the inner portion of the central axis previously described, but magnified thirty-five diameters. The middle part is not very well preserved, but it sufficiently shows that the pith or medulla occupied by cellular tissue in *Lepidodendron Harcourtii* is here formed of barred tubes, like those in *Lepidodendron vasculare* and *Sigillaria vascularis*.

Fig. 7 is a horizontal section of a single Sporangium and a portion of a pedicel of a scale or bract, magnified five diameters. The former is so much disarranged that its original form cannot now be well recognised; and no trace of Microspores can be seen, the whole of the Sporangium having been changed into carbonate of lime. If any Microspores ever were in the Sporangium, they may have been shed or destroyed before the calcification of the Cone.

Fig. 8 is a vertical section of the pedicel and apex of a scale or bract (magnified four diameters) tolerably well preserved, together with part of the Sporangium which it supported, not so well preserved. The structure and shape of the bract is like that shown in Plate VII, fig. 8; but of the original form of the Sporangium there is not much evidence left. No trace of Microspores, or of paraffine, is now to be seen in it. The scale is chiefly formed of cellular tissue, enclosing in its centre a bundle of vascular tissue, which is shown in the specimen to proceed from the axis and to traverse the scale to its apex. This latter is broad, dilated at right angles to the pedicel, and produced upwards into a triangular acute point, and downwards into a blunt lobe, as described by Dr. Hooker in his *Lepidostrobus*.

Fig. 9 is the longitudinal section of the inner portion of the central axis of the Cone, magnified twenty-eight diameters.

In both specimens, No. 17 and No. 19, the chief value of the information they afford is in the structure of the axes of the two Cones. In the specimens treated of by Dr. Brown, Dr. Hooker, and MM. Brongniart and Schimper, the upper portions of the Cones (so far as the scales or bracts and Sporangia are concerned) have been fully described by the two former authors, and the whole of the Cone by the two latter; but there is no complete description of the structure of the central axis. My specimens appear to me to supply to a great extent that deficiency. We have seen how the whole of the specimen "No. 17" not only agrees with that of Dr. Brown, but that its axis is identical in structure with that of *Lepidodendron Harcourtii*. M. Brongniart appears to think that Dr. Brown's specimen was merely the upper part of a Cone similar to his, called by Prof. Schimper *Lepidostrobus Dabadianus*. If this should be proved to be the case, both my "No. 17" and Dr. Brown's specimen may probably prove to be the upper portion of a Cone with Sporangia containing Microspores, having its lower portion composed of Sporangia containing Macrospores, and thus prove that all these three cones are the fructification of *Lepidodendron*, and, not unlikely, that of *L. Harcourtii*.

No. 19 bears considerable resemblance in structure, so far as its central axis is concerned, to the stem of *Lepidodendron vasculare* (see below); and therefore it is here referred to that plant, but not without doubt. One thing is certain that, although externally it is like No. 17, it is quite a different Cone so far as its internal structure is concerned. This specimen also, probably owing to its advanced stage of growth, had shed its Spores before it was mineralized.

Specimen No. 20; *Lepidodendron vasculare*. Plate VIII, fig. 6.

Fig. 6 is a transverse section of the inner portion of a stem of *Lepidodendron vasculare*, magnified twelve diameters, showing the centre, composed of hexagonal tubes of barred vessels of different sizes, more regular and of less diameter towards the outside. There is also an outer zone of tissue, with interruptions in it.

This is a representation of the specimen described and figured (p. 110, Plate VI, figs. 2 and 3) in my paper "On some Fossil Plants, showing Structure, from the Lower Coal-Measures of Lancashire."[1] It is here reproduced for the purpose of showing the structural similarity of the axis of the Cone now under consideration with that of *Lepidodendron vasculare,* and its difference from *Lepidodendron Harcourtii* (see above, page 48).

§ 2.—SPECIMENS Nos. 21 and 22; *Lepidostrobus Russellianus,* sp. nov. Pl. IX, figs. 1, 1 *a*, 2, 2 *a*.

Specimen No. 21, *Lepidostrobus Russellianus* (Plate IX, fig. 1), natural size, is a compressed imperfect Cone, six inches in length, by eight tenths of an inch in breadth, having a central column one tenth of an inch in diameter. The upper portion of the fossil is not preserved, so its form is unknown; but the lower portion, for about two inches, shows the scales or bracts of the Cone, springing nearly at right angles to the column, and arranged in spiral order, together with numerous disc-shaped bodies, about one thirty-second of an inch in diameter, having their insides smooth and coriaceous, and their outsides granular, but showing no clear evidence of a triradiate ridge, although there is some sign of an elevation on some of the discs.[2] The bracts on the upper part of the Cone do not show such bodies.

The matrix in which the fossil is imbedded is a Black Band Ironstone; but the disc-shaped bodies are chiefly composed of granular bisulphide of iron, coating the coriaceous layer, of a yellowish colour, on their outsides; whilst their insides are full of a granular substance of a bright-yellow colour, also resembling bisulphide of iron. The column, scales, and Sporangia are all converted into coal, and as yet have afforded no evidence of their former structure.

This and the four next described specimens are from the Coal-measures, near Airdrie, Scotland, and were found by Mr. James Russell, of Chapelhall.

Fig. 1 *a* (magnified five diameters) represents a portion of the column of the Cone and two Sporangia, each containing fifteen of the disc-shaped bodies, in seven pairs and one at the end. The scale or bract goes out nearly at right angles from the column to the end of the Sporangium, when it turns upwards nearly parallel to the stem. Both the scale and Sporangium have been converted into a mass of coal. The discs are both concave and convex; and some of them appear as if they had been separated into two by the splitting of the specimen.

[1] 'Quart. Journ. Geol. Soc.' for May, 1862, vol. xviii.

[2] In this, as well as in the other specimens of macrospores hereinafter described, no conclusive evidence of a triradiate ridge has been observed.

Their arrangement appears to me to show that they were contained in a Sporangium, and were Macrospores, rather than separate Sporangia, attached to the surface of the scales, as Mr. Carruthers described was the case in his specimen;[1] and hereinafter they will be termed Macrospores.

This specimen also shows the Macrospores only on the lower, and not on the upper, part of the Cone. The outside of the scales is not very well shown; but their quincuncial arrangement and the form of the scar, where they were attached to the column, are both very clearly shown, and cannot be distinguished from such parts in *Lepidostrobus* or the leaf-scars of *Lepidodendron*. It is named *Lepidostrobus Russellianus* from Mr. Russell, who discovered the specimen.

Specimen No. 22, *Lepidostrobus Russellianus*. Plate IX, figs. 2 and 2 *a*.

Fig. 2, of natural size, is another compressed, imperfect Cone of *Lepidostrobus Russellianus*, four inches long, nine tenths of an inch in breadth, and having a column one tenth of an inch across. The upper part is wanting; but what of the lower portion now remains shows Sporangia, of a somewhat oval form, springing nearly at right angles from the column, and full of Macrospores, only one thirty-second of an inch in diameter but similar in all other respects to those described in the last specimen, No. 21; and like it, the base and apex of the Scale or Bract and the Sporangium-wall are not well shown, all these parts being converted into bright coal, so that none of them can be clearly distinguished. The scars on the column of the Cone shows that the Scales were arranged spirally around the axis.

Fig. 2 *a* (magnified five diameters) shows a portion of the column of the Cone, with traces of the Bract-scars, and a single Sporangium, containing fourteen Macrospores, arranged in a double series, like those in Specimen No. 21, except that the odd one at the end is here wanting. The Macrospores have their outsides formed of a yellowish paraffine, covered with granular bisulphide of iron. Their insides contain bright granules of bisulphide of iron, which at first sight might be mistaken for Sporules.

As this Cone is not to be distinguished from No. 21, it has also been called *Lepidostrobus Russellianus*. It is also from a Blackband Ironstone near Airdrie.

§ 3. Specimen No. 23, *Lepidostrobus* (?) *dubius*, sp. nov. Plate IX, figs. 3, 3 *a*.

Specimen No. 23, Plate IX, fig. 3, is another imperfect, compressed Cone, from the Blackband Ironstone, near Airdrie, four inches in length, six tenths of an inch in breadth, with a column one twelfth of an inch wide. All the Cone exposed shows

[1] 'Geological Magazine,' vol. ii (No. XVI), p. 434.

Scales or Bracts springing almost at right angles to the column, and supporting Sporangia, full of Macrospores, one twenty-fifth of an inch in diameter, very similar in their characters and state of preservation to those contained in the two specimens described above. The apices of the Scales are both longer and stronger than those of No. 21 and No. 22. The column is not so well exposed, and the lower portion is covered up in the matrix of Blackband Ironstone, so that the connection of the Cone with the associated stem, striated, knotted, and jointed, resembling a small Calamite, cannot be traced, a quarter of an inch intervening. The occurrence of this stem may be accidental, having no connection with the Cone, but the column of the latter, if projected forwards, would run to the joint of the stem; and as there are two specimens, No. 27 and No. 30, connected with somewhat similar stems and containing Macrospores, to be hereinafter described, it is possible that this Cone may have belonged to a different plant than those of No. 21 and No. 22. For this reason it has been designated *Lepidostrobus* (?) *dubius*.

Fig. 3 *a* (magnified five diameters) represents a portion of the column and two Scales supporting two Sporangia, each containing three large Macrospores, with several smaller ones; the upper Sporangium has eight smaller ones, in two rows, and one by itself at the end; whilst the lower Sporangium contains eleven of the smaller Macrospores, in five pairs, and one at the end. In all other respects the Sporangium and its Macrospores, in their present state of preservation and contents, cannot be distinguished from those previously described. The presence of the striated, jointed, and knotted stem, and the different sizes and arrangement of the Macrospores, may be differences indicating that this specimen is more allied to No. 27 and No. 30, hereinafter described, than to No. 21 and No. 22. As there is no evidence to show that the Scales were spirally arranged round the column, it is possible that they may have had a verticillate arrangement, as in specimens to be hereinafter described.

§ 4. Specimen No. 24; *Lepidostrobus tenuis*, sp. nov. Pl. IX, figs. 4, 4*a*.

Specimen No. 24 (Pl. IX, fig. 4, natural size) represents another imperfect compressed Cone, two and two tenths of an inch long, six tenths of an inch broad, and having a column about one fortieth of an inch thick. Both the upper and lower portions of the Cone are wanting; but the whole of the specimen shows Scales or Bracts, supporting elongate-oval Sporangia, containing Macrospores, one twenty-fifth of an inch in diameter, in a similar condition to the specimens previously described. The only remarkable feature in this specimen is the great delicacy of the Scales and Column, which are much less in size than in any of the other specimens. The apex of the scale also is more divergent, and is not so parallel to the column as in No. 21.

Fig. 4*a* (magnified 5 diameters) shows two Scales and two Sporangia, each containing Macrospores, all nearly of the same size; fourteen are seen in the upper Sporangium, and fifteen in the lower one. The apex of the Scale is stronger, and diverges more from the vertical direction than most of the specimens previously described.

This *Lepidostrobus* may be of the same species as No. 21 and No. 22, but for the present it is probably better to distinguish it as a provisional species by the name of *tenuis*.

§ 5. Specimen No. 25; *Lepidostrobus levidensis.* Pl. X, figs. 1, 1*a*, 1*b*.

Specimen No. 25 (Pl. X, fig. 1, natural size) represents a beautiful Cone in a compressed state, and nearly perfect, six and a half inches in length and eight tenths of an inch in breadth; its central column or axis measuring one tenth of an inch across. This is longer, and tapers more than any of the specimens previously described. Excepting a small portion, it shows the apex. The base of the Cone is broken off, so we cannot now see how far it may have extended; but for the space of an inch the lowest part of the Cone shows Scales or Bracts arranged in spiral order around the column, springing out at right angles to it, and supporting elongate oval Sporangia, full of Macrospores, one twentieth of an inch in diameter. The upper portion of the Cone is for the most part covered with rhomboidal scales; but on the right hand side, near the top, are exposed some oval Sporangia, containing very small spheroidal bodies, converted into a substance like paraffine, and resembling Microspores. Thus we have, in this case, a Cone, with the form and external characters of a *Lepidostrobus,* possessing two kinds of Sporangia, namely the lower series inclosing Macrospores similar to those described in the previous specimens, and the higher set containing Microspores resembling those in *Lepidostrobus Dabadianus,* Schimper.

Fig. 1*a* (magnified 2½ diameters) represents a portion of the Column of the Cone, showing the Scars of the Bracts, arranged in quincuncial order, and four Bracts on each side of the Column, at right angles to it, and supporting long-oval Sporangia, containing from fourteen to sixteen Macrospores in each. The Macrospores are chiefly composed of granular bisulphide of iron on a coriaceous covering of a yellowish colour. Their insides consist also of grains, resembling bisulphide of iron. The Column, Bracts, and Sporangia are converted into coal, and as yet have afforded no evidence of their former structure.

Fig. 1*b* (magnified 5 diameters) represents a Bract, supporting an irregularly oval Sporangium, full of small spheroidal bodies, converted into a yellowish substance like paraffine, and resembling Microspores. Of course these Microspores are not so clear and distinct as those seen in Specimen No. 17, by the aid of transmittent light; but they are of the same substance, and much like those bodies when seen by reflected light. They appear to be about the same size as those found in *Lepidodendron Harcourtii.*

§ 6. Specimen No. 26 ; *Lepidostrobus Hibbertianus*, sp. nov. Pl. X, figs. 2, 2*a*, 2*b*.

Specimen No. 26 (Pl. X, fig. 2, natural size) represents another compressed Cone, nearly perfect, six inches in length, and nine tenths of an inch in breadth, with an axis one tenth of an inch across. A portion of the apex is wanting, but the greater part of the base is left, so that this Cone is in a more perfect condition than those previously described. For the greater part it exhibits a surface of broad, rhomboidal, and imbricated Scales (ends of Bracts), arranged spirally; but for about an inch of the lower portion stout Bracts are seen springing from the column at right angles, and bearing long-oval Sporangia, full of Macrospores, one twenty-eighth of an inch in diameter.

In its external character this specimen is not to be distinguished from *Lepidostrobus ornatus*, and most collectors would class it in that species. The only remarkable features it possesses are the Sporangia containing Macrospores.

This Cone is imbedded in Burdiehouse Limestone, from near Edinburgh, and not in Blackband Ironstone, as the five preceding specimens are; but the Column and Bracts are converted into coal, and the coriaceous covering of the Macrospores is of a yellowish matter, like crude paraffine, as in those other specimens. This fossil, from the Collection of the late Dr. Hibbert, of Edinburgh, was purchased by me at the sale of his museum.

Fig. 2*a* (magnified 5 diameters) represents a portion of the central Column and two well-defined Scales or Bracts, running at right angles from the Column, afterwards turning upwards nearly parallel to it, and supporting two long-oval Sporangia, full of Macrospores. In each Sporangium there are seen sixteen Macrospores, seven in the upper and eight in the lower series, with a terminal one.

Fig. 2 *b* (magnified five diameters) represents four of the rhomboidal scales on the upper part of the specimen.

This Cone[1] is named after that well-known geologist, Dr. Hibbert, of Edinburgh, in whose collection it was found.

§ 7. Specimen No. 27 ; *Lepidostrobus* (?) *ambiguus*. Pl. XI, figs. 1, 1*a*, 1*b*.

Specimen No. 27, Plate XI, fig. 1 (natural size), represents the stem and the lower part of a compressed Cone, the upper portion of which is wanting. Exclusive of the Stem it is one and one tenth of an inch in length, and four tenths of an inch in breadth. The leaves connected with the Stem, and the remaining Bracts of the Cones appear to have been

[1] It is desirable that the upper portion of this Cone should be carefully ground down, in order to ascertain whether or not it contains Sporangia, full of Microspores, similar to those found in the specimen last described. It appears to me that this could be done with some little trouble.

arranged in whorls, and not spirally, as the Bracts are in most of the specimens previously described. In the upper part the Bracts go off from the column nearly at right angles, supporting oval Sporangia ; whilst in the lower part the Bracts are inclined downwards at a considerable angle. The Sporangia all contained Macrospores, about one twenty-fifth of an inch in diameter ; but, owing to compression, their characters are not well shown.

This interesting specimen, consisting probably of not even all the lower half of the original cone, was found in the Carboniferous Ash-beds at Laggan Bay, in the Isle of Arran, by Mr. Russell.

Fig. 1*a* represents the lower part of the Cone and the upper portion of the stem, to which it is attached, magnified five diameters. The Leaves connected with the stem are not very well defined ; but they appear to have had a verticillate arrangement. The Sporangia in the lower part of the Cone were pear-shaped, and inclined downwards ; and, from signs of Macrospores in the specimen, they appear to have contained those bodies, which are not well shown.

Fig. 1*b* (magnified five diameters) represents the crushed upper portion of the specimen ; and in it are seen some indistinct Macrospores.

This imperfect specimen is here figured and described for the purpose of showing that some of these Cones have their Leaves and Scales arranged verticillately. It bears some resemblance to No. 23 previously described, and to No. 30 hereinafter described (Plate XII, fig. 1). It is named provisionally *Lepidostrobus ambiguus*.

§ 8. Specimen No. 28 ; *Lepidostrobus Wuenschianus*, sp. nov. Pl. XI, figs. 2, 2*a*, 2*b*, 2*c*.

Specimen No. 28, Pl. XI, fig. 2 (natural size), represents a slender cone, one and eight tenths of an inch in length, and four tenths of an inch in breadth, found in the ash-beds at Laggan Bay by Mr. Russell. A portion of the Cone next the Stem is unfortunately wanting, but the specimen, on the whole, is in a more perfect condition than any of those previously described. The Sporangia are of an irregular oval form, and are supported by Scales or Bracts, which, in the middle of the specimen, spring from the Column at right angles, show a spiral arrangement, and have their apices pointing upwards nearly parallel to it. The Sporangia contain Spores of two kinds: the upper ones being filled with a granular matter, composed of small spheroidal Microspores; whilst the lower Sporangia, on each side of the column for the last four, so far as exposed, had Macrospores one twentieth of an inch in diameter, with granulated outsides. In each of the latter Sporangia there appears, from the evidence afforded by the specimen, to have been three Macrospores.

Fig. 2*a* (magnified five diameters) represents the upper part of the Cone, showing the apex and six Scales on each side of the Column, supporting Sporangia filled with fine granular matter.

Fig. 2*b* (magnified five diameters) represents the lower part of the Cone next the Stem, and exhibits evidence of four Scales, on each side of the Column, supporting Sporangia, containing Macrospores.

Fig. 2*c* (magnified ten diameters) represents a single oblong-oval Sporangium, full of spheroidal Microspores, from the upper part of the Cone. The Microspores are very small, and cannot be separated for measurement with any degree of certainty, owing to their having been converted into a bright substance resembling iron-pyrites.

Although this Cone is the least of any of the specimens described, its Macrospores are some of the largest. It has been named after Mr. Wünsch, who first discovered the true nature and position of the ash-beds in the Carboniferous formation at Laggan Bay.[1]

§ 9. Specimen No. 29; *Lepidostrobus latus,* sp. nov. Pl. XI, figs. 3, 3*a*, 3*b*, 3*c*.

Specimen No. 29, Pl. XI, fig. 3 (natural size), represents a stout Cone, of an oval form, nearly two inches in length by seven tenths of an inch in breadth in its middle, from the ash-beds of Laggan Bay; also found by Mr. Russell. This is by far the most robust Cone that has come under my notice. It was covered by strong Scales; each Bract having a thick median rib, and taking nearly a vertical direction, as shown in the upper portion of the specimen. In its middle and lower portions the specimen has lost its Bracts, and affords evidence, although not so well marked as in the specimen last described, of two kinds of Sporangia; the upper ones exposed being pear-shaped, and containing apparently Microspores; and the lower ones which slope downwards have irregularly discoidal bodies like Macrospores.

Fig. 3 *a* (magnified five diameters) shows the upper portion of the Cone and its stout, ribbed Scales.

Fig. 3 *b* (magnified five diameters) shows the lower part of the Cone with its Sporangia, and Scales inclining downwards, and some bodies resembling Macrospores.

Fig. 3 *c* (magnified fifteen diameters) shows a pear-shaped Sporangium, from the upper part of the Cone, filled with small granular bodies resembling Microspores.

The three specimens last described are, as previously stated, from the trap-ash of Laggan Bay, the same deposit as that from which the beautiful stems of *Sigillaria, Lepidodendron, Halonia, Antholithes,* and other Coal Plants discovered by Mr. Wünsch, of Glasgow, were obtained. The ash enveloping the stems is sometimes nearly as hard as greenstone, and at other times quite soft and pulverulent. It is of a greyish colour, contains small bright pieces of iron-pyrites, and is intersected by narrow veins of common and fibrous carbonate of lime: the mass effervesces when treated with hydrochloric acid. By the kindness of Mr. Wünsch, I am enabled to give the chemical composition of this ash.

[1] 'Transact. Geol. Society of Glasgow,' vol. ii, p. 97.

"It consists of carbonates, soluble and insoluble silicates, quartz, and iron-pyrites. The carbonates are removed by dilute acetic acid, and consist of carbonate of lime, with a very little of carbonate of iron, and carbonate of magnesia. The insoluble silicates consist principally of the silicate of alumina, with a little lime, magnesia, potash, and soda.

"Composition of the 'Ash,' after drying it at 212° Fah.:

Soluble silicates and carbonates.	Silicic acid	13·20
	Ferrous oxide	18·26
	Manganese	·78
	Alumina	8·13
	Lime	13·47
	Magnesia	5·06
	Carbonic acid	8·40
	Insoluble silicates	28·76
	Bilsulphide of iron	·70
	Water	3·23
		99·99

Specific gravity 2·790.

"Analysis of a stem of *Lepidodendron* from the Ash, previously dried at 212° Fah.

Carbonate of Lime	89·16
Carbonate of Magnesia	1·26
Carbonate of Iron	1·06
Carbonate of Manganese	2·22
Ferric Oxide	1·39
Insoluble matter	2·24
Carbon	2·44
	99·77

Specific gravity 2·611."

The analysis of this fossil plant shows apparently that the decomposing wood had the power of attracting the carbonate of lime from the surrounding matrix in which it was imbedded.

Both the form and the structure of the fossil plants in the ash have been beautifully preserved. They remind us much of the plants found in the Coal-measures of Lancashire, so far as their genera and species are concerned. From the appearances which they now present, we see they were growing in water, on the spots where they are now found, when fine ash, erupted from a neighbouring volcano, quietly and gradually enveloped them in the matrix in which they occur. We find the fragile leaves of the most delicate *Sphenopteris*, and the fine-pointed leaves of *Lepidodendron*, just as they grew, without the slightest fracture or disarrangement. Nearly all the stems appear to have suffered little from compression or disturbance in their parts. (See notices of this trappean ash interstratified with the Lower Carboniferous series of Arran, in the 'Geol. Mag.,' vol. ii, 1865, p. 474; vol. iv, 1867, p. 551; 'Trans. Geol. Soc.,' Glasgow, vol. ii, part 2, 1866, p. 97, &c.).

§ 10. SPECIMEN No. 30; *Bowmanites Cambrensis*, gen. et sp. nov. Plate XII, figs. 1, 1 *a*, 1 *b*, 1 *c*, 2, 3.

Pl. XII, fig. 1 (natural size), and fig. 1 *a* (magnified two diameters), represent a branch and part of the lower portion of the Cone of a singular plant, found many years since by the late Mr. John Eddowes Bowman, F.G.S., in a nodule of clay-ironstone at the Varteg Iron-works, near Pontypool, South Wales. For these specimens, my thanks are due to his son, the late Professor Eddowes Bowman, who liberally presented them to me. The branch proceeded from the stem at the hole seen in the lower part of the specimen (fig. 1), and consisted of a slight, ribbed and furrowed, cylindrical stem, parted at regular intervals by joints and knots, giving rise to verticillate leaves; it was terminated by a long Cone, cylindrical in the middle, and tapering at its extremities. The whole of the substance of the Stem and Cone was replaced by a white powder, so that only a mould of the fossil has been left in the matrix of clay-ironstone, with the exception of dark-coloured and granulated discs, about one twenty-second of an inch in diameter, which have been left on the sides of the mould, in the exact position which the corresponding spots occupied in the original plant.

The leaves of the plant came out in whorls of sixteen, at each knot, and were of a subulate form, and strongly ribbed in the middle. They resemble those of *Asterophyllites.*

The form of the stem and branch remind us of the *Bechera grandis* of Lindley and Hutton; but the shape and characters of the Cone and its contents differ very considerably from those of that plant.

Fig. 1 *a* (magnified two diameters) represents a portion of the stem and of two whorls of leaves, as they now appear in the specimen.

Fig. 1 *b* (magnified two diameters) represents a cast, taken in gutta-percha, of a portion of the stem, showing its ribbed and furrowed surfaces, and the joints and knots, whence proceeded the leaves, apparently sixteen in each whorl.

Fig. 1 *c* (magnified two diameters) represents a cast, in gutta-percha, of the branch to which the Cone was attached; its ribs, furrows, and knots, and the origin of the leaves are very distinct.

As previously stated, the two specimens of this plant belonged to the late Mr. J. E. Bowman. More than thirty years since, when my late friend first showed them to me, the whole consisted of six or seven pieces, comprising apparently the entire original nodule.[1] At that time he had made an enlarged drawing of the whole of the specimen,

[1] Mr. Wm. Bowman, F.R.S., has kindly allowed me to search his late father's cabinet, but the missing parts of the fossil have not yet been found.

restoring the plant, according to his idea of its form and character, from the parts then in his possession. Fig. 2 (natural size) represents the restored Stem, Branch, Leaves, and Cone, as it appeared to Mr. Bowman. This is copied from his original drawing.

Fig. 3 (magnified six times) represents, according to Mr. Bowman's view, and from his original drawing, two of the lower Scales, each supporting five Macrospores, but not giving evidence of the walls of any Sporangium that enclosed them.

In fig. 1 *a*, where the two whorls of Leaves are seen, they appear to be distinct and separate, springing from the rounded knobs at the joints, just as they appear on the stem and branch, figs. 1 *b* and 1 *c*. Now, in Mr. Bowman's restored drawing (fig. 2), he makes the leaves united at their base, and springing from a kind of sheath that embraces the stem to which they were attached. No doubt Mr. Bowman, who was a skilled botanist, and had better information than we possess, must have been better qualified to speak with certainty on this point than, from the two fragments in our possession, we are now.

Whatever may be the true characters of the leaves of this plant, it undoubtedly furnishes us with evidence of the former existence of a stem, with verticillate leaves, possessing a Cone with Macrospores in its lower part; and thus it induces us to believe that Specimens No. 23 and No. 27, hereinbefore described, may be more nearly allied to this plant than to the genus *Lepidostrobus* with which they have been, in doubt, provisionally classed.

At first, from the characters of the stem and leaves, it occurred to me to place this Cone in the genus *Calamostachys* of Schimper; but the Macrospores in it are so different to the spores of *Calamostachys* that it is probably better to establish a new genus. It is, therefore, here called *Bowmanites*, after its discoverer, Mr. Bowman, and *Cambrensis* from the country where it was found.

V. Concluding Remarks.

This Monograph, no doubt the reader will have perceived, was intended to be of a descriptive character rather than an attempt to trace the analogy of those plants, the remains of which have formed our valuable beds of coal, with living vegetables. My endeavours have been to collect materials and give them to the public for botanists to work upon. The subject is surrounded with difficulties; and, although it has been my good fortune to meet with many specimens in a fair state of preservation, the specimen, as a rule, when the internal structure is well preserved, is in a fragmentary condition, and when several parts of a plant are found connected together we are not favoured with structure, as is the case of the beautiful fossil plant last described.

When we consider how common a fossil a *Lepidostrobus* is, met with in abundance in all our Coal-measures, and described in nearly every work on Carboniferous fossils, it is very remarkable how few of the specimens afford us much evidence of the true nature of their organs of fructification.

Until the description of *Lepidostrobus Dabadianus* was given by M. Brongniart and Professor Schimper, we were ignorant of a fossil Cone with Sporangia full of Microspores in its upper part, and Macrospores in its lower part; and even this valuable specimen was found in drifted deposits, so we cannot be quite certain as to its having originally come from the Coal-measures. True it is that both Dr. Robert Brown and Dr. Hooker adduced evidence of Cones with Sporangia containing Microspores; but those distinguished authors never stated that such Cones might also have contained Macrospores in their lower portions.

In addition to *Lepidostrobus Dabadianus* two more Cones, namely, *Lepidostrobus levidensis* and *Lepidostrobus Wuenschianus*, and probably a third, *L. latus* (all from undoubted Carboniferous Strata) have to be added to the list of Cones with both Microspores and Macrospores; whilst seven other Cones, also from the Coal-formations, have been described, which, so far as they can be examined, afford evidence of Macrospores alone.

The Cone first described in this Monograph (No. 17) might, as far as its external characters are concerned, be taken for *Lepidostrobus ornatus;* and it contains Microspores in a most beautiful state of preservation, not to be distinguished from those found in Dr. Brown's Cone and in *Lepidostrobus Dabadianus.* On the other hand, in my Cone, No. 26 (*Lepidostrobus Hibbertianus*), which would also pass for a good example of *L. ornatus,* we cannot see the Sporangia in its upper portion, owing to the Scales, but where the interior of the lower part is exposed we meet with Sporangia containing Macrospores, like those in *L. Dabadianus.* This leads us to conclude that similar Cones, well preserved, on being subjected to careful examination, will afford the two kinds of spores, in the upper and lower portions respectively.

In nearly the smallest Cone described (No. 28, *L. Wuenschianus*) the largest Macrospores were found; thus showing that the size of the Cone had nothing to do with producing a large Macrospore.

The Cones No. 23 and No. 27 have been classed under *Lepidostrobus* with considerable doubt, as there is not sufficient evidence, especially as regards No. 23, to place them with *Calamostachys.* They are evidently fragments, and the lower portions only of two Cones; they may, therefore, have had Microspores in their upper parts. The last-described Cone (No. 30) has been referred to a new genus (*Bowmanites*), as it differs from *Calamostachys* in its organs of fructification. An important feature in these three Cones is that they appear to have had a verticillate arrangement of Scales, with whorled Leaves on their Stems, and that in their lower portions they have yielded Macrospores.

The Macrospores in all the specimens appear to be of large size, when compared with those found in *Lepidostrobus Dabadianus;* but it must be borne in mind that the former have been much compressed, and even flattened out, while the latter retain their original form. This will, to a certain extent, account for the apparent difference in size. No doubt there might be various sizes of both Microspores and Macrospores in the plants then existing; and, indeed, we could scarcely expect to find them all of one size. In the flora of the Carboniferous epoch, Cones having Sporangia with two kinds of spores appear to have constituted a more marked character of the period than has been hitherto supposed.

In the calcareous nodules found in the Lower Brooksbottom Seam of Coal, as well as that of the Upper Foot Coal, plenty of detached Macrospores are to be met with, and in a few instances in or near a Sporangium. There are also numerous traces of Microspores to be found in the same nodules, when the slices have been ground down fine enough; but this is not very easily done, for the paraffine-like matter of which the spores are composed is apt to tear away in the operation of grinding. With all this allowance, however, it must be admitted that in neither of these seams of coal are Macrospores to be met with in anything like the quantity in which they are found in the "splint" and "brown cannel" coals of Scotland.

PLATE VII.

Lepidodendron Harcourtii, L. and H.

Fig. 1 (No. 17). The imperfect Cone from the Upper Foot seam of Coal, near Oldham, as it appeared before it was sliced. Natural size.

Fig. 2. A transverse section. Natural size.

Fig. 3. A longitudinal section. Natural size.

Fig. 4. A transverse section (fig. 2). Magnified 2 diameters.

Fig. 5. A transverse section of the pith and vascular cylinder. Magnified 45 diameters.

Fig. 6 (No. 18). A transverse section of the pith and vascular cylinder of *Lepidodendron Harcourtii*, from the Dudley Coal-field. Magnified 10 diameters.

Fig. 7 (No. 17). A transverse section of a single Sporangium, full of Microspores. Magnified 5 diameters.

Fig. 8. A longitudinal section of a single Sporangium, with a Scale or Bract. Magnified $4\frac{1}{4}$ diameters.

Fig. 9. A longitudinal section of the pith and vascular cylinder. Magnified 45 diameters.

Fig. 10. A group of Microspores (converted into a substance resembling paraffine), and a portion of the wall of the Sporangium containing them. Magnified 50 diameters.

N°17

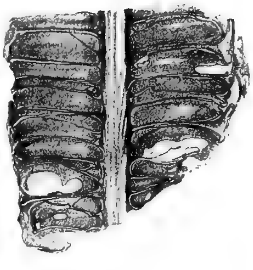


Fig 3

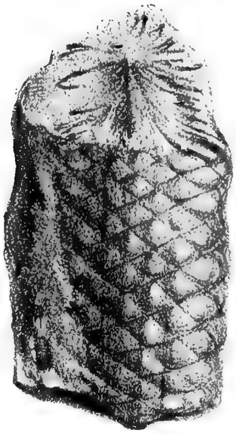


Fig 1

Fig 2

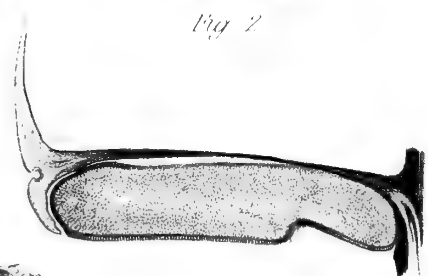
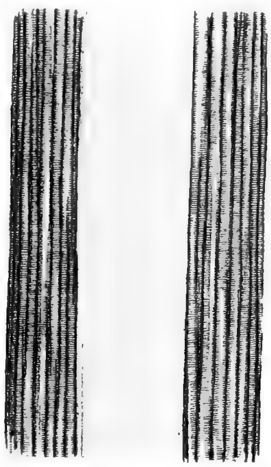


Fig 8

Fig 9



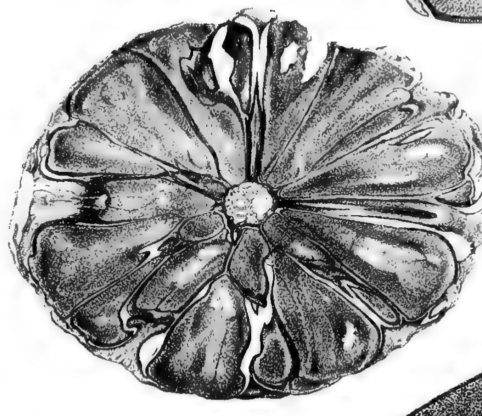
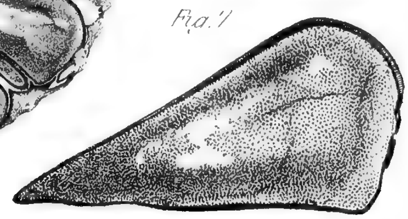


Fig 4

Fig 7



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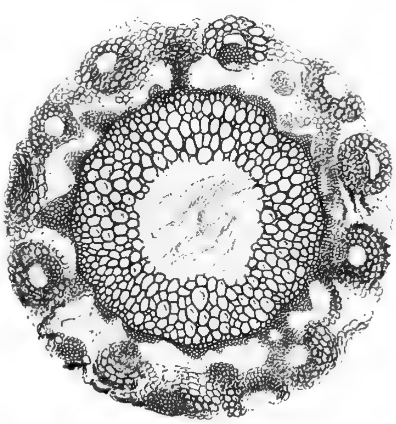


Fig 5

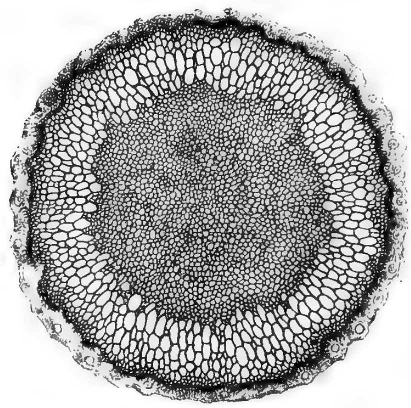


Fig 6.

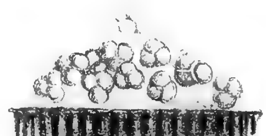


Fig 10

J N Fitch, del et lith

R. Fitch, imp

PLATE VIII.

Lepidodendron vasculare, Binney.

Fig. 1 (No. 19). The imperfect Cone from the Upper Foot seam of Coal, Oldham, as it appeared before it was sliced. Natural size.

Fig. 2. A transverse section. Natural size.

Fig. 3. A longitudinal section. Natural size.

Fig. 4. A transverse section (fig. 2). Magnified $2\frac{1}{4}$ diameters.

Fig. 5. A transverse section of the pith and vascular cylinder. Magnified 35 diameters.

Fig. 6 (No. 20). A transverse section of *Lepidodendron vasculare*, from the "Bullion Mine" Spa, Clough, near Burnley, showing the central axis and medullary sheath. Magnified 12 diameters.

Fig. 7 (No. 19). A transverse section of a single Sporangium. Magnified 4 diameters.

Fig. 8. A longitudinal section of a single Scale or Bract and its Sporangium. Magnified 4 diameters.

Fig. 9. A longitudinal section of the pith and vascular cylinder. Magnified 28 diameters.

No 19

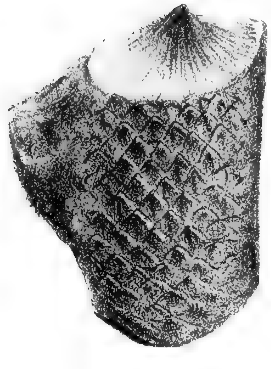


Fig 1

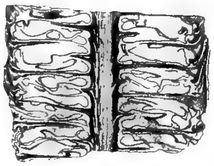


Fig 3

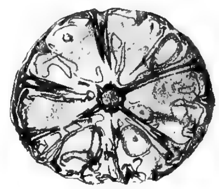


Fig 2

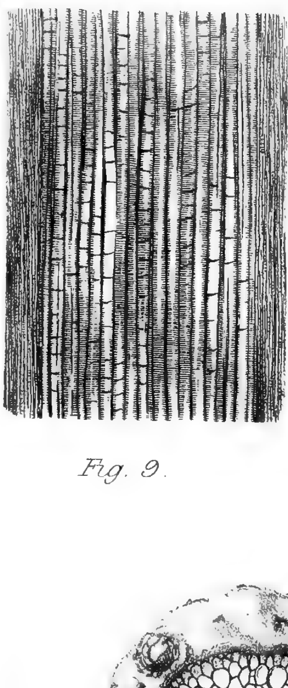


Fig. 9.

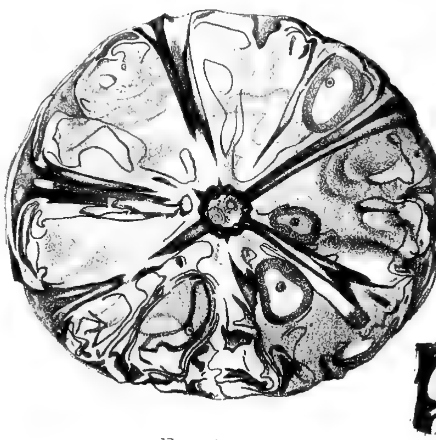


Fig. 4.

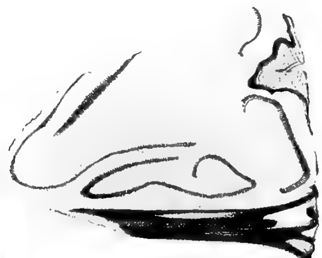


Fig. 7

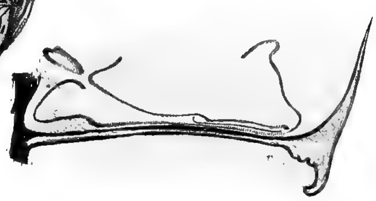


Fig 8.

No. 20.

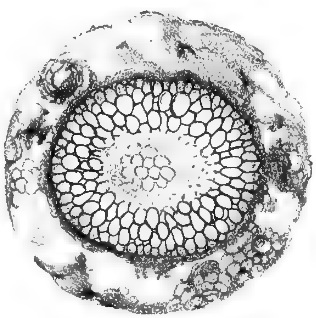


Fig. 5

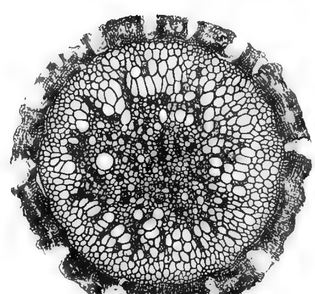


Fig. 6

J N Fitch, del et lith

R Fitch, imp

PLATE IX.

Lepidostrobus Russellianus, Binney.

Fig. 1 (No. 21). A Cone, not perfect, from the Blackband Ironstone, near Airdrie, Scotland. Natural size.

Fig. 1*a*. A portion of the column of the Cone, and two Scales, supporting two Sporangia, full of Macrospores. Magnified 5 diameters.

Fig. 2 (No. 22). An imperfect Cone from the Blackband Ironstone, near Airdrie. Natural size.

Fig. 2*a*. A portion of the Column, and a Sporangium, full of Macrospores. Magnified 5 diameters.

Lepidostrobus ? dubius, Binney.

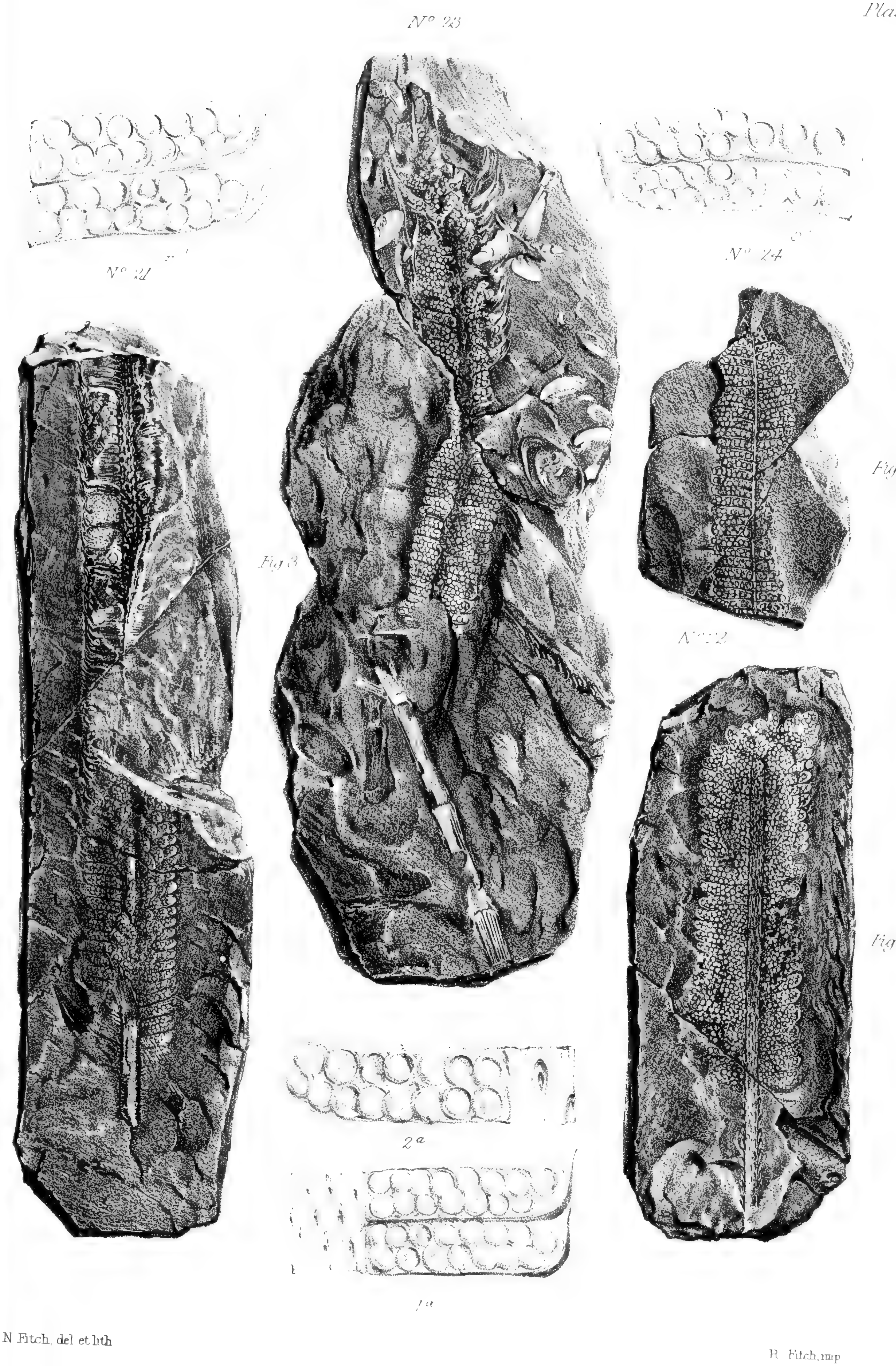
Fig. 3 (No. 23). The imperfect Cone from the Blackband Ironstone, near Airdrie. Natural size.

Fig. 3*a*. A portion of the Column, and two Scales, supporting two Sporangia, full of Macrospores. Magnified 5 diameters.

Lepidostrobus tenuis, Binney.

Fig. 4 (No. 24). A fragment of a Cone from the Blackband Ironstone, near Airdrie. Natural size.

Fig. 4*a*. Two Scales, and two Sporangia, full of Macrospores. Magnified 5 diameters.



J N Fitch. del et lith

R. Fitch, imp

PLATE X.

Lepidostrobus levidensis, Binney.

Fig. 1 (No. 25). A nearly perfect Cone from the Blackband Ironstone, near Airdrie. Natural size.

Fig. 1*a*. A portion of the lower part of the Column, and eight Scales, supporting eight Sporangia, containing Macrospores. Magnified $2\frac{1}{2}$ diameters.

Fig. 1*b*. A Scale from the upper portion, and a Sporangium, containing Microspores. Magnified 15 diameters.

Lepidostrobus Hibbertianus, Binney.

Fig. 2 (No. 26). An almost perfect Cone, from the Burdiehouse Limestone (Lower Carboniferous), near Edinburgh. Natural size.

Fig. 2*a*. A portion of the Column of the lower portion, and two Scales, supporting Sporangia, full of Macrospores. Magnified 5 diameters.

Fig. 2*b*. Four of the rhomboidal Scales, or ends of Bracts, from the upper part of the Cone. Magnified 5 diameters.

Plate X.

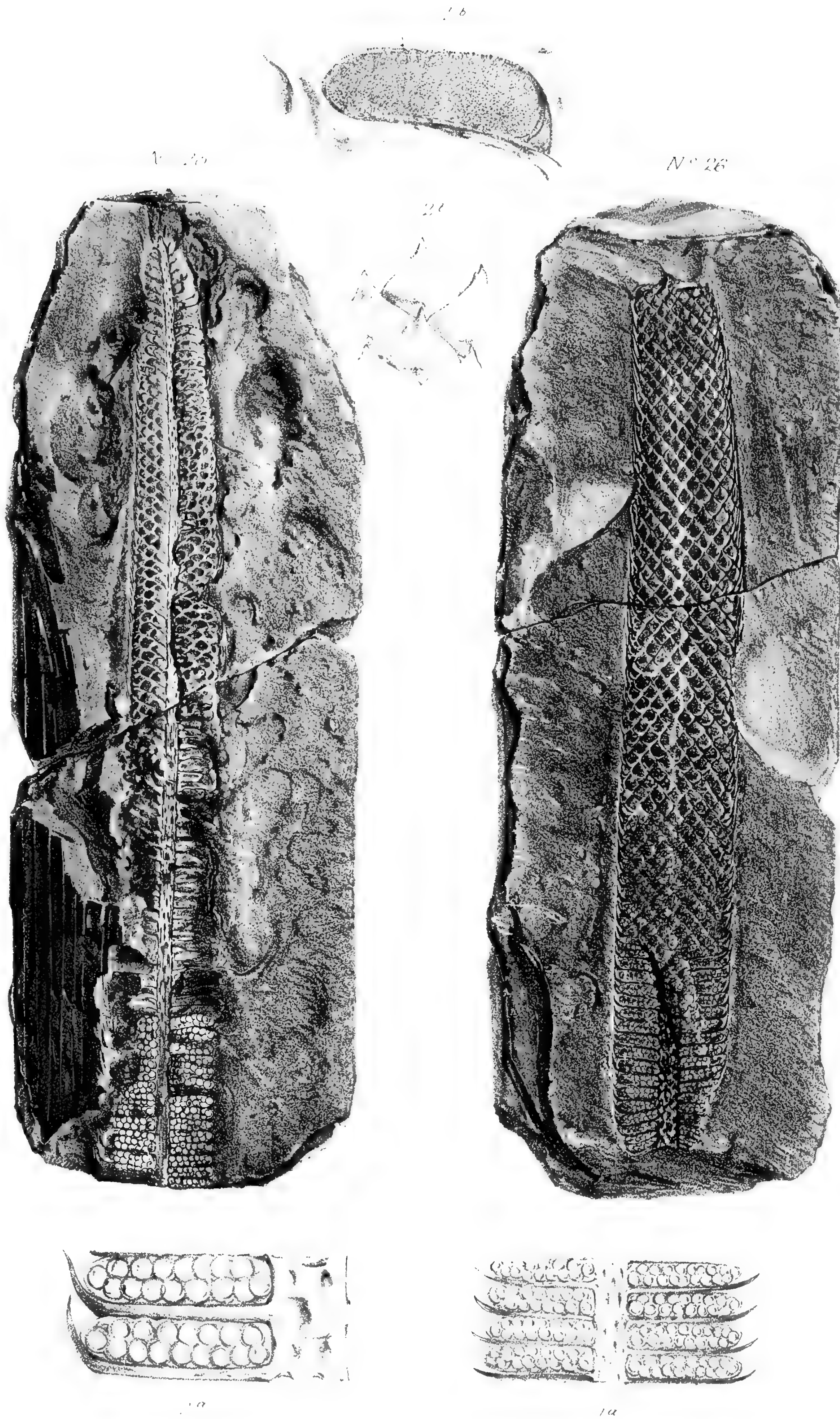


Fig 1

Fig 2

Fitch del et lith

R. Fitch imp

PLATE XI.

Lepidostrobus ambiguus, Binney.

Fig. 1 (No. 27). The lower portion of a Cone, from the trappean ash of Laggan Bay, in the Isle of Arran. Natural size.

Fig. 1*a*. A portion of the Stem, and the base of the Cone. Magnified 5 diameters.

Fig. 1*b*. The upper part of the specimen. Magnified 5 diameters.

Lepidostrobus Wuenschianus, Binney.

Fig. 2 (No. 28). A Cone, from the trap-ash, Laggan Bay. Natural size.

Fig. 2*a*. The upper portion of the Cone, showing the Column, Scales, and Sporangia. Magnified 5 diameters.

Fig. 2*b*. Part of the lower portion of the Cone, showing the Column, Bracts, and Sporangia, with Macrospores. Magnified 5 diameters.

Fig. 2*c*. A Scale, from the upper part, with a Sporangium, full of Microspores. Magnified 10 diameters.

Lepidostrobus latus, Binney.

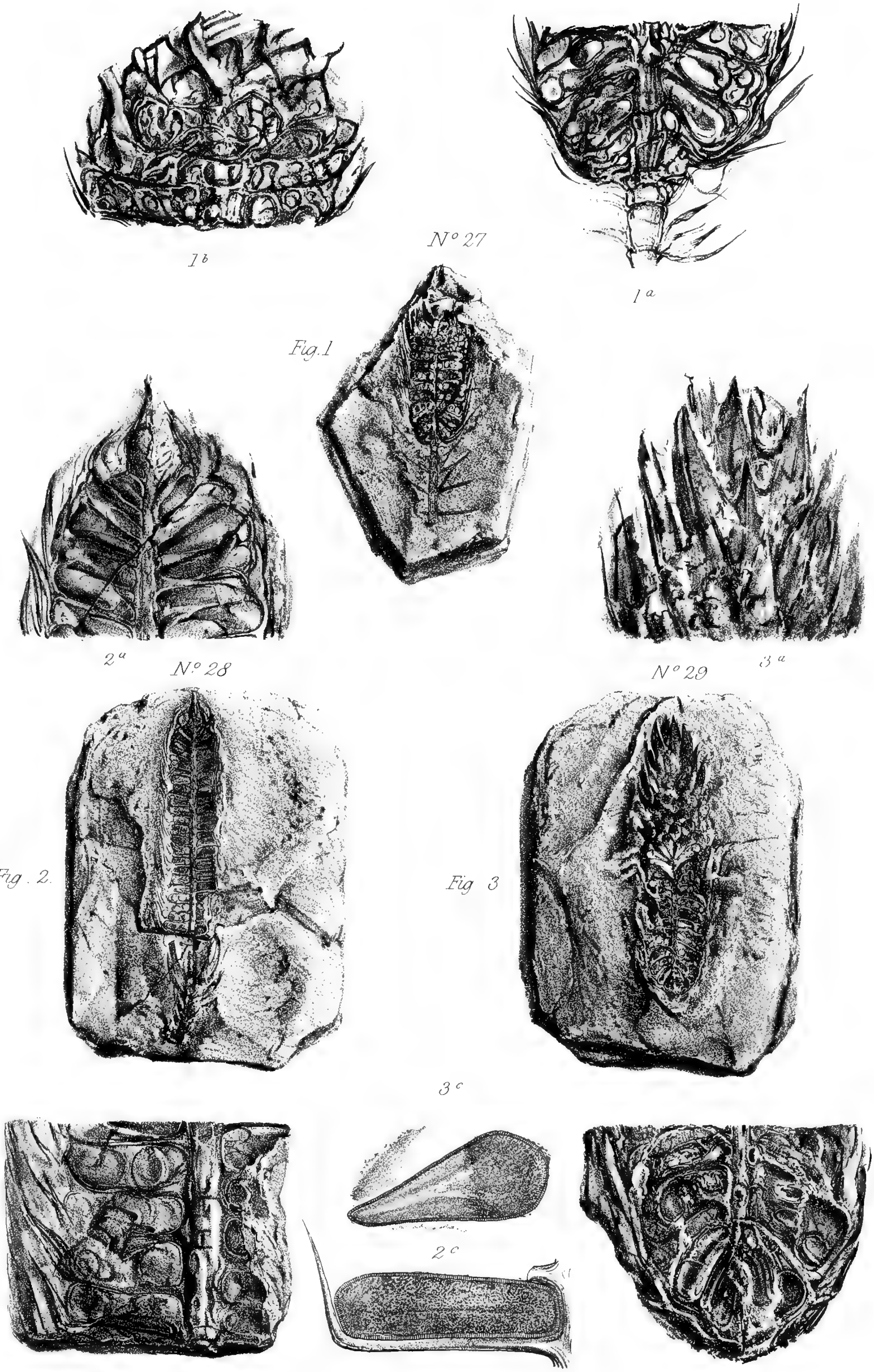
Fig. 3 (No. 29). A Cone, from the trap-ash, Laggan Bay. Natural size.

Fig. 3*a*. The upper portion of the Cone. Magnified 5 diameters.

Fig. 3*b*. The lower portion of the Cone. Magnified 5 diameters.

Fig. 3*c*. A Sporangium, from the higher part of the Cone, containing Microspores. Magnified 10 diameters.

Plate XI



N. Fitch, del. et lith.

R. Fitch, imp

PLATE XII.

Bowmanites Cambrensis, Binney.

Fig. 1 (No. 30). Natural mould of the Stem, Branch, and lower portion of the Cone, containing Macrospores, in a nodule of clay-ironstone, from the Varteg Iron-works, South Wales. Natural size.

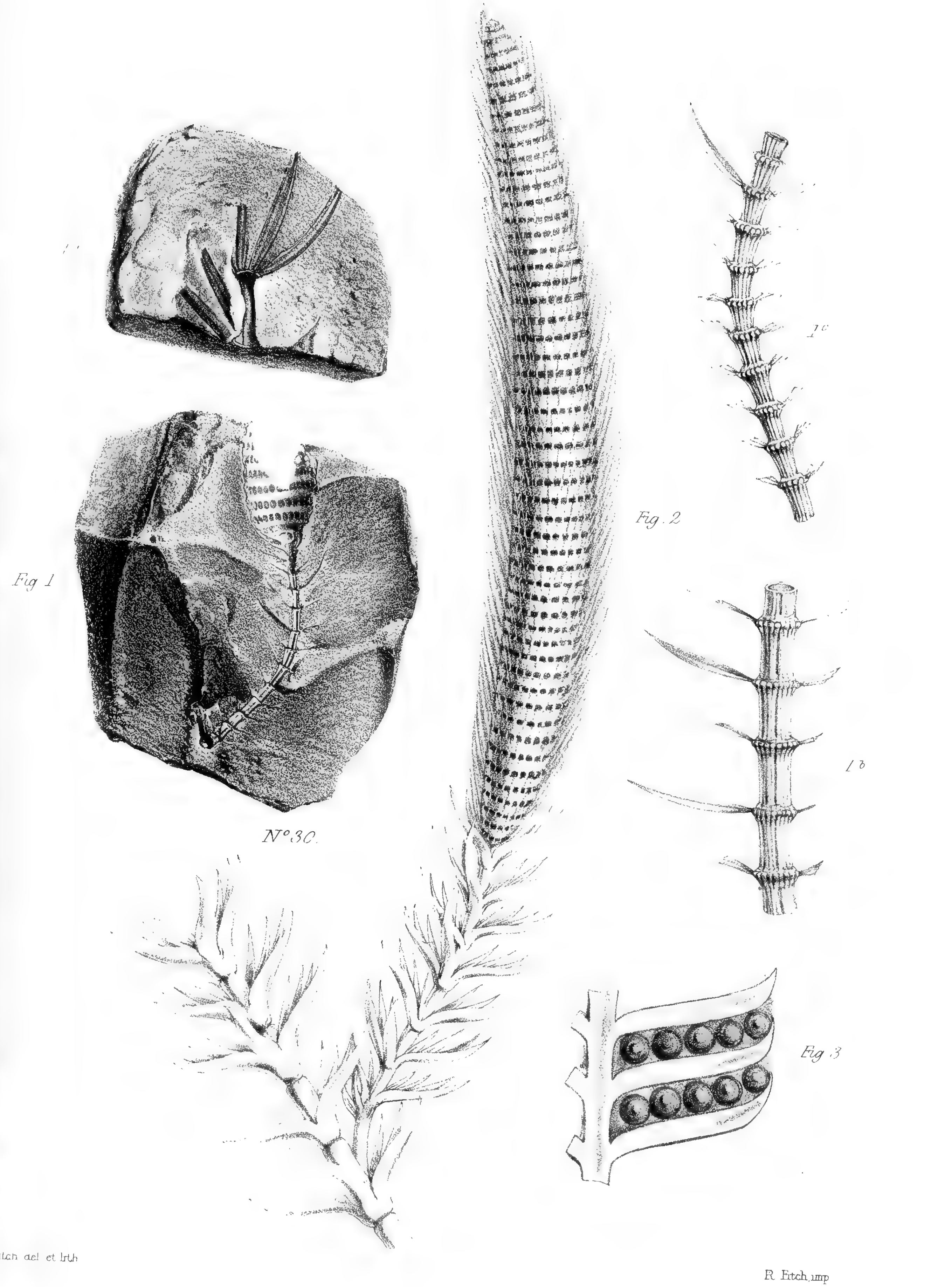
Fig. 1*a*. Natural mould of a portion of the Stem and two whorls of Leaves, in another piece of the nodule. Magnified 2 diameters.

Fig. 1*b*. A cast (in gutta percha) of a portion of the Stem, with Joints, Knots, and Leaves. Magnified 2 diameters.

Fig. 1*c*. A cast (in gutta percha) of the Branch to which the Cone was attached. Magnified 2 diameters.

Fig. 2. The Stem, Branch, Leaves, and Cone, as restored by the late Mr. Bowman. Natural size.

Fig. 3. Three of the lower Scales or Bracts, two of them supporting each five Macrospores, from Mr. Bowman's original sketch. Magnified 6 diameters.



N Fitch del et lith

R Fitch imp

THE

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VOLUME FOR 1870.

LONDON:

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MONOGRAPH

ON THE

BRITISH FOSSIL

ECHINODERMATA

FROM

THE CRETACEOUS FORMATIONS.

BY

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

CORRESPONDING MEMBER OF THE ROYAL SOCIETY OF SCIENCES OF LIÈGE, THE SOCIETY OF NATURAL SCIENCES OF NEUFCHATEL, AND SENIOR SURGEON TO THE CHELTENHAM HOSPITAL.

VOLUME FIRST.

PART FOURTH.

ON THE DIADEMADÆ AND SALENIDÆ.

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CYPHOSOMA MAGNIFICUM, *Agassiz*, 1840. Pl. XXV, figs. 1, 2 *a*, *b*, *c*, *d*, *e*.

CYPHOSOMA MAGNIFICUM,	*Agassiz*. Catal. Syst. Ectyp., p. 11, 1840.
— SULCATUM,	*Agassiz* et *Desor*. Catal. raison. des Échinides, p. 351, 1846.
— MAGNIFICUM,	*Bronn*. Index Palæontol., p. 381, 1848.
PHYMOSOMA —	*Desor*. Synops. des Échinides foss., p. 88, 1856.
— SULCATUM,	*Desor*. Ibid., p. 90, 1856.
CYPHOSOMA MIDDELTONI,	*Woodward*. Mem. Geol. Surv., Decade V, App., p. 4, 1856.
— SULCATUM,	*Pictet*. Traité de Paléontol., 2e éd., t. iv, p. 243, 1857.
— —	*Cotteau* et *Triger*. Échinides de la Sarthe, pl. 44, fig. 9, 1860.
PHYMOSOMA —	*Coquand*. Synops. des Foss., Bull. Soc. Géol. de France, t. xvi, p. 992, 1860.
PHYMOSOMA —	*Dujardin* et *Hupé*. Hist. Nat. Zooph., p. 508, 1862.
CYPHOSOMA —	*Bourgeois*. Espèces Ter. Crétacés, Bull. Soc. Géol. France, deux. sér., t. xix, p. 674, 1862.
— MAGNIFICUM,	*Cotteau*. Échinides foss. des Pyrénées, p. 25, 1863.
— —	*Cotteau*. Paléontologie Française; Ter. Crétacé, t. vii, p. 635, pls. 1155-56-57, 1865.

Test circular, elevated, sides tumid, base concave; poriferous zones narrow, undulated, pores unigeminal; primary tubercles of both areas large at the base and ambitus, and small on the upper surface; areolæ large and confluent at ambitus and base, very small above; upper third of inter-ambulacra bordered with a row of small secondary tubercles; miliary zone wide, sulcated, and nude above; mouth-opening small, peristome equal-lobed; discal opening very large, pentagonal, angular, and elongated.

Dimensions.—A. Figured specimen, latitude ten lines; altitude six lines.

B. Specimen in my cabinet, latitude one inch; altitude half an inch; discal opening (antero-posterior diameter) six tenths of an inch.

Description.—This very rare British *Cyphosoma* was obtained by J. Middleton, Esq., from the Upper Chalk, near Norwich, and placed in the hands of the late Professor Edward Forbes for description, whose manuscript name for the same was *C. Middeltoni*. Under this designation a diagnosis of the species was given by my late friend Dr. Woodward, in his valuable appendix to Decade V of the 'Memoirs of the Geological Survey,' who kindly obtained another specimen, to enable me to give a detailed description of this rare British form; a careful examination of this fossil, however, has satisfied me that it is merely a small variety of *Cyphosoma magnificum*, Agassiz, and agrees in all its specific characters with the sulcate variety of that species.

The test is circular, elevated, or moderately depressed on the upper surface, inflated at the sides (Pl. XXV, figs. 1 *a* and *d*) and concave at the base (fig. 1 *c*). The ambulacral areas are wide, with two rows of tubercles, which are large at the ambitus and base and very small on the upper surface; the change from the large ambital to the small dorsal tubercles is very abrupt; the areolæ of all the large tubercles are wide and confluent, and those of the smaller are surrounded by circlets of granules.

The poriferous zones are narrow, and much undulated at the ambitus and infra-marginal region; they are less sinuous above, where the pores are small and unigeminal; the spaces between the pairs of holes often support two small granules (fig. 1 *e*).

The inter-ambulacral areas are about one third wider than the ambulacral, and provided with two rows of primary tubercles, twelve in each, nearly identical with those in the ambulacra; like them, they have wide areolæ at the ambitus and infra-marginal region, and very small on the upper surface; the transition from the large ambital to the small dorsal tubercles is likewise well marked in the specimen before me (fig. 1 *a*, *d*). A row of small irregular secondary tubercles, five or six in each, occupies the spaces between the primary series and the poriferous zones (figs. 1 *b*, *d*), and disappears among the granules of this region. Other secondary tubercles occupy the wide spaces by the zones at the angles of the plates (figs. 1 *c*, *e*, and figs. 2 *a*, *b*), and range in file with the small secondary series on the upper surface. The intermediate granules are large and abundant, of unequal size, and disposed in circles around the areolæ; these circles at the ambitus are incomplete at their basal border (fig. 1 *e*). The miliary zone is large, much depressed in the middle, and nude as it approaches the discal opening (fig. 1 *d*); the small granules forming complete circlets around the small tubercles of this region.

The primary tubercles at the under surface are moderately large, and nearly the same size in both areas (fig. 1 *c*, and fig. 2 *b*), which imparts a highly ornamented character to this region of the test and contrasts strongly with the small tubercles, and the naked and depressed miliary zone on the upper surface (fig. 1 *d*).

The mouth-opening is small, the peristome circular, and divided into nearly equal-sized lobes by feeble incisions (fig. 1 *c*). The discal opening is large, pentagonal, angular, and elongated in the antero-posterior direction (fig. 1 *b*).

Cyphosoma magnificum, so rare in England, is a very common species in the south-west of France, where two well-marked varieties are found. The *first type of the species* is characterised by having its ambulacral and inter-ambulacral tubercles large and prominent at the ambitus, becoming gradually smaller on the upper surface, the miliary zone wide and not depressed in the middle. In the *second type* the transition in size from the large ambital to the small dorsal tubercles is more abrupt, the upper part of the miliary zone is quite destitute of granules and much depressed in the middle, near the coronal plates, which are marked with very distinct sutures; the areolæ at the ambitus are larger and more superficial, and the under surface has a more ornamented appearance. This variety has been described as *C. sulcatum*, and is that to which our specimen is referred. It attains a much larger size than the first or type form, as a specimen collected from the Chalk of Royan

(Charente-Inférieure) measures two and a half inches in diameter, and one inch and one tenth in height.

The English specimens of this Urchin that have hitherto been collected are small and immature, they consequently have fewer tubercles in each row than the French specimens possess, and the poriferous zones, for a like reason, have the pores in single file, the bigeminal arrangement being a character of more mature age.

Affinities and Differences.—This species differs so much from its English congeners that it is readily distinguished from all of them by its wide ambital areolæ and large tubercles, and the series of small tubercles on the upper surface, with a secondary row on the zonal side. In its general characters *C. magnificum* resembles *C. Archiaci* from the same stage, but the latter has a more pentagonal test, wider inter-ambulacral areas, smaller primary tubercles, and four rows of secondary tubercles; the base likewise is flatter, and the mouth-opening larger and more superficial.

Locality and Stratigraphical Position.—The English specimens have been found only in the Upper Chalk at Norwich, where they are extremely rare.

M. Cotteau states that this species is common in the Etage Sénonien inf. at Saint-Pierre de Chevillé, Saint-Paterne, Saint-Calais, Marcon (Sarthe); Villers, Villedieu (Loir-et-Cher); Saint-Christophe, Semblançy (Indre-et-Loire); Barbezieux, Aubeterre, Espagnac, près Angoulême, Charmant, Lavalette (Charente); Royan, Talmont, Saintes, Cognac (Charente-Inférieure), Saint-Georges près Perigueux, Tretissac (Dordogne); Belbèze (Haute-Garonne).

History.—The table of synonyms gives the history of this species, which was unknown to my old friend Professor Forbes, who named the only specimen he ever saw after the friend who communicated it for description.

Cyphosoma Wetherelli, *Forbes.* Pl. XXVII, figs. 1, *a—h.*

Cyphosoma Wetherelli, *Forbes.* In Morris's Catalogue of British Fossils, 2nd ed., p. 75, 1854.
— — *Woodward.* Mem. Geol. Surv., Decade V, Supplement, p. 2, 1856.

Test circular, inflated at the sides, depressed at the summit, and flat beneath; ambulacra wide, two rows of large tubercles, nine to ten in each, gradually diminishing in size towards the poles; inter-ambulacra, two rows of primary tubercles, nine in each, with a small secondary tubercle in the centre of the zonal margin of each plate; poriferous zones narrow, undulated; pores unigeminal throughout; mouth-opening one third the diameter of the test; discal opening large, angular, pentagonal.

Dimensions.—Transverse diameter one inch; height half an inch.

Description.—This Urchin very much resembles *C. corollare*, Klein, but was separated from that species by the late Professor Edward Forbes, and dedicated to N. T. Wetherell, Esq., F.G.S., who presented it to the Museum of the Royal School of Mines. This unique typical example, partly imbedded in flint, was obtained at Gravesend. The test is of moderate size, has a circular figure, and is depressed a little above and below; the sides are inflated and the base is flat; the ambulacral areas are wide, with two rows of large tubercles (figs. 1 *c*, *b*), nine or ten in each; the areolæ occupy nearly the entire width of the plates, and are bordered by a series of prominent miliary granules, which are absent only on the zonal sides of the plates (figs. 1 *e*, *g*, *h*); the tubercles gradually diminish from the ambitus to the oral (fig. 1 *h*) and the discal apertures (fig. 1 *g*); the areolæ retain throughout, even to the smallest tubercles, the border of granules special to each (figs. *g*, *h*).

The poriferous zones are much undulated, and form a series of crescents around the large tubercles (fig. 1, *d*); the rows are narrow, the pores simple and unigeminal throughout, and there are from five to six pairs of holes opposite each of the large plates (figs. *e*, *g*, *h*).

The inter-ambulacral areas, a little wider than the ambulacral, have two rows of primary tubercles, nine in each, and two rows of secondary tubercles placed near the zones, and extending from the peristome to the ambitus (fig. 1 *c* and fig. 1 *h*). The areolæ of the primaries are wide, occupying nearly the whole surface of the plates, and each is bordered by a row of distinct miliary granules (fig. 1 *e*), which completely separates the areolæ from each other. The secondary tubercles are small, and form a short row of twelve tubercles set on bosses; they occupy a space between the zones and the primary tubercles (figs. 1 *c*, *h*), and extend from the peristome to the ambitus.

The tubercles of both areas are very prominent, and nearly of the same size; the bosses are large, with feebly crenulated summits, closely embracing the mammillon, which is large and conspicuous (figs. 1 *e* and *f*).

The miliary zone is narrow at the ambitus, with two rows of granules; on the upper surface it becomes wider, depressed, and nude in the middle, and is sparsely supplied there, and at the sides, with very small granules (fig. 1 *b*).

The mouth-opening, small and circular, is one third the diameter of the test; the peristome is divided into ten nearly equal-sized lobes, by well defined incisions (fig. 1 *c*).

The discal opening is directly opposite to, and of the same proportional size as the oral aperture; it has a pentagonal form, and the single ovarial plate that extended into the single inter-ambulacrum protruded farther into this area than either the antero- or postero-lateral ovarials (fig. 1 *b*).

The upper surface of the test is considerably depressed, and the base is flat. This contour of the shell is well shown in fig. 1 *d*.

Affinities and Differences.—This species has the closest affinities with *Cyphosoma corollare*, of which it may, perhaps, prove to be only a variety. As it is at present a unicum, we wait for the discovery of other specimens with spines before stating with confidence its affinitive relations.

Locality and Stratigraphical Position.—Found imbedded in a flint nodule at Gravesend, from the Upper Chalk. The specimen belongs to the Museum of the Royal School of Mines.

CYPHOSOMA SPATULIFERUM, *Forbes*,1850. Pl. XXVIII, figs. 1 *a, b, c, d, e, f, g, h;* Pl. XXIX, figs. 1 *a, b, c, d.*

CYPHOSOMA SPATULIFERUM, *Forbes.* Dixon's Geology of Sussex, pl. xxiv, fig. 20, p. 340, 1850.
— — *Forbes.* In Morris's Catalogue Brit. Foss., 2nd ed., p. 75, 1854.
— — *Woodward.* Mem. Geol. Surv., Decade V, Supplement, p. 2, 1856.

Test small, circular, inflated at the sides, concave at the base, and depressed on the upper surface; ambulacra prominent, two rows of tubercles, eight to ten in each; areolæ wide, bordered by granules; inter-ambulacra with two rows of primary tubercles, nine in each, and two short rows of secondary tubercles; areolæ wide, bordered by granules. Poriferous zones much undulated; pores unigeminal; tubercles of both areas nearly alike in size and structure. Mouth-opening one third the diameter of the test; discal aperture pentagonal, large and angular. Spines spatulate, very much flattened, smooth except near the base, where there are fine longitudinal lines.

Dimensions.—Height nine twentieths of an inch; transverse diameter seven tenths of an inch.

Description.—This beautiful little *Cyphosoma* has a circular body, with inflated sides and small projecting equal-sized tubercles; the ambulacral areas are prominent, and have two rows of tubercles; fig. 1 *f* shows one of these segments magnified six times; the areolæ are wide, and fill nearly the entire plate; the inner and upper margins of each are bordered by a series of miliary granules, which define the boundary of the areolæ, and entirely prevent them becoming confluent. The tubercles at the ambitus are a little larger, and they gradually become smaller as they approach the two apertures. The narrow poriferous zones are much undulated, and form a series of crescents around the large plates; there are, in general, six pairs of holes opposite each plate, and they are entirely unigeminal throughout (fig. 1 *f*).

The inter-ambulacral areas are a little wider than the ambulacral, and composed of large plates (Pl. XXVIII, fig. 1 *g*; Pl. XXIX, fig. 1 *d*), of which there are nine in each column. The areolæ are wide, and bordered by a circle of miliary granules, complete on five sides of the plate, but absent on lower margin (Pl. XXIX, fig. 1 *d*). The miliary zone is narrow at the ambitus, where it is crowded with granules, and wide at the upper surface, where it is depressed and nearly nude (Pl. XXVIII, fig. 1 *b*). At the base of the area, between the primary tubercles and the poriferous zones, there is a short row of small secondary tubercles (fig. 1 *c*), which extends from the peristome to the ambitus; fig. 1 *h* shows the base of this segment magnified six times; the small secondaries are raised upon bosses (fig. 1 *h*).

The tubercles of both areas are nearly of the same size; the boss is large, with feeble crenulations, closely embracing the mammillon, which is very prominent (Pl. XXIX, fig. 1 *d*).

The base is concave, and the mouth-opening, one third the diameter of the test, is in a slight depression (fig. 1 *c*). The peristome is divided by slight incisions into ten nearly equal-sized lobes. The discal opening is large and pentagonal. The mould of the single ovarial plate descends further into the segment than either the antero- or postero-lateral ovarials into their respective areas.

The spines of this Urchin are spatulate, and the stem is extremely smooth, except near the milled ring, where the base is marked by fine longitudinal lines.

Affinities and Differences.—The spatulate form of the spines distinguish this species from *C. corollare*, with which it has many affinities in the anatomy of the test; *C. spatuliferum* is, however, a smaller Urchin, more compressed and pentagonal, less inflated at the sides, and more depressed on the upper side than *C. corollare;* the surface of the test is, likewise, rougher in consequence of the numerous small tubercles that project sharply from the plates.

Locality and Stratigraphical Position.—This is a rare species in the Upper Chalk of Kent and Sussex. The type specimens of the Dixon Collection are now in the British Museum. One of these I have figured in Pl. XXVIII, fig. 1; and a still larger specimen, from the Rev. T. Wiltshire's Cabinet, in Pl. XXIX, fig. 1.

Cyphosoma radiatum, *Sorignet*, 1850. Pl. XXIX, figs. 2 *a, b, c;* figs. 3 *a, b.*

Cyphosoma ? (small or young), *Dixon.* Geol. Sussex, p. x, pl. xxiv, figs. 28—31, 1850.
— radiatum, *Sorignet.* Oursins foss. du Dép. de l'Eure, p. 28, 1850.
— simplex, *Forbes.* Morris's Catalogue of Brit. Foss., p. 74, 1854.
— — *Woodward.* Mem. Geol. Surv., Decade V, App., p. 1, 1856.
Phymosoma Heberti, *Desor.* Synopsis des Échinides foss., Supplément, p. 450, 1858.
Cyphosoma perfectum, *Cotteau* et *Triger* (pars). Échinides du Départ. de la Sarthe, p. 375, 1862.
Phymosoma Heberti, *Dujardin* et *Hupé.* Hist. Nat. des Echinoderm., p. 508, 1862.
— simplex, *Dujardin* et *Hupé.* Ibid.
Cyphosoma radiatum, *Cotteau.* Paléontologie Française; Ter. Crét., pl. 1147, figs. 10—14; pl. 1148, p. 609, 1864.

Test small, subpentagonal, convex above, base concave; ambulacra, two rows of tubercles, eight in each, with large confluent areolæ at the ambitus; inter-ambulacra, two rows of primary tubercles, nine to ten in each, with two short rows of small secondaries at the base; primary tubercles prominent at the ambitus, small and inconspicuous above; areolæ large, radiated, and nearly confluent at the middle, very small above; poriferous zones undulated, unigeminal; pores small.

Dimensions.—Height three tenths of an inch; transverse diameter six tenths of an inch.

Description.—This beautiful little species occurs in the hard gritty Chalk of Dover. The test is more highly ornamented than any of the preceding forms; the tubercles at the ambitus are highly developed, with radiated areolæ, and nearly all of the same size. On the upper surface they are proportionally small. The ambulacral segments slightly project; this imparts a subpentagonal form to the body (fig. 2 *a*). There are two rows of tubercles therein, eight in each, those at the ambitus being very large, and those on the upper surface very small (fig. 2 *c*). The areolæ of the large ambital tubercles are confluent, and the smaller ones are separated from each other by a few granules (fig. 2 *c*).

The poriferous zones are narrow and much undulated (fig. 3 *a*); at the ambitus the pores are small and unigeminal, and there are five pairs opposite each of the larger plates.

The inter-ambulacral areas are a little wider than the ambulacral, with two rows of tubercles, nine to ten in each. The areolæ are wide; those at the ambitus and superior surface have a radiated border at the circumference, the radii being formed of elongated granules developed into a pyriform shape; (fig. 3 *b*) represents four central plates of an inter-ambulacral segment magnified eight times. In some of the plates small miliary granules are introduced within the rayed circle.

The discal opening is large, and of an elongated pentangular shape; the angle corresponding to the single inter-ambulacrum projecting far down that segment (figs. 2 *a* and *b*).

Affinities and Differences.—This species in its general facies resembles *C. spatuliferum*, but differs from it in having the tubercles on the upper surface disproportionately small when compared with the large size they attain at the ambitus (figs. 2 *b*, *c*). This character is very evident when fig. 2 *c*, Pl. XXIX, is compared with fig. 1 *f*, Pl. XXVIII. The radiated structure of the areolæ is likewise another good diagnostic character between these nearly allied forms. M. Cotteau appears to consider *C. Wetherelli* and *C. spatuliferum* as varieties of *C. striatum;* but, after a careful comparison of the specimens themselves and with each other, I must dissent from this opinion. However much the tests of *Echinidæ per se* may resemble one another, still we must not forget that the shell alone is not the complete body of the animal, and that without its spines our evidence of specific identity is incomplete: for example, the test of *Hemicidaris crenularis*, Ag., is identical with *Hemicidaris intermedia*, Flem.; but the spines of the former are very different from those of the latter, and without these appendages it is impossible to distinguish the test of the one Urchin from that of the other, and the same conditions may be true of the tests of other, nearly allied forms. *C. Wetherelli* may be considered a variety of *C. corollare* until proof to the contrary is discovered; but the structure of the test of *C. spatuliferum* and the remarkable form of its flattened spines, when compared with the test and spines of *C. corollare*, afford presumptive evidence that they are distinct forms. It is very desirable to diminish the number and correct the synonyms of species in our lists; to do this, however, correctly requires much literary research and a critical examination and comparison of the specimens themselves, before a true solution of the difficulty can be arrived at; and in doing all this the best observers very often confuse analogy with identity of structure, from the imperfect materials upon which they are too often obliged to work.

Locality and Stratigraphical Position.—*Cyphosoma striatum* is usually found in the hard, gritty beds of Lower Chalk near Folkestone, and occasionally in the Upper Chalk with flints in Sussex.

The type specimen figured in Pl. XXIX belongs to the Museum of the Royal School of Mines. I have examined several others collected by my kind friend, the Rev. T. Wiltshire, F.G.S., from the Lower Chalk, near Folkestone, where he found it associated with *Salenia granulosa*, Forb.

SALENIDÆ.

Family 5.—Salenidæ, *Wright*, 1856.

This natural family nearly corresponds to the Salénies of MM. Agassiz and Desor, and is distinguished from other families of the *Echinodea Endocyclica* by the peculiar structure and great development of the apical disc, which, besides the five genital and five ocular plates, has an additional or sur-anal plate, developed in the centre of the disc, immediately before the anal opening; this plate in some genera is single, in others it is composed of from one to eight separate elements.

The test is thin, and in general small, spheroidal, hemispherical, or depressed; the ambulacral areas are always narrow, straight, or flexuous, with two rows of granules or small tubercles, that alternate with each other on the margins of the area.

The poriferous zones are narrow; the pores unigeminal, except near the peristome, where they fall into oblique ranks of threes.

The inter-ambulacral areas are wide, with two rows of primary tubercles, which have large bosses and crenulated summits; in *Acrosalenia* and *Pseudosalenia* the tubercles are perforate, in *Peltastes, Goniophorus,* and *Salenia* they are imperforate. The mouth-opening differs in size in the different genera; the peristome is more or less decagonal, and sometimes deeply notched, or only feebly indented. The jaws are known in one genus, in which they resemble those of *Hemicidaris*.

The spines in *Acrosalenia* are long, slender, angular, or flattened, and the surface of the stem, although apparently smooth, is covered with very fine longitudinal lines. In *Pseudosalenia* they are enlarged, ovoid, sub-glandiform, and more or less granular; in *Peltastes* and *Salenia* they are elongate, aciculate, straight, curved, or bent.

From a misconception of the true relative position of the elements of the apical disc in this family, much confusion exists in the works of different authors in the description of this part of the test. "The great difficulty in the study of this group," says M. Desor,[1] "is to find the place of the madreporiform body; we are consequently embarrassed when we attempt to assign the lateral parts to the longitudinal axis of these animals, unless we admit that the sur-anal replaces the madreporiform body; but this would be contrary to all analogy, because in all the other Cidarides the madreporiform body is an integral part of one of the genital plates. M. Agassiz got rid of the difficulty by means of an hypothesis, by admitting that the sur-anal plate is invariably placed in the plane of the animal, that it therefore could only be anterior or posterior; hence his two divisions in the genus *Salenia*, the first with a sur-anal plate posterior, and, consequently, with the *périprocte* excentral and before; the second with the sur-anal plate anterior, and, consequently, with the *périprocte* excentral and behind."[2]

Professor Johannes Müller assigns the left posterior genital plate as the bearer of the madreporiform body in *Salenia personata*. "Dies wird auch durch die Salenien bestätigt, wo die Längsachse durch die plaque suranale vor dem After bestimmt wird. An einem im mineralogischen Museum aufbewahrten ausgezeichnet schönen Exemplar der *Salenia personata*, Ag., mit vorderem After, Taf. I, fig. 9, ist die linke hintere Genitalplatte porös und Madreporenplatte."[3]

I have selected fine specimens of *Peltastes Wrightii*, Desor, from the Lower Greensand, *Peltastes Austeni*, Forbes, from the Lower Chalk, and *Salenia petalifera*, Desmarest, from the Upper Greensand, and in all of these the madreporiform body occupies the surface of the right anterior genital plate, as in the *Cidaridæ*, *Hemicidaridæ*, *Diademadæ*, and *Echinidæ*. The sur-anal plate is central, and the anal opening posterior in a line with the axis of the body, or inclined to the right side. In fact, the madreporiform body and sand canal, whatever their true functions may be, have the same position in all the Echinidea, recent and fossil, which I have examined, and probably the same in all Echinodermata. Professor Müller's mistake, therefore, may have arisen from placing the *Salenia* in a false position before him. The study of the apical disc in the *Acrosalenia* reveals the true relation of its elements to each other, and proves that the sur-anal plate

1 'Synopsis des Échinides fossiles,' p. 138.

2 For further details on this subject, M. Agassiz's 'Monographies d'Échinodermes: première Monographie des Salénies,' may be consulted.

3 Joh. Müller, 'Ueber den Bau der Echinodermen,' p. 7.

has nothing in common with the spongy madreporiform body which occupies the surface of the right anterior genital plate (Pl. XV, fig. 4, *a, i*). I had the good fortune to make this discovery some years [1] ago, when figuring and describing *Acrosalenia hemicidaroides*, which urchin has furnished a key to the true relation of the bilateral parts to the longitudinal axis of the SALENIDÆ. On this point M. Desor observes:

"Nous devons en outre à M. Wright une autre découverte plus importante, celle du corps madréporiforme, qui fait partie intégrante de l'une des plaques génitales comme dans les autres Cidarides. Or comme nous savons maintenant que cette plaque a une position fixe dans tous les oursins, nous sommes par là même en mesure de déterminer l'avant et l'arrière de ces animaux; et puisque les plaques sur-anales sont situées en arrière de cette plaque, il s'ensuit que le périprocte se trouve réellement refoulé en arrière. Il ne peut dès-lors plus être question d'Acrosalénies à périprocte eccentrique en avant, comme on supposait que c'était le cas de l'*Acrosalenia tuberculosa*." &c.

"Il n'arrive que trop souvent que le disque apicial manque, et dans ce cas, il est très difficile de distinguer les Acrosalénies du genre Hemipedina decrit-ci-dessus. Cependant, comme par suite du refoulement du périprocte en arrière la plaque genitale impaire ou postérieure gagne plus que les autres sur le test, on peut encore, d'après M Wright, reconnaître la place de cette plaque même dans les individus dépourvus d'appareil apicial." [2]

A Table showing the Classification of the SALENIDÆ.

Family.	Sections.	Diagnosis.	Genera.
SALENIDÆ.	*Section A.* Tubercles perforated. Apical disc small.	Ambulacral areas straight, large, with two rows of small tubercles; apical disc small and not prominent; sur-anal plate composed of one or many pieces granulated on the surface; vent posterior and central in the axis of the test; spines long.	*Acrosalenia*, Agassiz.
		Ambulacral areas narrow, flexed, with two rows of granules; apical disc prominent, not granulated, and marked with impressions; vent excentral posterior, in the axis of the test; spines enlarged, ovoid, sub-glandiform, more or less granular.	*Pseudosalenia*, Cott.
	Section B. Tubercles imperforate. Apical disc large, shield-like, and prominent.	Inter-ambulacral tubercles moderate; apical disc large and prominent; genital plates in the form of elongated lobes; sur-anal plate single; vent posterior and central in the axis of the test.	*Peltastes*, Agassiz.
		Inter-ambulacral tubercles large, few in number; apical disc large, and forming a regular pentagon, with elevated angular carinæ independent of the sutures; sur-anal plate angular; vent large, excentral, oblong, and posterior.	*Goniophorus*, Agassiz.
		Inter-ambulacral tubercles large; apical disc wide and very solid, with an undulated circumference; surface of the large plates ornamented with punctuations or sculptured figures along the line of the sutures; sur-anal plate single; vent posterior excentral and directed towards the right side.	*Salenia*, Gray.

[1] Wright, 'Annals and Magazine of Natural History,' 2nd series, vol. viii, p. 261.

[2] 'Synopsis des Échinides fossiles,' p. 140.

M. Cotteau thus describes the family "Salénidées," Wright:—Pores disposed in single pairs; ambulacra sometimes large, straight, and presenting a double range of small tubercles; sometimes narrow, and undulated, and garnished with granules; interambulacral tubercles few in number, largely developed, perforated, or imperforate, always crenulated. Peristome sub-decagonal and furnished with entailles. Periprocte excentric and posterior, placed in the axis of the animal or inclined a little to the right side. Apical disc very large, solid, most often marked with deep depressions, composed of five ovarial plates and five ocular plates perforated, with one or many sur-anal plates which determine the excentricity of the periprocte. Madreporiform plate distinct, different from the others by its spongy aspect and sometimes by a simple laceration, a fissure more or less large which corresponds to the genital pore and seems directed invariably to the left side. The spines are sometimes elongate, aciculate, or sub-cylindrical, furnished with fine longitudinal striæ in the *Acrosalenia hemicidaroides*, Wright, sometimes enlarged, ovoid, sub-glandiform, more or less granular, as in the *Pseudosalenia tuberculosa.*

The SALENIDÆ are divided into two natural groups.

1st. The *Acrosaleniæ* have narrow ambulacra gradually enlarged towards the oral aperture and provided with perforated tubercles more or less developed; the peristome is divided into two lobes by deep incisions; the apical disc is very large and provided with a sur-anal plate composed of one or many elements; in consequence of the number of small sur-anal plates, and their feeble union with each other, they are seldom preserved.

2nd. The *Saleniæ*, and the genera dismembered from them, have narrow ambulacra, often undulated and garnished with tubercles; their peristome is feebly incised; the apical disc is large and solid, projecting beyond the surface, and more or less deeply marked with impressions at the sutures of the plates.

The *Acrosaleniæ* resemble *Hemicidaris* and *Hypodiadema,* except in the structure of the apical disc, and when this portion is absent it is often difficult to determine the genus to which the mutilated specimen belongs; but the great size of the discal aperture, and the extension of the single ovarial plate into the single inter-ambulacrum readily enable the trained eye of the observer to distinguish it from *Hemicidaris.*

The *Saleniæ,* on the other hand, resemble the CIDARIDÆ by their narrow sub-flexuous ambulacra, furnished with granules, their wide inter-ambulacral areas, their large primary tubercles, and the inflated ovoid or sub-glandular spines, sometimes supported on them; their peristome is likewise feebly incised, like that of *Cidaris.*

The *Acrosaleniæ* form only a single genus, the species of which, with one exception, are distributed throughout the Jurassic rocks.

The *Saleniæ* have certain distinctive characters by which they are readily distinguished from the *Acrosaleniæ.* 1st. Their tubercles are all imperforate, and 2nd, the position of the vent, or periprocte, is always excentric and posterior; sometimes it is situated in the axis of the body, and sometimes out of the axis, and inclines to the right side. For this reason

MM. Agassiz and Desor have separated from the true *Saleniæ* the genera *Peltastes* and *Hyposalenia.* By the same authors a doubt has been suggested about the value of this character, as it may be only an accidental and variable condition ; to this objection M. Cotteau replies, "that he has examined more than four hundred specimens of *Saleniæ* appertaining to the different stages of the Cretaceous formations, and representing almost all the known species, many among which, such as *Peltastes acanthoides, P. Studeri, Salenia petalifera, S. Prestensis,* and *S. Bourgeoisi* present characters that are clearly defined. Nevertheless we have recognised in each of those species that the periprocte, whether in the axis of the animal or out of the axis, occupies a place which is invariably the same."

The structure of the apical disc, and the lines and impressions marked thereon, afford a character of secondary importance, for although the general outline of these sutures is remarkably constant, still there are exceptions which show that caution must be exercised in using it, along with others, in the determination of species. The size of the ambulacra, and the number and magnitude of the granules contained therein; the form of the test, the size of the inter-ambulacral tubercles; the dimensions of the oral aperture, the structure of the peristome, and the depth of the incisions or entailles, collectively form good specific characters on which we can rely.

M. Cotteau divides the family SALENIDÆ into six genera, of which he gives the opposable characters in the following table.[1]

A. Ambulacra large, straight, furnished with small tubercles; apical disc with a compound sur-anal plate, the elements of which are covered with granules.	ACROSALENIA.
B. Ambulacra narrow, sub-undulated, furnished with granules; apical disc large, prominent; sur-anal plate single; elements large shield-shaped, marked by regular impressions.	
a. Tubercles perforated.	
x. Periprocte excentral and posterior, situated in the axis of the animal	PSEUDOSALENIA.
xx. Periprocte excentral and posterior, situated without the axis of the body	HETEROSALENIA.
b. Tubercles imperforate.	
x. Periprocte excentral and posterior, situated in the axis of the animal. 1. Ambulacra destitute of poriferous impressions	PELTASTES.
2. Ambulacra furnished with poriferous impressions	GONIOPHORUS.
xx. Periprocte excentral and posterior, situated without the axis of the body and inclined to the right side	SALENIA.

[1] 'Paléontologie Française; Terrain Crétacé,' tom. vii, p. 90.

The family SALENIDÆ commenced their life-career in the lower zone of the Inferior Oolite. *Acrosaleniæ* abound in the Inferior Oolite and the Cornbrash; and one is found in the Coralline Olite. *Pseudosalenia* was discovered in the Corallian of the Haut Jura. *Heterosalenia* is represented by one solitary species in the Chalk with Hippurites (Senonien Inférieur). *Peltastes* and *Goniophorus* are found chiefly in the Lower Cretaceous. *Saleniæ* occur in the Lower, Middle, and Upper Cretaceous rocks; and in the Tertiary Nummulitic limestone of Biarritz, are represented by a curious species, *Salenia Pellati*, recently found in that formation. Our present seas contain, we are told, a representative form of this family, which was recently dredged up off the American coast by the deep-sea dredging-operations performed in 1869; beyond the alleged fact I know nothing whatever of the genus to which this existing form belongs.

Genus—PELTASTES, *Agassiz*, 1838.

SALENIA (pars), *Agassiz*, 1838. HYPOSALENIA, *Desor*, 1856.

Test small, circular, more or less inflated above, and almost flat below; pores simple in the zone and crowded near the peristome; ambulacra straight, or slightly flexuous, furnished with two rows of small, close-set, homogeneous mammillonated granules. Interambulacra large, provided with two rows of large, crenulated, imperforate tubercles.

Mouth-opening moderate in size, peristome divided into unequal lobes by feeble incisions. Periprocte excentral and posterior, situated in the line of the animal's axis. Apical disc shield-shaped, composed of large plates, more or less undulated at the border; the disc covers in general a large portion of the upper surface of the test, and is marked by sutural impressions and striæ that vary in the different species; the right antero-lateral ovarial plate has an oblong fissure always directed from right to left, corresponding to the oviductal pore and representing the madreporiform body.

Peltastes in its general form and structure resembles *Salenia;* it is distinguished from the latter, however, by the position and direction of the periprocte, which is excentral, and directed obliquely backwards and outwards and towards the right side; the ambulacra likewise are less flexed, the mouth-opening is smaller and lies in a deeper depression; the madreporiform fissure in the right antero-lateral ovarial plate is smaller.

The genus *Peltastes* was established in 1838 by Professor Agassiz; and in 1846 MM. Agassiz and Desor comprised in the genus all the SALENIADÆ in which the periprocte was situated in a line with the axis of the animal, and this forms the leading character by which it is distinguished from *Salenia.*

The genus *Peltastes* is special to the Cretaceous formations; it commences with some remarkable forms in the Lower Greensand, appears in full force in the Upper Greensand and Lower Chalk; becomes rare in the Upper Chalk, and finally disappears from its upper stages.

A. *Species from the Lower Greensand or Neocomian.*

PELTASTES WRIGHTII, *Desor.* Pl. XXX, fig. 1 *a—f*, fig. 2.

SALENIA PUNCTATA,	*Forbes.* In Morris' Catalogue of British Fossils, 2nd ed., p. 89, 1854.
— —	*Woodward*, Memoirs of Geol. Surv., App. to Decade V, p. 7, 1856.
HYPOSALENIA WRIGHTII,	*Desor.* Synopsis des Échinides fossiles, p. 148, 1856.
PELTASTES —	*Cotteau.* Paléontologie Française; Terrain Crétacé, tome vii, pl. 1028, figs. 1—7.

Diagnosis.—Test circular, upper surface convex, sides inflated, under surface flat, ambulacra narrow, slightly flexuous, with two rows of granules fifteen in each, equal in size, and mammillated; poriferous zones slightly flexed, pores unigeminal, set in oblique pairs, and multiplied around the peristome; inter-ambulacra wide, with five or six large prominent tubercles, increasing in size from the peristome upwards. Apical disc very large, convex, subcircular, plates smooth, sutures marked with isolated points, periprocte transversely oblong, a little prominent; mouth-opening large, peristome divided by feeble indentations into ten lobes.

Dimensions.—Height six tenths of an inch; transverse diameter one inch.

Description.—This beautiful typical form of *Peltastes*, and the oldest we at present know, appears in our lists of English fossils as *Salenia punctata*, one of the synonyms of *Peltastes stellulatus*. A comparative study of specimens, however, convinced M. Desor that the identification was erroneous; and he described[1] our Farringdon urchin as a well-marked and distinct species, resembling *Peltastes stellulatus*, but separated from it in having a more inflated test, with more numerous and less prominent tubercles, the apical disc thinner and smoother, and marked only with some isolated punctations.

The test is circular, the sides are a little inflated, and the upper surface is convex and depressed; the ambulacral areas are narrow and very slightly flexed with two rows of mammillated granules, about fifteen in each. They are very uniform in size and arrangement throughout the area, except at the base, where two pairs are a little larger; a line of microscopic granules down the middle of the area divides the larger lateral rows from each other (Pl. XXX, fig. 1 *e*). The poriferous zones are wide for so small a test, and the pairs of pores are obliquely but very regularly arranged in a unigeminal series; near the peristome, however, they become a little more crowded and doubled.

The inter-ambulacral areas are wide, and in the large specimen I have figured fig. 1 *a*

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

there are six plates in each column; the tubercles increase in size from the peristome upwards, so that the three upper pairs of tubercles are the largest and most prominent of the series (fig. 1 *d* and fig. 1 *f*). A few large mammillated granules, unequal in size, are arranged round the areola and in the miliary zone; a double row of smaller granules occupy the middle space; the tubercles are raised upon large bosses with deeply crenulated summits, and the mammillon is prominent, projecting, and imperforate (fig. 1 *f*).

The apical disc is very large, convex, subcircular, and entirely smooth, presenting in the line of its sutures two or three isolated superficial punctations in some of them (fig. 1 *b*); the sur-anal plate occupies the centre of the disc, and is situated immediately before the vent; in one example (fig. 2) however, it is abnormal and rudimentary, and forms an exceptional variety in an otherwise remarkably regular and symmetrical structure. Of the many specimens of this Urchin that have passed through my hands this is the only exception that has come under my notice. All the ovarial plates are perforated near the centres of each; the madreporic laceration is small, but very distinct in the right antero-lateral ovarial (fig. 1 *b*). The periprocte is sub-elliptical, rounded anteriorly, angular posteriorly, and somewhat elevated and inflated at the border (fig. 1 *b* and fig. 2).

The base is flat and the mouth-opening large, one half the diameter of the test (fig. 1 *c*). The peristome is circular and divided by feeble incisions into ten nearly equal-sized lobes.

Affinities and Differences.—This species presents great uniformity in its specific characters, after a careful examination of a great many specimens I have found very little variation from the type form I have figured and described. This specimen, belonging to the British Museum, is unexceptionally large, and perfect in all its parts. Smaller specimens are, however, equally good for description. The Sponge-gravel in which this Urchin is most commonly found is in general a very bad matrix for the preservation of the tests of Echinidæ; when shielded by a ferruginous crust, derived from the matrix, the more delicate portions of the urchin are wonderfully preserved. *P. Wrightii* resembles *P. stellulatus;* it is separated from that form by having a greater number of less prominent tubercles in the area; the apical disc is likewise thinner and smoother, and the sutural punctations are more isolated and more feebly marked.

Locality and Stratigraphical Position.—I have collected *Peltastes Wrightii* from the Sponge-gravel bed of the Lower Greensand near Farringdon, Berks; it has been found likewise in the Lower Greensand at Hythe, Kent; and at Atherfield and Sandown, Isle of Wight; it is, therefore, a true Neocomian or Lower Greensand form.

History.—This species is a very distinct form, and has been separated by Professor Desor from *P. punctatus*, with which it had been identified by most of our English authors. The accuracy of this determination has been sanctioned by M. Cotteau, who has given a very good description of the species, with excellent figures thereof, in his great work on the Cretaceous Echinidæ, in the 'Paléontologie Française.'

Peltastes stellulatus, *Agassiz*, 1846. Pl. XXXI, figs. 1, 2, 3; Pl. XLI, fig. 1 *a—g*.

Salenia stellulata,	*Agassiz*. Monog. des Salénies, pl. ii, figs. 25—32, p. 15, 1838.
— areolata,	*Agassiz*. Ibid., pl. iii, figs. 1—8, p. 16.
— stellulata,	*Agassiz*. Échin. foss. de la Suisse, pl. xxiii, figs. 6—10, p. 90, 1840.
— areolata,	*Agassiz*. Ibid., figs. 11—15, 1840.
Peltastes stellulatus,	*Agassiz* et *Desor*. Cat. raison. des Échinides, Ann. Sc. Nat., 3e sér., tom. vi, p. 342, 1846.
— punctata,	*Agassiz* et *Desor*. Ibid.
— —	*Marcou*. Jura salinois, Mém. Soc. Géol. de France, 2e sér., t. iii, p. 140, 1848.
— pentagonifera,	*A. Gras*. Ours. foss. de l'Isère, p. 29, pl. i, figs. 11, 12, 1848.
Salenia stellulata,	*Bronn*. Index Palæontologicus, p. 1008, 1849.
Peltastes —	*D'Orbigny*. Prod. de Paléont. strat., t. ii, p. 89, 1850.
— punctata,	*D'Orbigny*. Ibid.
Peltastes stellulata,	*Cotteau*. Catal. des Échinid. néocomiens, 1851.
— —	*Bronn*. Leth. Geognost., Kreidegeb., pl. xxix, fig. 5, 1852.
Hyposalenia —	*Desor*. Synops. des Échinid. foss., pl. xx, figs. 6—8, 1856.
— punctata,	*Desor*. Ibid.
Peltastes stellulata,	*Pictet*. Traité de Paléont., 2e éd., t. iv, p. 248, 1857.
— punctata,	*Pictet*. Ibid.
— pentagonifera,	*Pictet*. Ibid.
— Courtaudina,	*Pictet*. Ibid.
— —	*Leymerie* et *Raulin*. Géol. de l'Yonne, Stat. géol. du dép. de l'Yonne, p. 420, 1858.
— stellulata,	*Leymerie* et *Raulin*. Ibid.
Hyposalenia —	*Cotteau*. Éch. foss. de l'Yonne, pl. 54, figs. 1—10, 1859.
Peltastes stellulatus,	*Cotteau*. Paléontol. Française; Terrain Crétacé, pl. 1023, p. 100, 1862.

Diagnosis.—Test small, circular, convex above, flat below, poriferous zones straight, formed of oblique pairs, ambulacra straight, two rows of homogeneous mammillated granules, set closely together, fourteen in each row. Inter-ambulacra wide, two rows of tubercles, five in a row, unequal in size, large at the ambitus, and small near the base; apical disc very large, round, and depressed; sutures well marked with isolated points, and fine incisions; madreporic fissure small, distinct, and surrounded by an elevation of the plate.

Dimensions.—Height three tenths of an inch; transverse diameter half an inch.

Description.—The table of synonyms affords evidence how changes of form in certain parts of an Urchin lead to confusion in the identification of the species, and how impossible it is to define in a few words certain organisms among which the same structures vary much in different individuals with age and the changing conditions of their existence. The apical disc of *Peltastes stellulatus,* Ag., is one of these; M. Cotteau remarks[1] that the ovarial plates are sometimes almost smooth, and present hardly any isolated points, as in *P. pentagoniferus,* Gras. In certain examples the number of these points augment sensibly, and the plates remaining perfectly smooth, the lines of the sutures are punctuated (*P. punctatus,* Ag.). Instead of isolated points, the sutures are often marked with lines or incisions which extend along the surface of the plates, and give to the apical disc a very remarkable parsley-leaved aspect (*P. stellulatus,* Ag.). Sometimes this character is exaggerated; the incisions become deep, and penetrate even into the interior of the plates, which unite at certain points, and produce a remarkable variety of disc seen in certain specimens collected from the calcaires à *Echinospatagus cordiformis* in the environs of Auxerre. In other examples, the plates independent of the points, more or less elongated which exist on the suture, are bordered by little flexuous bourrelets, which become attenuated as they approach the centre, as in *P. Courtaudinus,* Cot. These varieties, when studied separately, as they were discovered by different observers, were regarded as so many distinct types; but a careful comparison of the series has taught M. Cotteau that they are only so many varieties of the same species. The admirable figures given of these variations fully confirm my learned friend's conclusions on the unity of the species. The structure of the apical disc forms, therefore, an important character in the history of this species; and as the observations that have been made upon the differences noted on the ornamentation and sculpture of its elements are applicable to other forms of *Peltastes,* the careful study of this structure requires thoughtful notice in making a diagnosis of all supposed new forms of Salenidæ.

The ambulacral areas are quite straight (fig. 1 *b*), and between the two lateral rows of mammillated granules a zigzag line of microscopic granulets extends from the base to the summit (fig. 3 *b*).

The inter-ambulacral areas are wide and furnished with two rows of tubercles having crenulated bosses and imperforate mammillons; they are prominent, unequal in size, largest at the ambitus, and decrease towards the peristome; very large mammillated granules fill up the miliary zone and form very regular circlets around the primary tubercles. Between these granules in well-preserved specimens a number of microscopic granulets are seen closely arranged around their base.

The mouth-opening lies in a slight depression, and the peristome is divided into ten lobes by feeble incisions, with reflected borders (fig. 2).

The vent is transversely oval (fig. 3 *a*), and the periprocte has a slightly elevated and inflated border.

A variety of *Peltastes stellulatus,* Ag., figured in detail (Pl. XLI, fig. 1 *a—g*), was collected by the Rev. T. Wiltshire, F.G.S., from a greenish yellow band of the Red Chalk at Speeton, Yorkshire. The true position of this specimen was between the upper por-

[1] 'Paléontologie Française, terrain Crétacé,' t. vii, p. 102.

tion of the Gault and the base of the Upper Greensand; this stratum, about nine feet thick, contained small *Gryphææ* and *Terebratula semiglobosæ* with the *Peltastes;* and few fossils besides these. The apical disc (fig. 1 *b*) shows many punctuations in the line of the sutures; one entire ambulacra, magnified four times, is shown (fig. 1 *f*), and one entire inter-ambulacra, equally enlarged, in fig. 1 *e;* the structure of a single plate, magnified six times, in fig. 2 *g*, and the disc isolated, magnified four diameters, is shown in fig. 1 *d*. All these figures are drawn with the utmost care and truthfulness for comparison with other varieties of this species collected from the Sponge-Gravel of Farringdon and figured in Pl. XXXI, figs. 1—3. For an account of the Red Chalk of Speeton, in which this *Peltastes* was collected, the reader is referred to page 8 of this Monograph.

Affinities and Differences.—*P. stellulatus* resembles *P. Wrightii*, but, according to M. Cotteau, the species are quite distinct. M. Cotteau had a large series of the different varieties of *P. stellulatus* to compare with specimens of *P. Wrightii* from Farringdon, sent him by my lamented colleague, Professor Edward Forbes, and after a careful study of these fossils my learned friend observes, it is true, that *P. stellulatus* (var. *punctata*) closely resembles *P. Wrightii*, but nevertheless it is separated from it by its form being more inflated, its tubercles more numerous and less prominent, its apical disc more smooth, less thick, and marked only with some isolated points.[1]

Locality and Stratigraphical Position.—This species, which is very rare in England, was collected from the Lower Greensand at Farringdon, Berks, and the Red Chalk at Speeton, near Filey Bay, Yorkshire.

It is abundant, according to M. Cotteau, in France, in the Néocomien inf. et moyen at Saint-Sauveur, Fontenoy, Leugny, Auxerre, Bernouil, Tronchoy (Yonne); Marolles, Soulaines (Aube); Saint-Dizier (Haute-Marne); Germigney (Haute-Saône); Fontanil (Isère); Censeau, les Rousses (Jura), where it is abundant; and in Switzerland, according to Professor Desor, in the étage Valanginien or Néocomien inf. at La Chaux-de-Fonds, Sainte-Croix, Hauterive, Lauderon près Neuchâtel.

PELTASTES LARDYI, *Desor*. Pl. XXXI, fig. 4 *a, b, c, d*.

HYPOSALENIA LARDYI, *Desor*. Synops. des Échinides Fossiles, p. 148, 1856.
SALENIA ACUPICTA, *Desor*. Ibid., p. 152.
HYPOSALENIA LARDYI, *Pictet* et *Renevier*. Foss. du terr. Aptien de la Perte du Rhone, p. 161, 1858.
PELTASTES LARDYI, *Cotteau*. Paleontologie Française, terr. Cretace, t. vii, p. 106, pl. 1024, 1862.

Test circular, upper surface convex, under surface flat, sides inflated, poriferous zones straight, ambulacra narrow, straight, two rows of homogenous mammillated granules,

[1] 'Paléontologie Française, terrain Crétacé,' t. vii, p. 105.

eighteen in each. Inter-ambulacra wide, two rows of tubercles, five to six in each, largest at the ambitus. Apical disc large, circular, with undulating borders. Mouth-opening circular, peristome decagonal, vent transversely oval.

Dimensions.—Height four tenths of an inch; transverse diameter eight tenths of an inch.

Description.—This Salenia, belonging to the British Museum, is a very rare form, and was referred by my late friend Dr. Woodward to *P. Lardyi.* The test is circular with inflated sides; the upper surface is convex and elevated, and the base is flat. The poriferous zones are straight, formed of oval pores arranged in oblique pairs; separated a small granule, and unigeminal, throughout, except at the base, where they are a little crowded.

The ambulacral areas are straight, with two rows of marginal homogenous, mammillated, granules, eighteen in a row (fig. 4 *c, d*); between the rows there are a double series of microscope granulets filling in the spaces.

The inter-ambulacral areas are large, with two rows of tubercles, five to six in each (fig. 4 *d*), largest at the ambitus, diminishing above towards the disc, and below towards the peristome; a double row of large mammillated granules extends down the middle of the area, and forms circlets around the tubercles; a large mammillated tubercle occupies the outer angle of each plate near its union with the poriferous zones (fig. 4 *c, d*). Around the base of these granules a number of small granulets are freely distributed; the surface of the test has therefore a highly ornamented appearance.

The apical disc is large and undulated at the border; in our specimen (fig. 4) the sutures are much filled in, and the typical character of the species is thereby obscured. In the beautiful specimens from the Aptien of Auxerre the sutures are sharply engraved with isolated points and lines of incision, so as to impart a parsley-leaved character to all the elements of the disc. The vent is moderately wide and transversely oval, and the rim of the periprocte is a little elevated.

The mouth-opening lies in a slight depression, it is about half as wide as the diameter of the test. The peristome is decagonal, and marked by feeble incisions; of the ten lobes those over the ambulacra are the largest.

Affinities and Differences.—In its form and general characters *P. Lardyi* approaches *P. stellulatus;* it is, however, a larger Urchin, with its upper surface more convex and inflated, sometimes it even assumes a sub-conical shape; the marginal rows of mammillated granules on the ambulacra are more numerous, and separated from each other by a double series of microscopic granulets; the apical disc is likewise thicker and more prominent.

Locality and Stratigraphical Position.—Collected from the Sponge-gravel of the Lower Greensand, near Farringdon, where it was associated with *P. Wrightii.* It is a very rare form in the English Neocomian strata. The fossil figured belongs to the British Museum, and is the only English specimen I know.

B. *Species from the Upper Greensand.*

PELTASTES CLATHRATUS, *Agassiz.* Pl. XXXII, fig. 1 *a—f*, 2, 3, 4.

Parkinson's Organic Remains, vol. iii, pl. i, fig. 13, 1811.
SALENIA CLATHRATA, *Agass.* MSS. Morris's Catalogue of British Fossils, p. 58, 1843.
— STELLULATA, *Id.* Ibid. Ibid.
— UMBRELLA, *Id.* Ibid. Ibid.
— ORNATA, *Id.* Ibid. Ibid.
— CLATHRATA, *Bronn.* Index Palæontologicus, p. 1007, 1849.
— UMBRELLA, *Id.* Ibid., p. 1008.
— CLATHRATA, *Forbes.* In Morris's Catalogue of British Fossils, 2nd ed., p. 89, 1854.
— STELLULATA, *Id.* Ibid. Ibid.
— UMBRELLA, *Id.* Ibid. Ibid.
— CLATHRATA, *Woodward.* Mem. of Geol. Survey, App. to Decade V, p. 6, 1856,
— — *Desor.* Synopsis des Échinides Fossiles, p. 151, 1856.
PELTASTES CLATHRATUS, *Cotteau.* Paléontologie Française, terr. Cretacé, tome vii, p. 119, pl. 1028, fig. 8—18, 1862.

Diagnosis.—Test subglobose very convex above, poriferous zones straight, ambulacra narrow, straight, with two rows of mammillated granules. Inter-ambulacra wide, three pairs of prominent tubercles, miliary zone narrow. Apical disc very large, covering nearly the entire upper surface, its outline very deeply indented between the ovarial and ocular plates, which are smooth, and deeply notched at the sutures; those connecting the centres of the plates forming a distinct pentagon, each of the ovarial pores is the centre of five radiating grooves with angular depressions between them.

Dimensions.—Height nine twentieths of an inch; six tenths of an inch.

Description.—This Salenia is a very common species in the Upper Greensand of Wiltshire, where it is often found in a fine state of preservation. The test in general is small and subglobose, although depressed varieties sometimes occur. It is collected likewise from the Grey Chalk near Folkestone, from whence the largest individuals have been obtained. In the subglobose forms the upper surface is convex and inflated, and the under surface is flat, with rounded sides (Pl. XXXII, fig. 1 *a*). The ambulacral areas are narrow and very slightly flexed; two rows of small mammillated tubercles, fourteen to sixteen in each, set closely together, are placed on the sides of the area (fig. 1 *d*), and a line of microscopic granules occupies the centre, and a few are scattered between the tubercles (fig. 1 *e*). The poriferous zones are slightly flexed (fig. 1 *d*), and the holes lie in oblique pairs (fig. 1 *e*); the septum separating each pair has a prominent elevation; and there are eight pairs of holes opposite the larger plates.

The inter-ambulacral areas are wide, and the plates in the columns unequal in size;

there are four or five tubercles in each series, and of these the two uppermost only attain a considerable development (fig. 1 *b*, and fig. 1 *d*, and fig. 3). The others are much smaller, and diminish in size as they approach the peristome (fig. 1 *c* and fig. 1 *d*); the margin of each plate is surrounded by a series of small mammillated granules (fig. 1 *e*, and fig. 3), which form a circle around the tubercles, and in the upper part of the area between the larger granules a number of smaller granulets are placed between them (fig. 1 *d*), thus completing the ornamentation of the miliary zone.

The base of this urchin is flat, and the mouth-opening small (fig. 1 *c*); the peristome is divided into ten nearly equal lobes, by feeble incisions (fig. 1 *f* and fig. 1 *c*).

The apical disc is very large, and occupies all the upper surface of the test (fig. 1 *b*, fig. 3). Its ovarial plates are deeply cut, with numerous incisions, which are much better defined by figures than words; faithful portraits of these most complicated impressions my friend Mr. Bone has given in fig. 1 *b*, fig. 2, fig. 3, and fig. 4. These incisions are large and deep, and extend through the thickness of the plates; three deep incisions mark the line of suture between the ocular and ovarial plates (fig. 2); the two antero-lateral ovarials have another series of impressions of a like character before the vent and behind the oviductal opening. The oviductal holes are large; the two anterior are placed forward on their respective plates; the three posterior lie near the inner borders of the genital plates and opposite the angles of the periprocte. The ocular plates are heart-shaped, and the orbit occupies a depression at the summit of the ambulacra, near the extreme border of the plates. The vent is large and transversely oblong, sometimes even becoming angular (fig. 1 *b*). The periprocte is elevated, and its funnel-shaped extremity encircled by a bourrelet directed backwards (fig. 3). Most specimens show this elevation of the vent, but in many varieties it is not so conspicuous as in the type specimen figured in fig. 3, where the test is magnified twice. The spines are long and needle-shaped (Pl. XLII, fig. 4); above the milled ring is a broad band of longitudinal lines, and the rest of the stem is covered with very fine longitudinal microscopic lines. For further details on the spines of this and other species, see description of Pl. XLII.

Affinities and Differences.—*Peltastes clathratus* is readily distinguished from its congeners by its subglobose test, the great size of its apical disc, and the number, width, and depth of the numerous incisions that divide its surface; its flat base and small mouth opening, with its rounded sides, present an ensemble of characters which well characterise the species and separate it from all the others.

Locality and Stratigraphical Position.—This species was in former years very common in the Upper Greensand near Warminster. Small examples were most abundant, and large specimens were rare. The largest tests are collected from the Grey Chalk near Folkstone; my kind friend the Rev. T. Wiltshire has obtained several large examples from this stratum, and several of these have their spines *in sitû* on the test.

M. Cotteau gives as the French localities of this species, where it is very rare, l'Étage Cenomanien, Le Havre, Seine-Inférieure, La Perrière, Orne, Craie à Scaphites.

Peltastes umbrella, *Agassiz*, MSS. Pl. XXXIV, fig. 1 *a—d*, fig. 2 and 3.

Salenia umbrella, *Agass.* MSS. Morris's Catalogue of British Fossils, p. 58, 1843.
— — *Id.* Forbes, in Morris's Catal. of British Fossils, p. 89, 1854.
— clathrata, *Id.* Woodward (pars), Mem. of Geol. Surv., App. to Decade V, 1856.

Diagnosis.—Body subglobose, convex above; apical disc large, covering the upper surface, its outline deeply indented between the ovarial and ocular plates, sutural grooves deeply and sharply cut, those connecting the centres of the plates forming a distinct pentagon. Each oviductal hole forms a centre, from which five grooves radiate, having angular pits between them; sur-anal plate marked with an inverted triangle formed by horizontal and inclined incisions. Ambulacra wide; two rows of mammillated tubercles crowded with granules around the base; interambulacra with four large tubercles in the upper part, and all the others small, diminishing towards the peristome; base flat, mouth-opening small.

Dimensions.—Height, one quarter of an inch; latitude half an inch.

Description.—I have figured the type specimen of this form belonging to the British Museum, as it is the species Prof. Agassiz gave this manuscript name to many years ago, when he examined the Cretaceous Urchins in the National Collection. Whether *P. umbrella* is specifically distinct from *Peltastes clathratus* I am not in a position to decide. The apical disc is certainly much more angularly incised, and more sharply defined than in *P. clathratus;* and placing two well marked specimens of these type forms in contrast, the decision would be in the affirmative; but then we have the evidence of M. Cotteau, who informs us that the incisions and impressions on the disc alone are not to be relied on as specific characters, as one form glides into another by a series of intermediate gradations, which connect together forms that appeared when isolated to be very distinct from one another.

The ambulacral areas are nearly straight, and have two marginal rows of small mammillated tubercles, fourteen in each. The mesial space between the rows and tubercles is filled with microscopic granules (fig. 1 *c*). The poriferous zones are conspicuous, and the pores placed in oblique pairs. The inter-ambulacral areas are wide, and the plates in the columns unequally developed, those above the ambitus are the widest, and support large tubercles; from the ambitus to the peristome they gradually become smaller, and their respective tubercles diminish in the same proportion (fig. 1 *b*, fig. 1 *c*, and fig. 2).

The apical disc is large, and its circumference much indented between the margin of the ocular and ovarial plates (fig. 1 *a*, and fig. 3), presenting two beautiful varieties of this remarkable structure. The sur-anal plate situated before the periprocte is marked with incisions that form a triangle; each oviductal hole of the two antero-lateral ovarial plates forms a centre, from which five incisions radiate, and from each oviductal hole in the other three ovarial plates four incisions radiate outwards, having angular pits between them. The vent is raised on an eminence which is directed backwards. The anal opening is transversely oval, and the periprocte forms a thickened bourrelet, which is oblong in the variety fig. 1 *a* and angular in fig. 3. In both figures the apical disc is magnified four diameters.

The base of the test is flat, and the mouth opening small, about one third the diameter of the test. The specimens figured in figs. 2 and 3 have been kindly communicated by W. Cunnington, Esq., F.G.S., as remarkably well marked forms of this species.

Affinities and Differences.—The test of *P. umbrella* closely resembles that of *P. clathratus*, the difference chiefly residing in the form and structure of the apical disc, which can be much better understood by a comparison of the figures in Pl. XXXII, fig. 2, and Pl. XXXIV, fig. 1 *a*, fig. 1 *b*, fig. 1 *d*, and fig. 3, and to which we must beg to refer the reader.

Locality and Stratigraphical Position.—The type specimen was collected from the Upper Greensand near Warminster, associated with *Peltastes clathratus* in the same stratum.

PELTASTES BUNBURYI, *Forbes*, sp. Pl. XXXIX, fig. 2 *a*—*i*.

SALENIA BUNBURYI, *Forbes*. In Morris's Catalogue of British Fossils, p. 89, 1854.
— — *Woodward*. Mem. Geol. Surv., App. to Decade V, p. 6, 1856.

Diagnosis.—Test subglobose, much elevated, sides tumid, base wide and flat; oral aperture depressed; apical disc large, very deeply indented at the border, between the ocular and ovarial plates; a series of ten elliptical ridges with central depressions forming an ornamented pentagon on the disc; sur-anal plate with two pairs of oblique elliptical ridges. Vent large, diamond-shaped, excentral, looking obliquely backwards, with a thickened periprocte. Ambulacra narrow, slightly flexed, with small remote marginal tubercles, separated by a prominent ridge of microscopic granules. Inter-ambulacra wide; three prominent tubercles at the ambitus, and four smaller near the base; upper surface covered with scattered granules.

Dimensions.—Height, half an inch; transverse diameter, thirteen twentieths.

Description.—The original and unique specimen of this *Salenia* was presented to the Museum of the Royal School of Mines by E. H. Bunbury, Esq., M.P. My late lamented colleague Professor Edward Forbes named this Urchin, without leaving any notes of its specific characters. A brief diagnosis of these were given by my late friend Dr. Woodward in his appendix to the fifth Decade of the Organic Remains in the Memoirs of the Geological Survey. It is now figured for the first time.

The test is subglobose and much elevated (fig. 2 *a*—*d*), inclining to a conical form. The ambulacral areas are narrow, and slightly flexed with two rows of small remote marginal tubercles, sixteen or seventeen in each row. These are separated by a median ridge formed of microscopic granules, which fill up all the space unoccupied by the tubercles.

The poriferous zones are narrow, the pores small and placed in oblique pairs, of which there are forty in each zone. The septa between the pores are capped by a prominent granule.

The inter-ambulacral areas are wide, and the plates in the columns of unequal size. There are three large tubercles in each area; of these one is very large, and two moderately so; the five others diminish gradually towards the peristome; the upper surface is destitute of tubercles, and this vacant space is covered with small, various sized, sparsely scattered, mammillated tubercles; a series of these encircle the areolas of the primary tubercles. Fig. 2 *f* represents an inter-ambulacral area, magnified four diameters, showing the great disparity existing between the volume of the different tubercles developed therein. The miliary zone is likewise ornamented with similar bodies. Fig. 2 *h* displays these parts, magnified six times, in a single plate, and fig. 2 *i* a tubercle seen in profile.

The base is wide and flat, and highly ornamented with the small close-set tubercles of the inter-ambulacral areas. The oral aperture, one third the diameter of the test, lies in a depression (fig. 2 *c*). The peristome is divided into ten lobes by feeble incisions.

The apical disc occupies a large portion of the upper surface; its border is exceedingly sinuous, and deeply incised at the marginal boundary line between the ocular and ovarial plates; from each oviductal hole two pairs of elliptical-shaped incisions proceed, and right and left to join those proceeding from the adjoining oviduct; and these form the sides of the pentagon which extends around the disc. The sur-anal plate is marked by two pairs of elliptical incisions, which join those from the anterior ocular, and thus form a diamond-shaped impression before the vent (fig. 2 *c*). The ovarial plates terminate in three-lobed cardiform expansions, and from each side of the orbits similar heart-shaped trilobate bodies stretch obliquely outwards. The disc of this species forms a most complicated structure, of which words fail to give any adequate idea. Fortunately, my friend Mr. Bones' admirable figures supply the eye with the fine symmetrical proportions of this intricate bit of anatomy. Consult fig. 2 *a, b, d, e,* for all details.

The vent is large and looks obliquely backwards; it is of a diamond shape, with a thick prominent periprocte; at the three posterior angles of this bourrelet the single and postero-lateral oviducts open, the two antero-laterals are placed much in advance on the lateral boundary of the sur-anal.

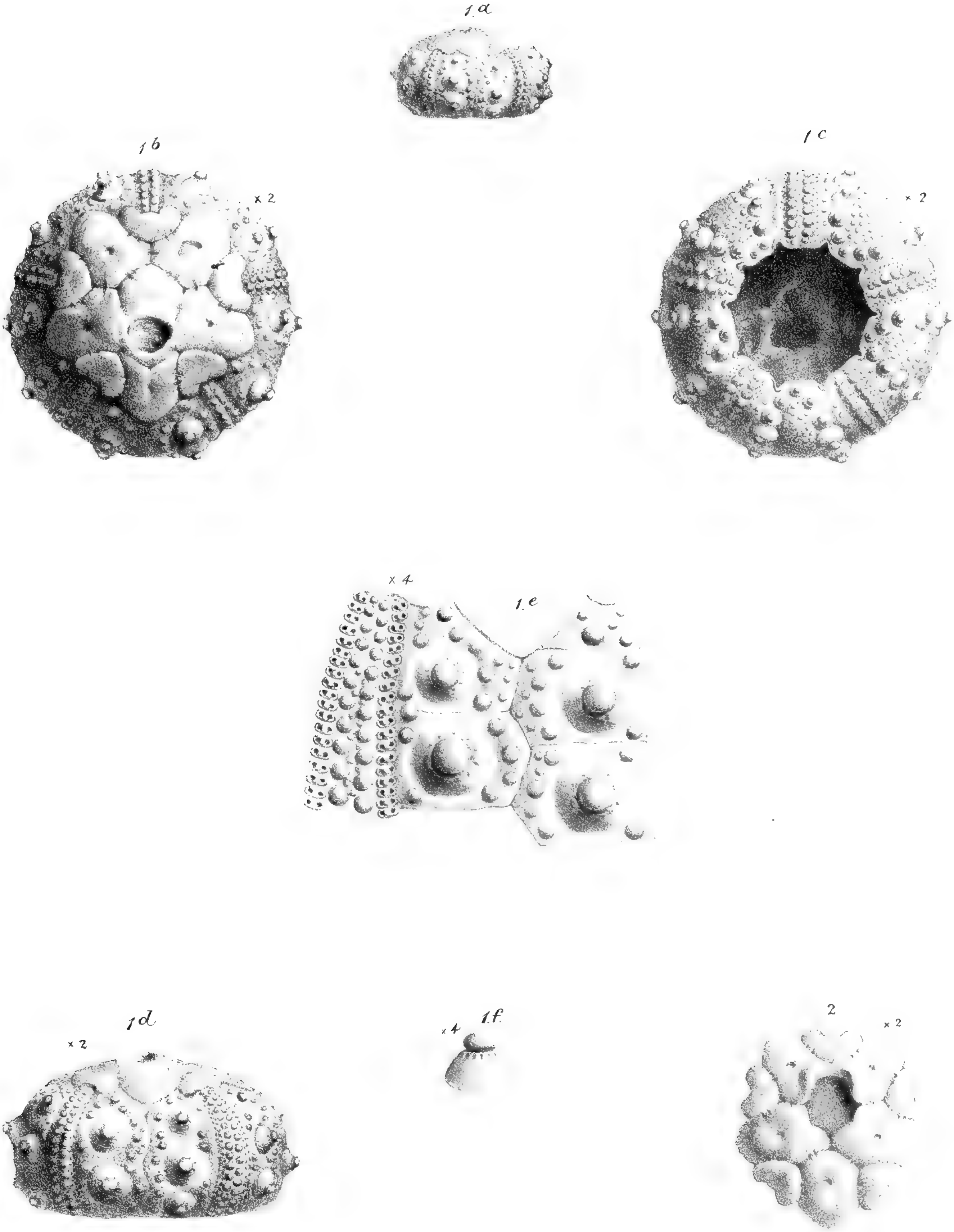
Affinities and Differences.—The sculpture of the apical disc and the deep incisions through the same reminds us of some forms of *Peltastes clathratus;* the margin, however, is more deeply indented, and the style of ornamentation on the same is different; the marginal tubercles on the ambulacra are smaller and more remote, and divided by a prominent granulated ridge; the structure of the inter-ambulacra exhibits a considerable difference, and the pores in the zones are smaller and more numerous.

Locality and Stratigraphical Position.—This rare Salenia was collected from the Lower Chalk, Mildenhall, near Bury St. Edmunds. The original and unique specimen is in the Museum of the Royal School of Mines.

PLATE XXX.

From the Neocomian or Lower Greensand.

Fig. 1 *a.*	PELTASTES WRIGHTII, *Desor.*		Test, natural size. British Museum. (P. 150.)
b.	,,	,,	Upper surface, showing disc magnified twice.
c.	,,	,,	Under surface, mouth opening and peristome, magnified twice.
d.	,,	,,	Lateral view of the same, magnified twice.
e.	,,	,,	Upper portion of an inter-ambulacral and ambulacral area, magnified four times.
f.	,,	,,	Inter-ambulacral tubercle, magnified four times.
Fig. 2.	,,	,,	Abnormal disc, suranal absent, do. twice.



C.R. Bone del & lith

M & N Hanhart imp

PLATE XXXI.

From the Neocomian or Lower Greensand.

Fig. 1 *a*. Peltastes stellulatus, *Agassiz*. Test, natural size. British Museum. (P. 152.)

1 *b*. ,, ,, Lateral view of do., magnified two diameters.

Fig. 2. ,, ,, Under surface, showing mouth opening and peristome, magnified two diameters.

Fig. 3 *a*. ,, ,, Upper surface, showing apical disc, magnified two diameters.

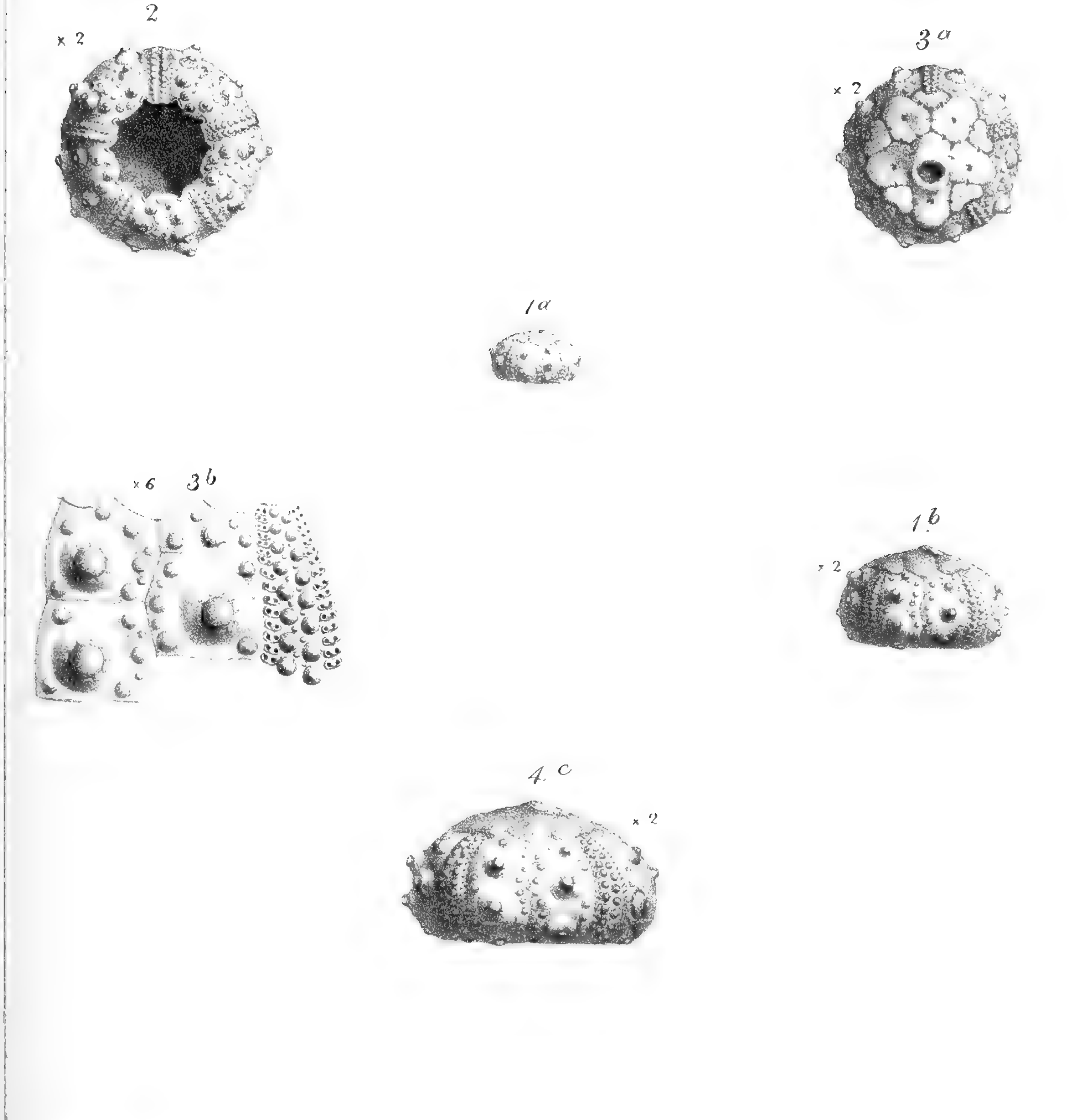
3 *b*. ,, ,, Upper portion of ambulacra and inter-ambulacra, magnified six diameters.

Fig. 4 *a*. Peltastes Lardyi, *Desor*. Test, natural size. British Museum. (P. 154.)

4 *b*. ,, ,, Upper surface, showing apical disc magnified two diameters.

4 *c*. ,, ,, Lateral view of apical disc, magnified two diameters.

4 *d*. ,, ,, Upper portion of ambulacra, and inter-ambulacra, magnified four times.



de del & lith

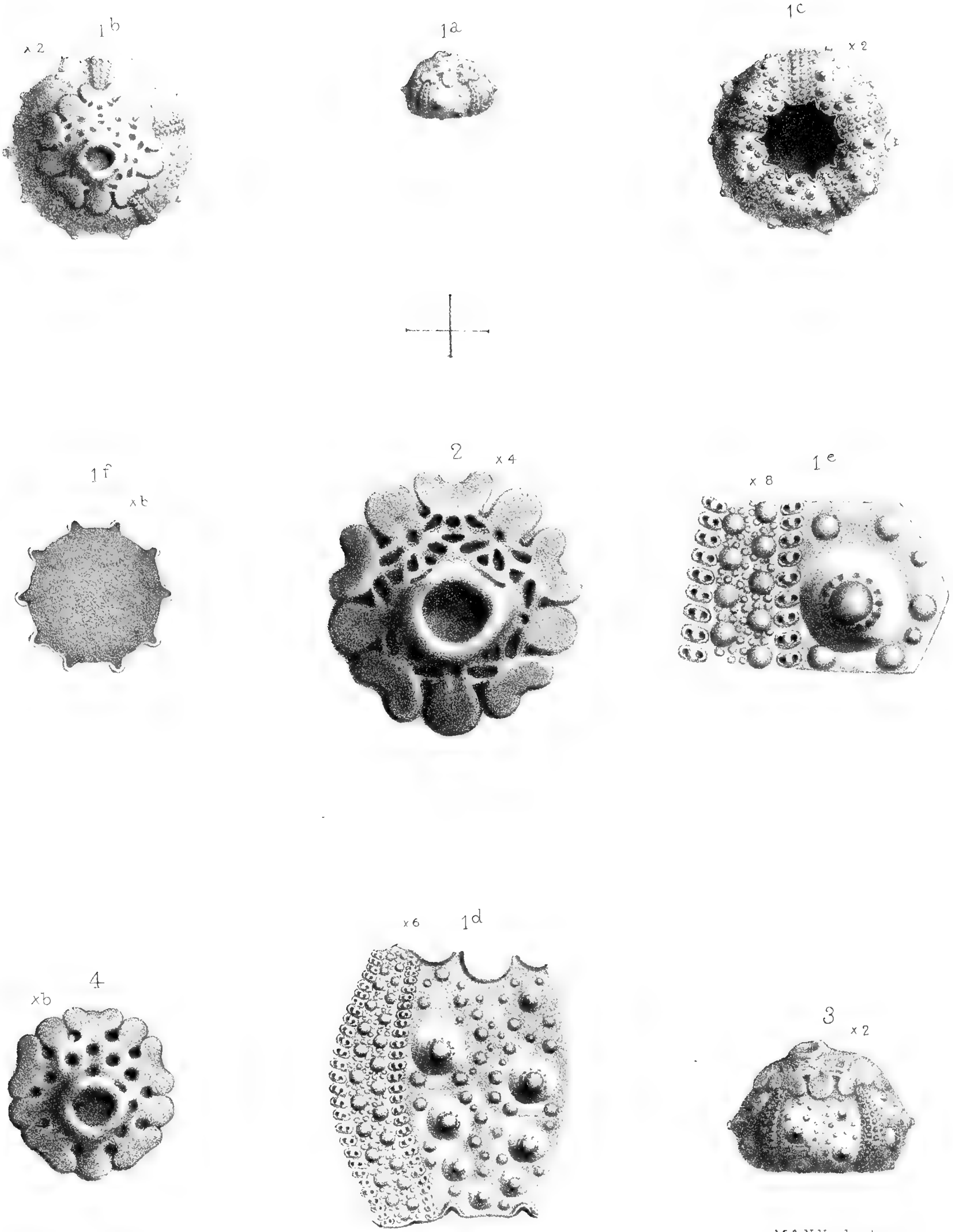
M & N Hanhart imp

PLATE XXXII.

From the Upper Greensand.

Fig. 1 *a*.	PELTASTES CLATHRATUS, *Agassiz*.	Test, natural size. British Museum. (P. 156.)
1 *b*.	,, ,,	Upper surface, showing the disc *in sitû*, magnified two diameters.
1 *c*.	,, ,,	Under surface, showing mouth opening and peristome, magnified two diameters.
1 *d*.	,, ,,	Ambulacra and inter-ambulacra, with poriferous zones, magnified six diameters.
1 *e*.	,, ,,	Single plate and portion of ambulacra with poriferous zones, magnified eight diameters.
1 *f*.	,, ,,	Mouth opening, magnified four diameters.
Fig. 2.	,, ,,	Apical disc detached, magnified four diameters.
Fig. 3.	,, ,,	Lateral view of another test, magnified two diameters.
Fig. 4.	,, ,,	Apical disc detached, magnified two diameters.

Pl. XXXII.



C.R.Bone del et lith.

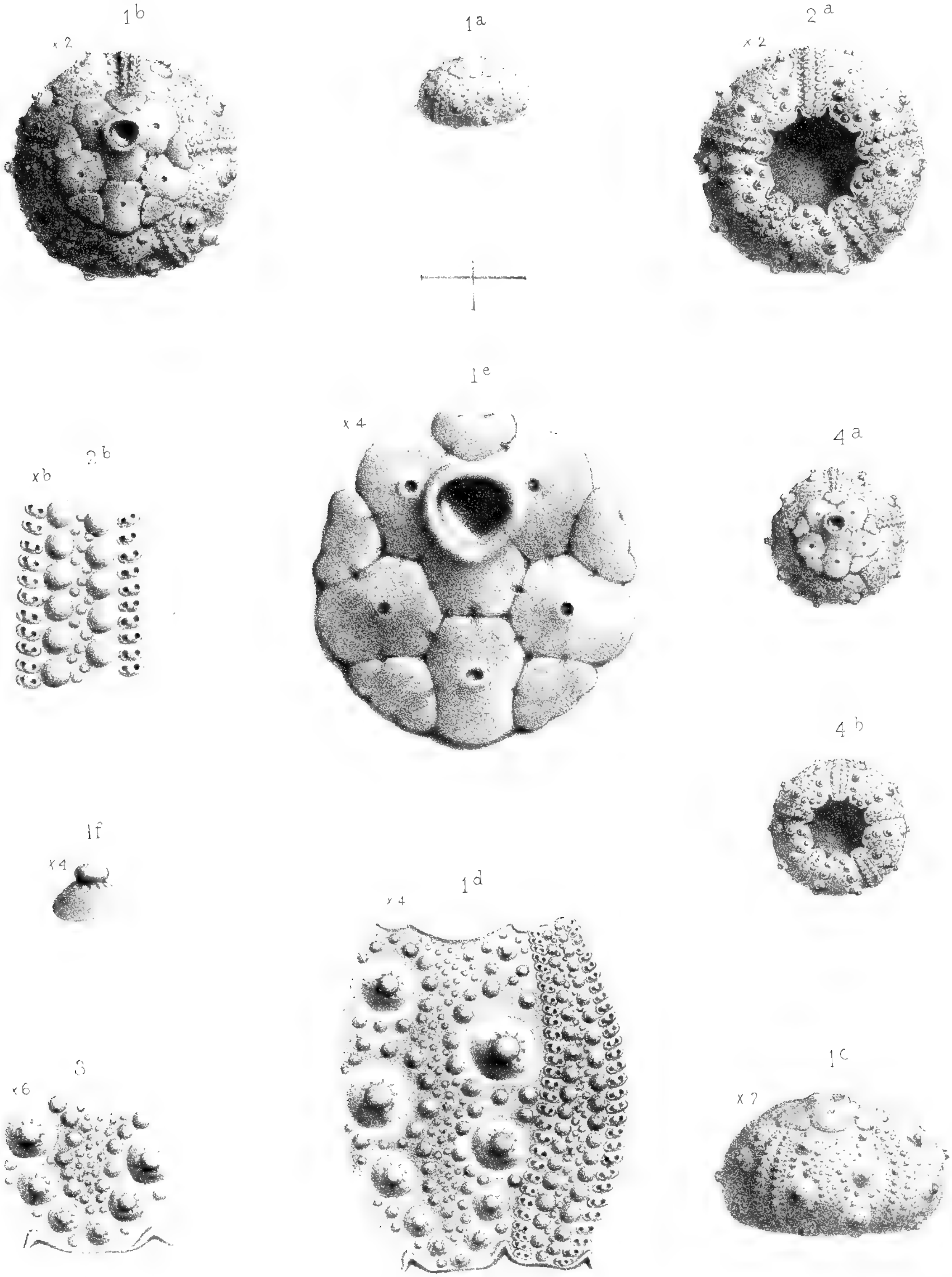
M & N Hanhart imp

PLATE XXXIII.

From the Upper Greensand.

Fig. 1 *a.*	Salenia petalifera, *Desmarest.*	Test, natural size. British Museum.
1 *b.*	" "	Upper surface, showing disc *in sitû,* magnified two diameters.
1 *c.*	" "	Lateral view of the same test, magnified two diameters.
1 *d.*	" "	Ambulacra, inter-ambulacra, and poriferous zones, magnified four diameters.
1 *e.*	" "	Apical disc detached, magnified four diameters.
1 *f.*	" "	Single primary tubercle profile, magnified four diameters.
Fig. 2 *a.*	" "	Under surface, showing mouth opening and peristome, magnified two diameters.
2 *b.*	" "	Ambulacra and poriferous zones, magnified six diameters.
Fig. 3.	" "	Inferior portion of inter-ambulacra, magnified six diameters.
Fig. 4 *a.*	" "	Upper surface of another fine test, Mr. Cunnington, F.G.S.
4 *b.*	" "	Under surface, do., do.

Pl. XXXIII.



C.R.Bone del & lith

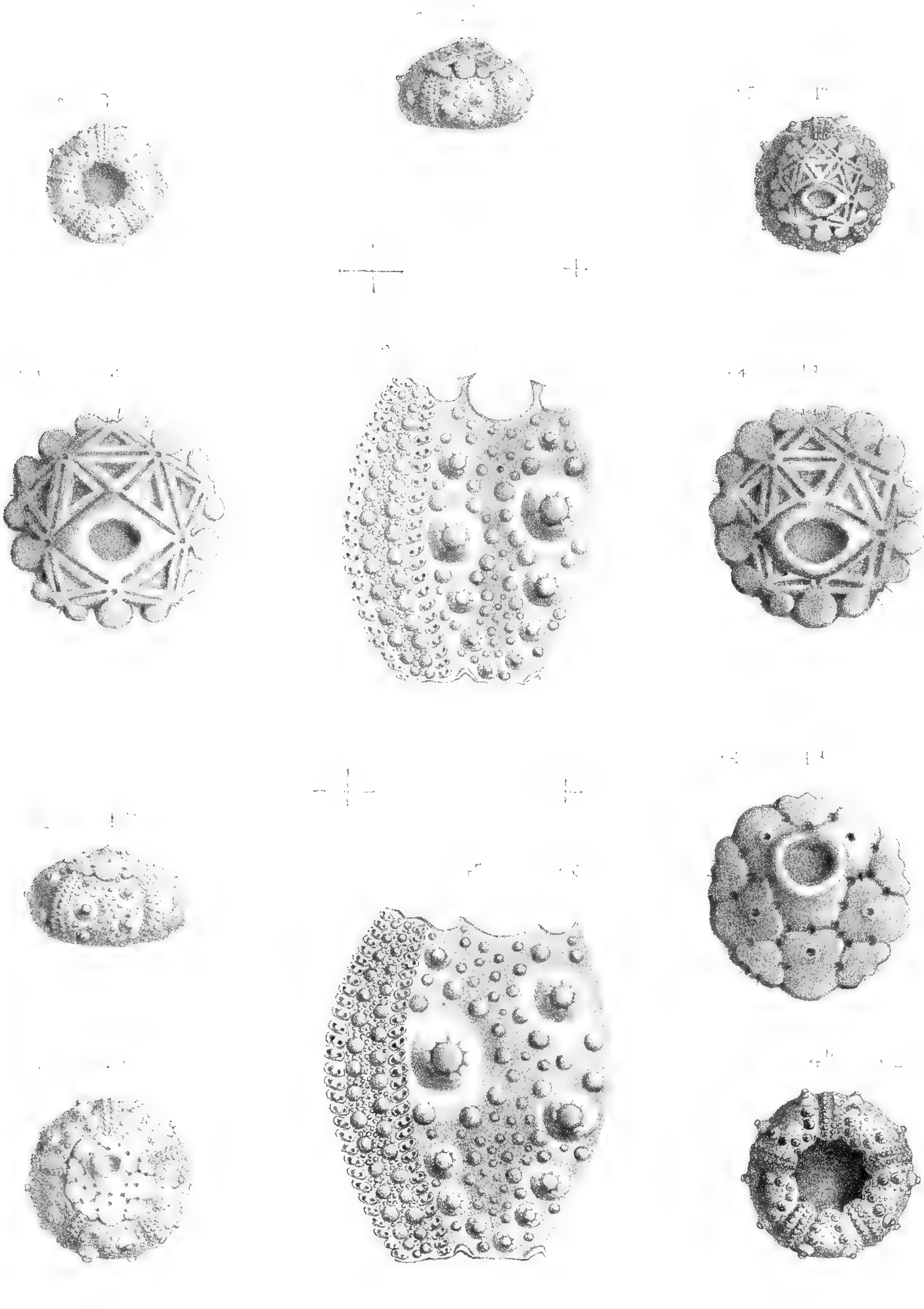
M & N Hanhart imp

PLATE XXXIV.

From the Upper Greensand.

Fig. 1 *a*.	PELTASTES UMBRELLA, *Agassiz*.	Test, magnified two diameters. British Museum. (P. 158.)
1 *b*.	,, ,,	Lateral view of the same, magnified two diameters.
1 *c*.	,, ,,	Inter-ambulacra, ambulacra, and poriferous zones, magnified six diameters.
1 *d*.	,, ,,	Apical disc detached, magnified four diameters.
Fig. 2.	,, ,,	Under surface of another test, magnified two diameters. Mr. Cunnington, F.G.S.
Fig. 3.	,, ,,	Apical disc of another test, magnified four diameters.
Fig. 4 *a*.	SALENIA GIBBA, *Agassiz*.	Test magnified, two diameters. British Museum.
4 *b*.	,, ,,	Under surface of do., do., do.
4 *c*.	,, ,,	Lateral view of do., do., do.
4 *d*.	,, ,,	Apical disc detached, four diameters, do.
4 *e*.	,, ,,	Ambulacra, inter-ambulacra, and poriferous zones, magnified six diameters.

Pl. XXXIV.



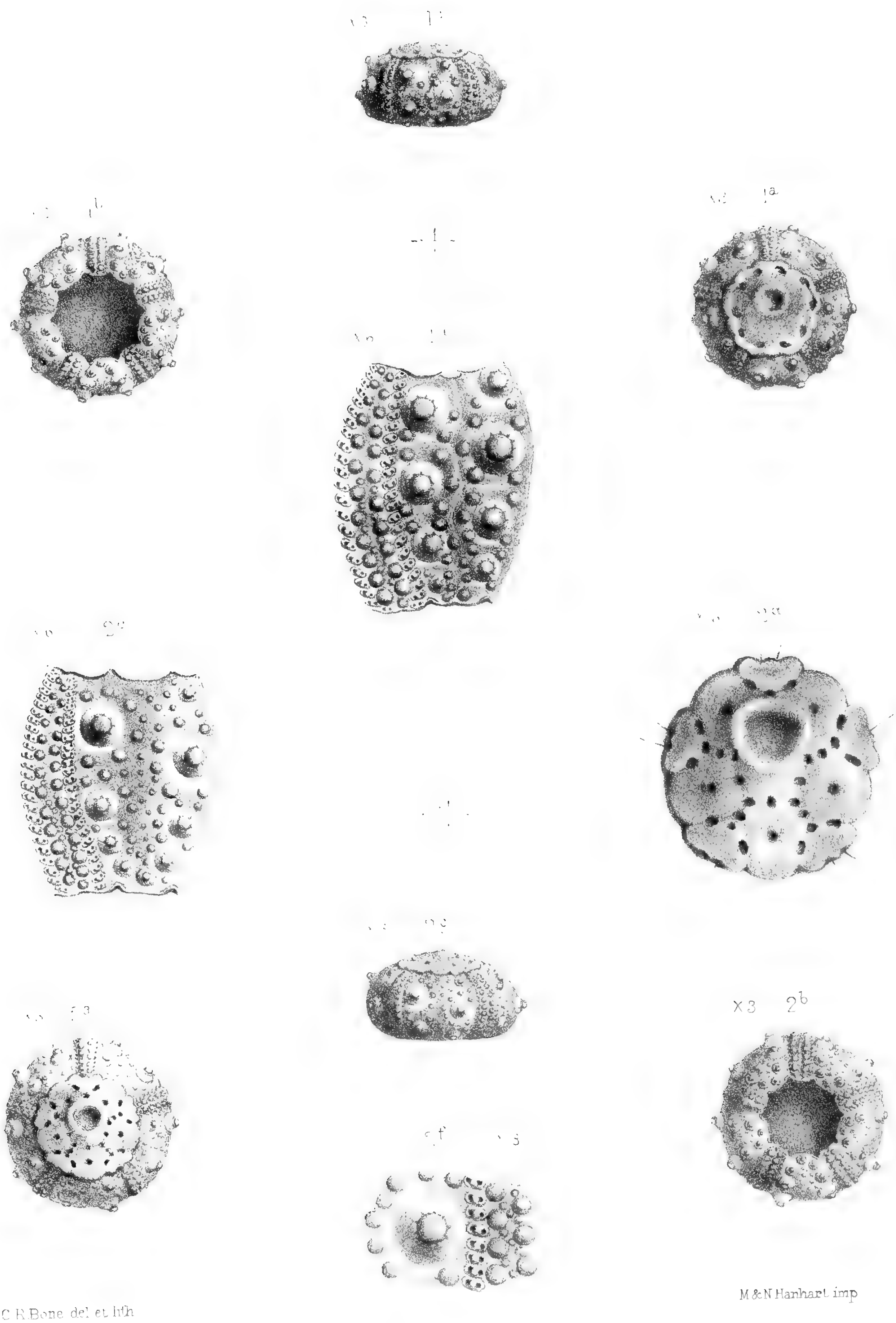
C. R. Bone del. et lith.

M & N Hanhart imp.

PLATE XXXV.

From the Upper Greensand.

Fig. 1 *a*.	SALENIA LORIOLII, *Wright*, nov. sp.	Upper surface, magnified three diameters. British Museum.
1 *b*.	,, ,,	Under surface, magnified three diameters.
1 *c*.	,, ,,	Lateral view, do. do.
1 *d*.	,, ,,	Ambulacra, inter-ambulacra, magnified six diameters.
Fig. 2 *a*.	SALENIA DESORI, *Wright*, nov. sp.	Upper surface, magnified three diameters.
2 *b*.	,, ,,	Under surface, do. do.
2 *c*.	,, ,,	Lateral view, do. do.
2 *d*.	,, ,,	Apical disc, do. six do.
2 *e*.	,, ,,	Ambulacra, inter-ambulacra, do.
2 *f*.	,, ,,	Single plate and ambulacra, eight do.



C. R. Bone del. et lith.

M & N Hanhart imp.

PLATE XXXVI.

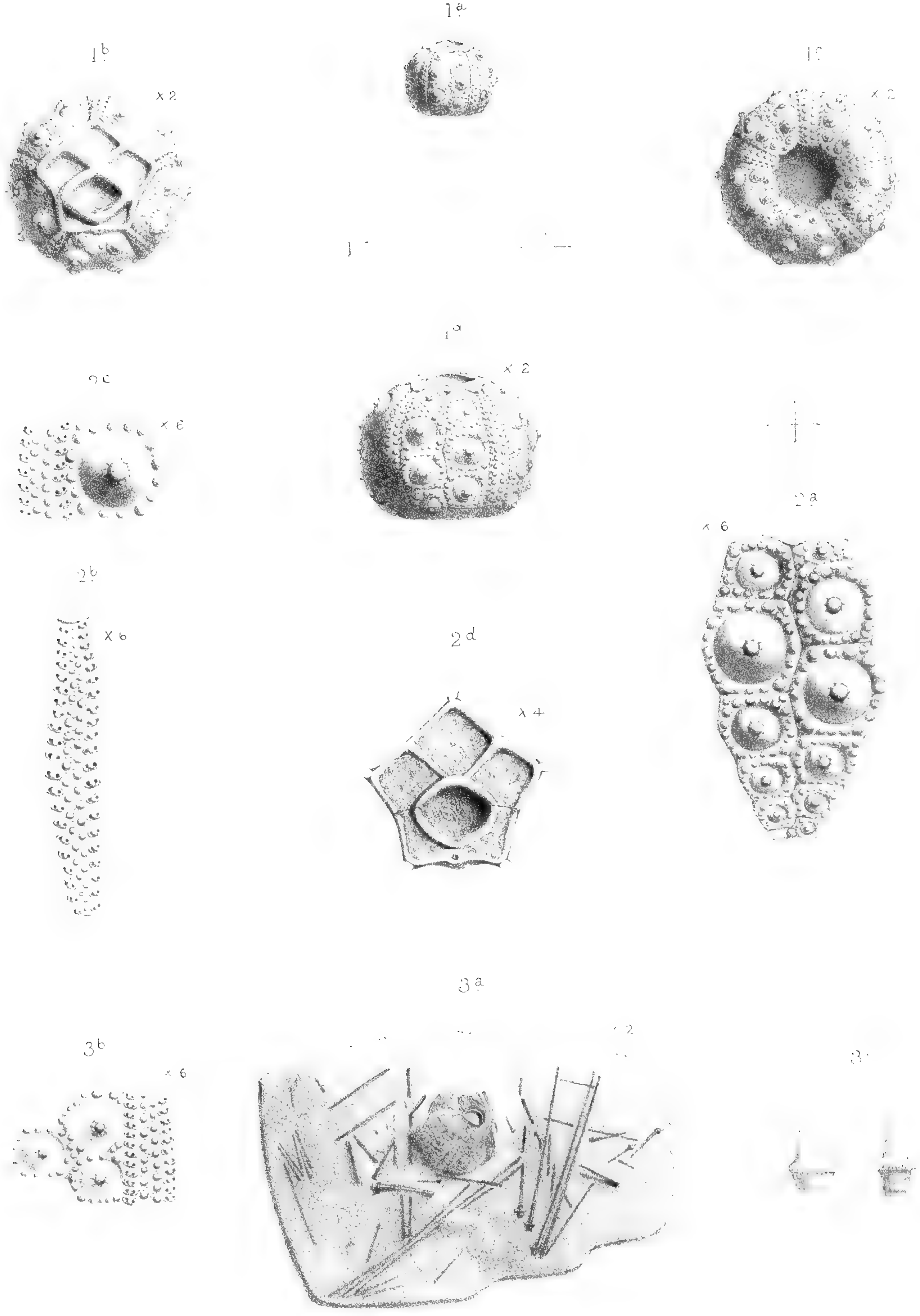
From the Upper Greensand.

Fig. 1 *a*.	GONIOPHORUS LUNULATUS, *Agassiz*.	Test, natural size. Mr. Cunnington, F.G.S. (P. 163.)
1 *b*.	,, ,,	Upper surface, showing disc magnified two diameters.
1 *c*.	,, ,,	Under surface, showing mouth and peristome magnified two diameters.
1 *d*.	,, ,,	Lateral view, inter-ambulacra, magnified two diameters.
Fig. 2 *a*.	,, ,,	Inter-ambulacra, entire, magnified six diameters. Royal School of Mines.
2 *b*.	,, ,,	Ambulacra, entire, magnified six diameters. Do. do.
2 *c*.	,, ,,	Single plate of ambulacra, magnified six diameters.

From the Gault.

Fig. 3 *a*.	GONIOPHORUS LUNULATUS, *Agassiz*.	Test, with spines, *in sitú,* magnified two diameters. Rev. T. Wiltshire, F.G.S.
3 *b*.	,, ,,	Ambulacra and inter-ambulacra, magnified six diameters.

Pl. XXXVI.



C. R. Bone del et lith

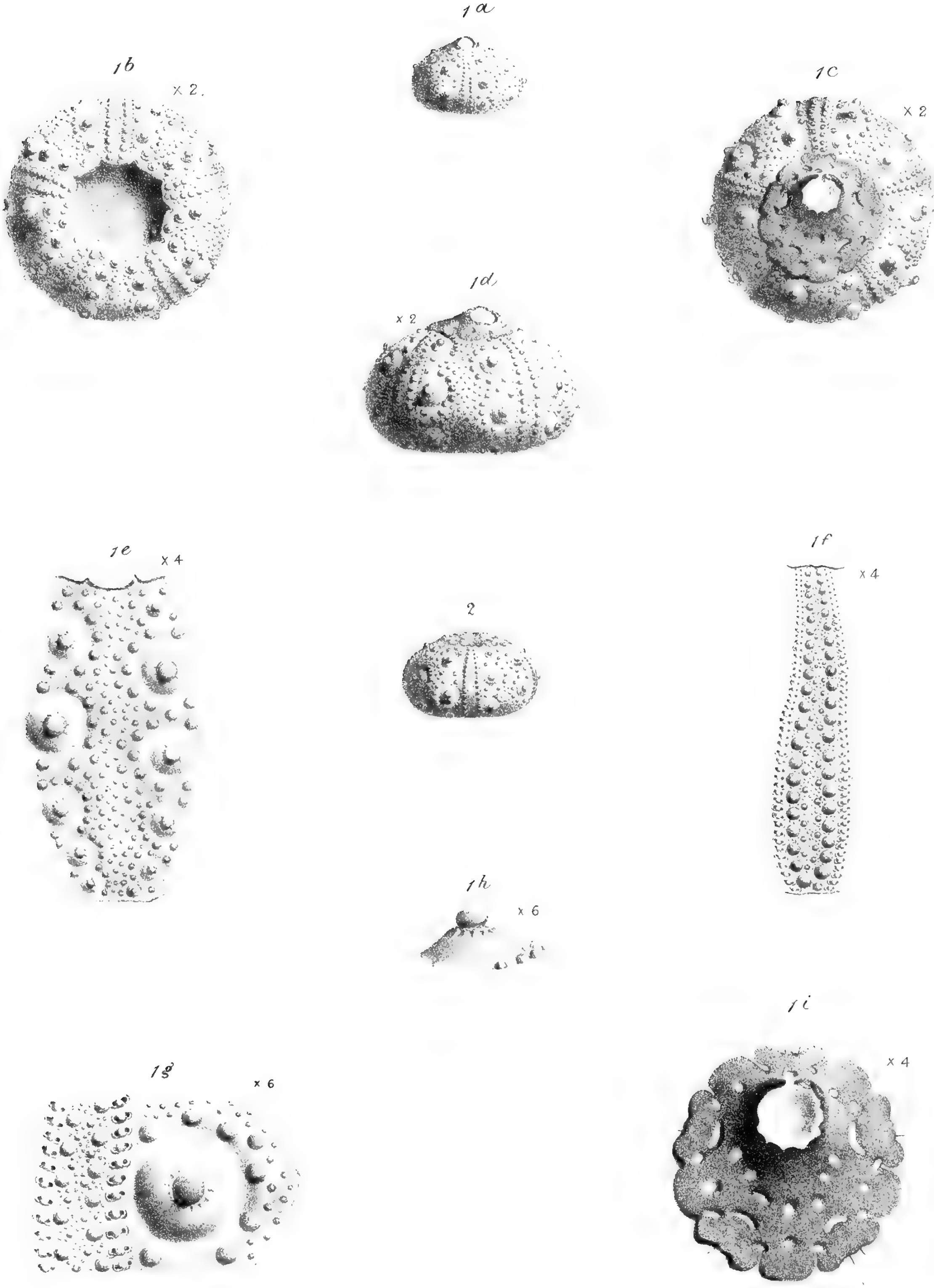
M & N Hanhart imp

PLATE XXXVII.

From the Lower Grey Chalk.

Fig. 1 *a.*	SALENIA AUSTENI, *Forbes.*	Test, natural size. British Museum.
1 *b.*	,, ,,	Under surface, showing peristome magnified two diameters.
1 *c.*	,, ,,	Upper surface, showing disc magnified two diameters.
1 *d.*	,, ,,	Lateral view, showing periprocte magnified two diameters.
1 *e.*	,, ,,	Inter-ambulacra, entire, magnified four diameters.
1 *f.*	,, ,,	Ambulacra, do., do. do.
1 *g.*	,, ,,	Single plate of ambulacra, do. six do.
1 *h.*	,, ,,	Single tubercle in profile, do. do.
1 *i.*	,, ,,	Apical disc detached, do. four do.
Fig. 2.	,, ,,	Test, natural size, do. do., Royal School of Mines.

Pl XXXVII



C.R Bone del et lith

M&N Hanhart imp

PLATE XXXVIII.

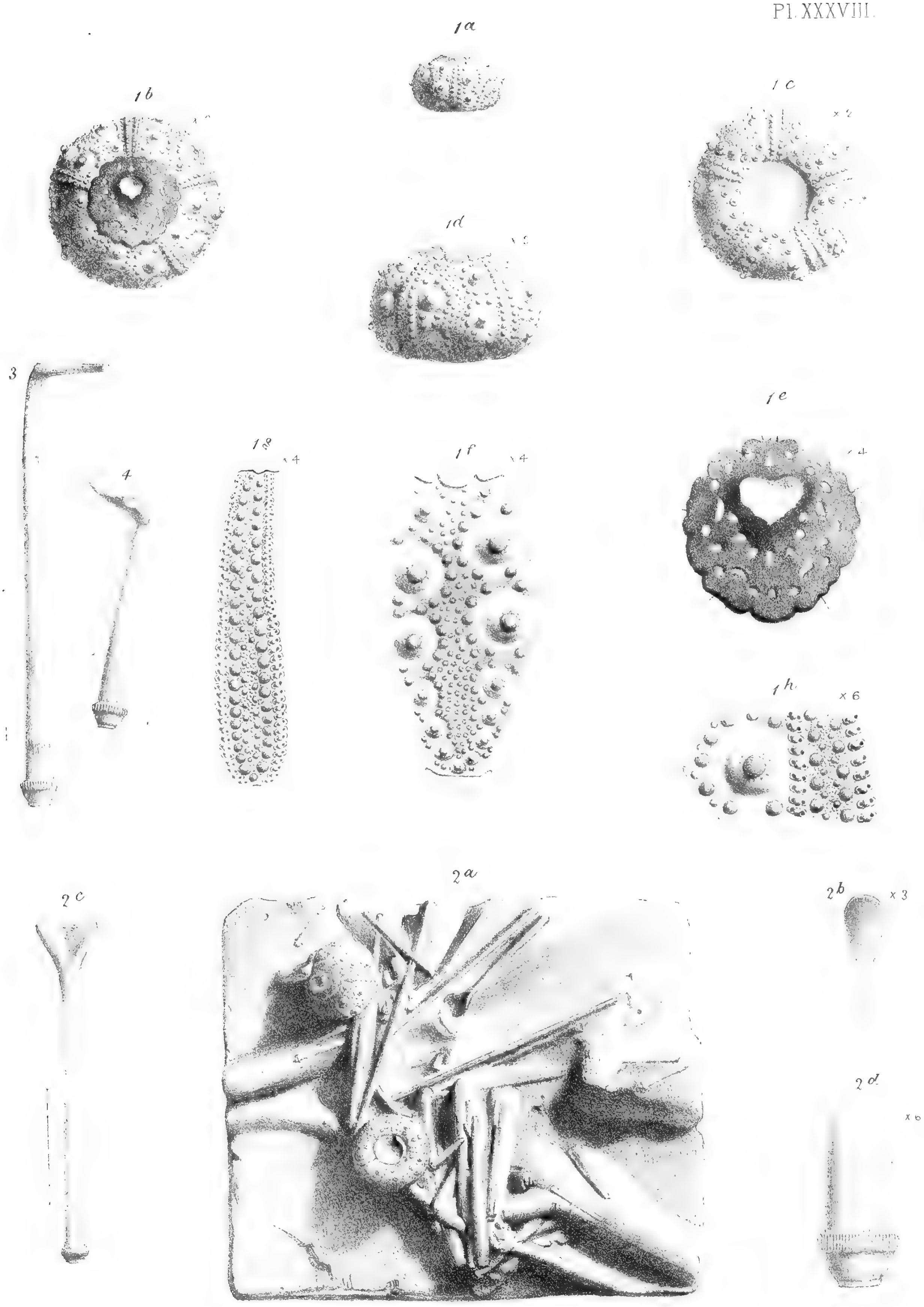
From the Lower Grey Chalk.

Fig. 1 *a*. SALENIA CLARKII, *Forbes*. Test, natural size. British Museum.
1 *b*. ,, ,, Upper surface, showing disc magnified two diameters.
1 *c*. ,, ,, Under do., do. peristome do. do.
1 *d*. ,, ,, Lateral view, showing ambulacral areas and poriferous zones, magnified two diameters.
1 *e*. ,, ,, Apical disc detached, magnified four diameters.
1 *f*. ,, ,, Inter-ambulacra entire, do. do.
1 *g*. ,, ,, Ambulacra entire, do. do.
1 *h*. ,, ,, One plate and ambulacra, do. six do.

Fig. 2 *a*. SALENIA, with spines *in sitû*, natural size, Royal School of Mines.
2 *b*. ,, do. club-shaped, magnified three times.
2 *c*. ,, do. spatulate do. do.
2 *d*. ,, Base of spine showing lines, &c., do. six do.

Figs. 3, 4. ,, Bent spines, magnified three times.

Pl. XXXVIII.



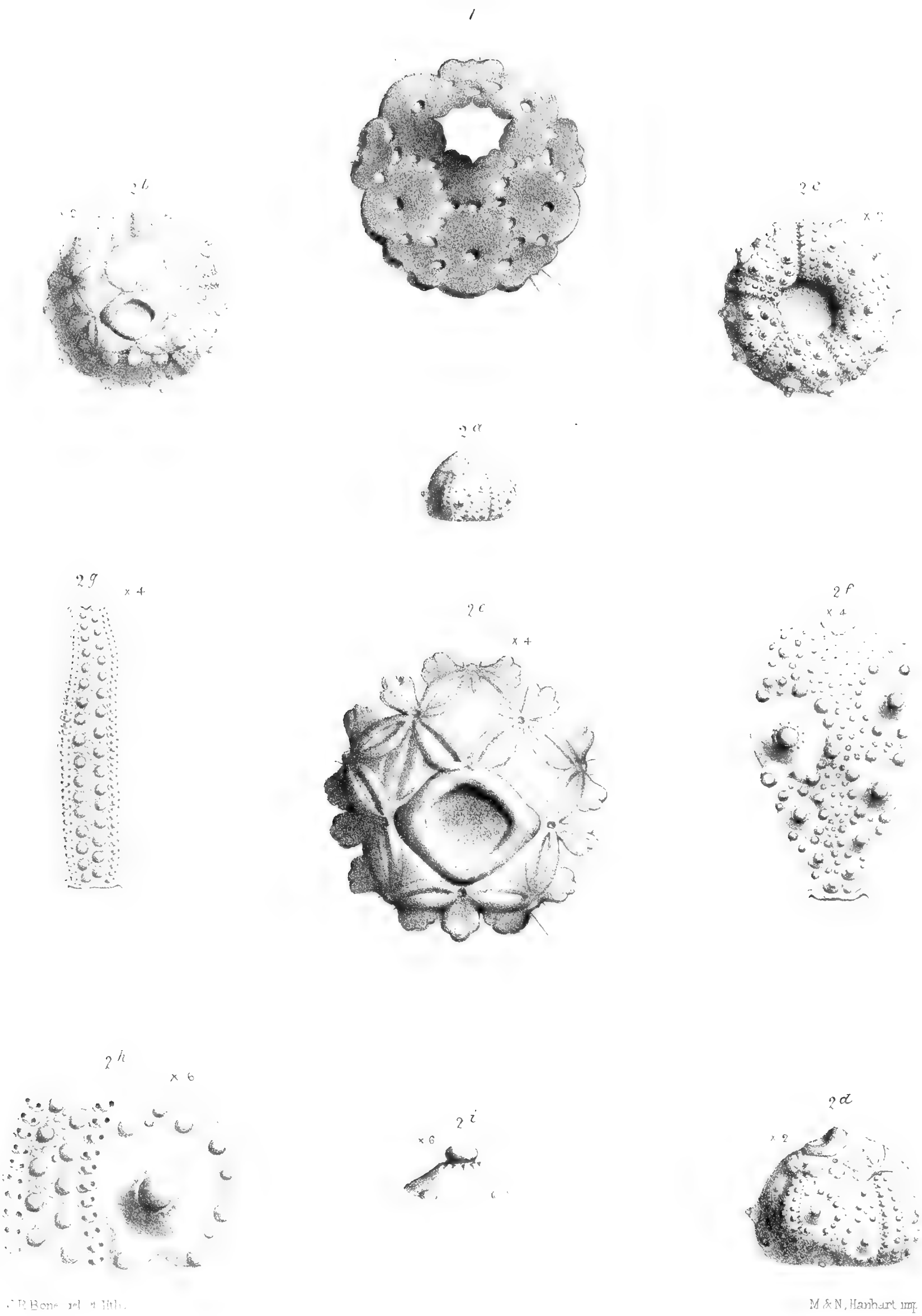
C R Bone del et lith

M & N Hanhart imp

PLATE XXXIX.

From the Lower Chalk.

Fig. 1.	SALENIA CLARKII, *Forbes.*	Apical disc detached, magnified four diameters. The Rev. T. Wiltshire, F.G.S.
Fig. 2 *a.*	SALENIA BUNBURYI, *Forbes.*	Test, natural size. Royal School of Mines.
2 *b.*	,, ,,	Upper surface, showing disc, magnified two diameters.
2 *c.*	,, ,,	Under surface, showing peristome, do. do.
2 *d.*	,, ,,	Lateral view, showing sides and periprocte, magnified two diameters.
2 *e.*	,, ,,	Apical disc detached, magnified four diameters.
2 *f.*	,, ,,	Inter-ambulacra entire, do. do.
2 *g.*	,, ,,	Ambulacra do., do. do.
2 *h.*	,, ,,	Single plate and ambulacra, do. six do.
2 *i.*	,, ,,	Single tubercle do. do.



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FOSSIL BRACHIOPODA.

BY

THOMAS DAVIDSON, F.G.S.,

MEMBRE ÉTRANG. DE L'INSTITUT DES PROVINCES; OF THE GEOLOGICAL SOCIETY OF FRANCE; LINNÆAN OF NORMANDY; ROYAL SOCIETY OF SCIENCES OF LIÉGE; ZOOLOGICAL SOCIETY OF VIENNA, ETC.

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WITH

OBSERVATIONS

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BY

SIR RODERICK IMPEY MURCHISON, BART.,

K.C.B., D.C.L., M.A., F.R.S., F.G.S.,

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THE SILURIAN BRACHIOPODA.

BY

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one specimen," and Mr. Salter states that "a few strong fringe-like varices of growth occur near the margin, giving the old shell an antiquated aspect," and that "at about half way down the shell the ribs fork in most of the varieties, and in many specimens fork again; when this is the case the ribs become angular instead of rounded." In Pl. XXXIV I have given a selection of figures in which all the important features or characters belonging to the species have been carefully represented, and a comparison of these with those of *O. calligramma* (Pl. XXXV) will, I think, convince the student as to the necessity of keeping them separate. As justly remarked by Mr. Salter, *O. flabellulum* bears a closer resemblance to *O. porcata*, M'Coy, an extremely near ally, but from which it can be distinguished by its wider or coarser ribbing, as well as by several other characters. In the extreme variety, *O. flabellulum*, var. *multifida*, from Snowdon, the number of ribs is greatly increased, but we are already prepared for such variations by the parallel case of *O. calligramma*, and I might add of most species, for in none do we meet with the exact same number of ribs on any individual. Beautifully preserved internal casts are often found, and it is from one of these in the Woodwardian Museum that I have made the gutta-percha cast from which the enlarged figure (12 *a*), showing the interior of the ventral valve with its vascular impressions, has been illustrated.

Position and Locality. *Orthis flabellulum* is a common shell in the Caradoc or Bala formation, and has been obtained from many localities in England, Wales, and Ireland. Murchison found it in the east flank of the Caradoc at Corton, Clunbury, and other places in the true Caradoc Sandstone. It is extremely abundant at Boduan, Carnedd Dafydd, Llyn-Idwal, Llyn-Ogwen, Bettws-y-coed, and Dolwyddelan, Caernarvonshire; at Cefn Llyfnog, south-east of Cerrig-y-Druidion, Glyn Ceiriog, Denbighshire; Llanwddyn, Meifod, north of Llangedwin, Llanfyllin, Montgomeryshire; east, west, and south-east of Bala Lake, Llanrhaidr, and Snowdon, Merionethshire (Ramsay and Salter). M'Coy names also several more localities, such as Coniston, North Lancashire; east of the Berwyn Mountains; Cader Dinmael, near Corwen, Denbighshire; the Bala Limestone of Applethwaite Common, Westmoreland, &c.

In Ireland it is stated by M'Coy to be abundant in the grey calcareous slates of Kilbride, Cong, County Galway; and in the schists and sandstone of Shanballymore, Cong, County Galway; and I have several fine internal and external casts from Grange Hill, Chair of Kildare, sent to me by Mr. Joseph Wright, of Cork.

In America Prof. Hall mentions it from Lockport, Rochester, Sweden, Wolcott, and other places.

ORTHIS PORCATA, *M'Coy*. Pl. XXXI, figs. 12—20. Pl. XLVI, fig. 4.

ORTHIS GRANDIS, *Portlock* (not of *Sowerby*). Report Geol. County of Londonderry, &c., p. 452, pl. xxxii, fig. 25, 1843.
— INFLATA, *Salter*. Quart. Journ. Geol. Soc., vol. i, table opposite p. 21, 1845.
— PORCATA, *M'Coy*. Sil. Foss. Ireland, p. 32, pl. iii, fig. 14, 1846.
— INFLATA, *Salter*. Mem. Geol. Survey, vol. ii, p. 372; and var. β, *retrorsa*, p. 373, pl. xxvii, figs. 3, 4, 1848.
— PORCATA, *M'Coy*. Brit. Pal. Foss., p. 223, pl. i H, figs. 41, 42, 1852.
— — *Salter*. Siluria, 2nd ed., p. 210, fig. 5, 1859.
— CARLEYI, *Hall*. 13th Rep. Reg. N. Y., p. 120, 1860.
— PORCATA and O. RETRORSA, *Billings*. Geol. Survey of Canada, Pal. Ser., vol. i, pp. 135, 136, 1862.
— ANTICOSTIENSIS, *Shaler*. Bull. Mus. Comp. Zool. Havard Coll., No. 4.
— PORCATA, *Billings*. Cat. of Sil. Foss. of the Island of Anticosti, Can. Survey, p. 74, 1866.
— — var. RETRORSA, *Salter*. Mem. Geol. Survey, vol. iii, p. 338, pl. xix, fig. 4, 1866.

Spec. Char. Semicircular, semi-elliptical, or slightly subquadrate, a little wider than long, broadest at half the length; hinge-line straight, rather less than the greatest breadth of shell; cardinal extremities angular, sides and front rounded. Ventral valve either almost flat or slightly convex at the beak and on the lateral portions, moderately depressed or gently concave longitudinally along the middle, so as to produce a slightly convex curve at the front margin; area not very wide, with a triangular open fissure in the middle. Dorsal valve evenly convex, but varying much in depth or gibbosity, the lateral portions close to the hinge-line being flattened; hinge-area rather narrow. Surface of valves marked by very numerous small, strong, radiating ribs, from forty to about eighty in number, with interspaces of about equal width, the ribs augmenting in number at a short distance from the beaks, and especially so in the vicinity of the margin, by the interpolation of one or two intermediary shorter ribs between the longer ones, the whole being crossed at intervals by concentric lines of growth. In the interior of the ventral valve the muscular area is remarkably square, and indented in front; while in the dorsal valve the cardinal process is small and placed between two deviating, moderately sized brachial laminæ, the oval muscular scars being separated by a rounded ridge. Three specimens measured—

Length 15, width 18, depth 8 lines.
„ 15, „ 15 lines.
„ 16, „ 20 „

Obs. The first British describer of this species seems to have been my distinguished friend the late General Portlock, who, in his excellent 'Report on the Geology of Londonderry, Tyrone, and Fermanagh,' published in 1843, described and figured our shell under the mistaken denomination of *Orthis grandis,* Murchison, to which species the shell in question does not belong. In 1845 Mr. Salter applied to it the catalogue name of *O. inflata.* In 1846 it was described and imperfectly illustrated by M'Coy at p. 32 of his 'Synopsis of the Silurian Fossils of Ireland.' In 1848 Mr. Salter gave a full description of his *O. inflata* and var. *retrorsa.* In 1852 Prof. M'Coy claimed priority for his name *porcata;* and this claim was subsequently (in 1859 and 1866) conceded by Mr. Salter, and adopted by the generality of British and foreign palæontologists. In America, however, in 1860 it received the designation of *O. Carleyi* from Prof. Hall, and that of *Anticostiensis* from Mr. Shaler. Some British palæontologists have also proposed to add *O. occidentalis,* Hall, *O. sinuata,* Hall, *O. subquadrata,* Hall, *O. subjugata,* Hall,[1] and *O. formosa,* to the synonyms of *O. porcata.* While I concur with Messrs. Sharpe and Salter that several of the above-named American fossils may be varieties of a single variable species, I am still very doubtful if they can with certainty be placed among the synonyms of the species under description. At p. 72 of the '12th Annual Report of the Regents of the University of the State of New York,' published in in 1859, I find the following statement by Prof. J. Hall:—"*O. occidentalis,* with *O. sinuata* and *O. subjugata,* may form but a single species, though, from the collections in my hands in 1847, I found what appeared to be a satisfactory means of distinguishing them. Since examining the species of the Lower Helderberg Limestone, I have found numerous forms which appear as closely allied as do these, but which are nevertheless clearly distinguished by their interior markings. I am not satisfied that the European species, *Orthis porcata,* is identical with ours." At p. 223 of his work on 'British Palæozoic Fossils,' M'Coy also intimates that *O. occidentalis* and *O. sinuata* are closely allied forms, but probably distinguished from *O. porcata* by the greater comparative depth of the ventral valve and its deep mesial sinus, which abruptly indents the margin. There seems to be also a difference in the ribbing. *O. porcata* varies, like all its congeners; and in Pl. XXXI I have endeavoured to illustrate some of its more prominent modifications in shape, the ribs being sometimes more numerously interpolated in some examples than in others. In England and in Ireland the species exists in great abundance under the condition of internal and external casts, but is very rarely found with its shell well preserved, or with its two valves united. In the Island of Anticosti, however, perfect examples of this species are common, and seem very constant in their shape and character, these last having been correctly described and illustrated by Mr. Billings at p. 135 of the first volume of the 'Memoirs of the Geological Survey of Canada (Palæontological Series).'

Position and Locality. In the British Isles *Orthis porcata* seems to be restricted to the Caradoc formation, of which it is a characteristic fossil. In England it occurs all through Shropshire; Mr. Salter mentions its occurrence at Bettws-y-coed, Caernarvon-

[1] Full descriptions and figures of these species will be found in vol. i of the 'Palæontology of New York,' p. 127, &c. 1847.

shire; south of Llangollen, Cyrn-y-brain near Wrexham, and Glyn Ceiriog, Denbighshire; Llanfyllin, Meifod, Llanwddyn, Welshpool, Montgomeryshire; near Corwen, Merionethshire. Prof. M'Coy quotes it from the Bala schists of Llansaintfraid, Denbighshire, at Meifod, and many other places, but it appears most abundant in the Coniston Limestone at Coniston, from which locality a fine series of specimens may be seen both in the Museum of Practical Geology and in Mr. Sharpe's collection in the Museum of the Geological Society. It has been likewise collected at Tan-y-Graig, in the Builth district; at Bird's Hall and Myddleton Hall in the Llandeilo district, &c.

In Ireland it was found for the first time by General Portlock at Tyrone, Desertcreat, and by M'Coy at Portraine, Malahide, County Dublin; also at Carrickadaggan, County Wexford.[1]

Abroad, *O. porcata* occurs in the shales of the Hudson-river group near Cincinnati; in the Trenton Limestone at Ottawa; also at Anticosti, &c.

ORTHIS ACTONIÆ, *Sow.* Pl. XXXVI, figs. 5—17.

ORTHIS ACTONIÆ, *J. de C. Sow.* Sil. Syst., p. 639, pl. xx, fig. 16, 1839.
— — *M'Coy.* Synop. Sil. Foss. Ireland, p. 28, 1846.
— — *Phillips* and *Salter.* Mem. Geol. Survey, vol. ii, p. 286, 1848.
— — *M'Coy.* Brit. Pal. Fossils, p. 213, 1852.
— — *Salter.* Mem. Geol. Survey, vol. iii, p. 339, pl. xxi, figs. 1, 8, 1866.
— — *Id.* Siluria, 4th ed., p. 192, fig. 2, and pl. v, fig. 11, 1867.

Spec. Char. Semicircular, wider than long, the hinge-line being the broadest part of the shell; cardinal extremities extending into short mucronate wings; front and sides rounded. Ventral valve evenly convex, without sinus, flattened at the ears; area narrow, foramen open, beak small, incurved. Dorsal valve flat or slightly concave, especially at the umbone, and flattened at the sides or in the proximity of the cardinal angles; hinge-area very narrow. External surface of both valves ornamented with a variable number of strong angular ribs, which increase in number from about the middle of the margin by the general or occasional interpolation of one or two smaller ribs between each pair of the larger ones. When young and up to a certain age the ribs are simple and comparatively few in number, with wide interspaces between them, and the surface is also covered by fine concentric lines. In the interior of the ventral valve a prominent hinge-tooth exists on each side of the fissure, and is supported by short dental plates, which partly enclose a moderately sized saucer-shaped muscular depression with raised

[1] Carrickadaggan is a famous fossil locality, especially for *Echinosphærites aurantium*, but is an obscure spot, and the above is the name of the townland. It is south of the road from New Ross to Taghmon, being about six miles south from the former place.

margin. In the interior of the dorsal valve the cardinal process is situated between two small brachial processes, on the outer side of which are placed the hinge-sockets; the quadruple impression of the adductor muscle is divided by a longitudinal ridge, and each pair again divided by a small oblique ridge.

Length 12, width 17, depth 4 lines.

Obs. In 1839 Mr. J. de C. Sowerby described this important Lower-Silurian species as "transversely obovate, with about fourteen large radii, bifid or quadrified at their extremities; one valve flat, the other very convex. Length $8\frac{1}{2}$, width 11 lines. Greatly resembling *O. flabbellulum*, but known at once by the forked radii, a character particularly useful in distinguishing the species among the slaty rocks." Murchison's specimens were incomplete and not over-well preserved casts, so that the original describer of the species had not the means of making known all the characters pertaining to his shell, and which subsequent observers have described. Had Sowerby's material been more abundant he would have seen that the number and strength of the ribs varied exceedingly in different specimens, from fourteen to thirty or upwards being at times present round the margin. The smaller or dorsal valve is sometimes flat, but in well-preserved examples it is often slightly concave and especially so near the umbone, and this concavity is the normal condition of the valve, and is not the result of any violence, as suggested by Prof. M'Coy to be the possible cause of the depression. Indeed, *Orthis Actoniæ* simulates certain forms of *Strophomena*, but the internal characters determine it to be an *Orthis*.

In his description of the fossils found by the Survey in North Wales, Mr. Salter alludes to this species in the following words:—"Of this I thought it necessary to give complete figures, and shall point out the characters on which we may rely to separate it completely from *O. flabellulum*. There is no danger of confounding it with any other British species. First, the relative convexity and concavity of the two valves is different in each. In *O. flabellulum* the ventral valve is the flat or slightly concave one, in *O. Actoniæ* the reverse is the case. *O. flabellulum* has a hinge-line shorter than the whole width of the shell; in *O. Actoniæ* it is much wider, and produced into sharp ears. The former has rounded, the latter sharply angular, ribs; and lastly, in *O. flabellulum* the ribs bifurcate; in *O. Actoniæ* they are simply interlined by other ribs (which towards the margin give rise to a cluster of small ribs). There are no longitudinal and but few transverse striæ; sometimes these last are sharp and distinct. But a few distinct varices of growth are always present, and it is beyond the last of these that the sudden multiplication of the ribs takes place which gives so curious an appearance to our fig. 3, and which has been well figured in 'Siluria.' . . . . The areæ are moderate, and equal in either valve."

Position and Locality. Very common in a great many localities in Wales and the South of Ireland in Caradoc rocks; but in 'Siluria' it is stated to occur also in the Llandeilo and Llandovery formations. In the Upper Llandeilo it is found at Garn, Arenig. In the Caradoc or Bala at Acton Scott, Church Stretton, in Shropshire, at Bryn-Bedwog near Bala, and in many localities in that district; Moelydd shales; Castell Craig Gwyddon, Goleugoed, and Bird's Hill, in the Llandeilo district; at Bettws-y-Coed, Penmachno, in Caernarvonshire; south-east of Cerrig-y-Druidion, and Glyn Ceiriog, in Denbighshire; Llanwddyn, Meifod, Llanfyllin, Alt-yr-Anker, Rhiwargor near Llanwddyn, in Montgomeryshire; east and south-east of Bala Lake, west of Corwen, Maes Meillion south of Bala, &c., in Merionethshire. Mr. Hughes found it in Coniston Limestone (Bala) at Helm Gill Dent in the lake district, also in Coniston shale at Pickering Gill, Cautley Sedberg; and several other localities are enumerated by Prof. M'Coy at p. 213 of his work on 'Brit. Pal. Fossils:' in the Lower Llandovery at Haverfordwest and Mandinam in Caernarvonshire; at Marthyrafal in Montgomeryshire.

From Ireland a long list of localities has been given by M'Coy at p. 28 of his 'Synopsis of the Sil. Fossils of Ireland,' but I dare not reproduce them all as authentic. Sir R. Griffith has the shell from Stieveroe Rathdrum; it occurs also at the Chair of Kildare in Caradoc Limestone, as well as at Carrickadaggan, New Ross, and Ballycale, in the County of Wexford, &c.; but some of these last localities may be in Upper Llandeilo according to Mr. Salter.

ORTHIS LEWISII (?), var. HUGHSII, *Dav.* Pl. XXXVIII, fig. 26.

Spec. Char. Shell small, somewhat pentagonal, wider than long, indented in front. Dorsal valve moderately convex, with a deep longitudinal angular sulcus, commencing at the extremity of the umbone and widening as it nears the front, hinge-area narrow. Ventral valve convex; hinge-line considerably less than the width of the shell, area triangular, rather wide; fissure open, narrow; beak small, incurved; surface of both valves marked by about twenty-four strong angular ribs, of which nearly half are due to interpolation. Interior not known.

Length 2, width $2\frac{1}{4}$, depth 1 line.

Obs. This small shell has so much of the shape of *Orthis Lewisii* that I am almost inclined to consider it a mere variety, with fewer and stronger ribs, of the last-named species, but its geological position is very different.

Position and Locality. It was discovered by Mr. Hughes in 1868, in the lowest Coniston Grits of Helmside Dent, and it appears to have been the only Brachiopod obtained from the Upper Coniston group (*i. e.* the Coniston Grits and Flags proper); another specimen was found by him likewise at Casterton Fell, much higher up in the Coniston Grit, and two or three more in the highest beds of the grit or the passage-bed from the grit to the Barmisdale Shale near Torbay, but these last specimens were too imperfect for correct identification. It is singular that the grits in question yield so few species of Brachiopoda.

ORTHIS SIMPLEX, *M'Coy*. Pl. XXXII, figs. 10, 11.

ORTHIS SIMPLEX, *M'Coy*. Synopsis of the Sil. Foss. of Ireland, p. 34, pl. iii, fig. 18, 1846.
— CALLIGRAMMA, var. SIMPLEX, *Salter*. Mem. Geol. Survey, vol. iii, p. 336, 1866.

Spec. Char. Shell rather small; ventral valve subconical, about as wide as long; hinge-line as long as, or slightly less than the width of the shell; area large, divided in the middle by a triangular fissure. Dorsal valve nearly semicircular, and slightly depressed along the middle; area narrow. Surface of valves regularly covered by simple radiating, obtusely angular ribs. In the interior of the ventral valve the saucer-shaped muscular cavity is longitudinally divided by a narrow ridge, which extends to some distance along the bottom of the valve and beyond the margin of muscular cavity. In the interior of the dorsal valve the cardinal process is rather large, while the brachial process is short; a narrow median ridge commences under the cardinal process, and extends to more than half the length of the shell, while shorter, similar, and parallel ridges margin the outer edge of muscular scars.

Length $5\frac{1}{2}$, width 5 lines.

Obs. Of this species (?) I have seen only very few valves, and consequently cannot say I know it well. Mr. Salter writes, "This, which is a very convex shell, is wider than any of Pander's varieties, though most like his var. *rotundata*. It is a small shell too, and has about thirty-two (M'Coy says twenty-four) equal ribs. . . . *O. simplex* has well-defined longitudinal and cross striæ, rather thicker hinge-teeth than usual, and the space for the muscular impressions in the ventral valve is narrower than in the majority of varieties." He considers it a variety of *O. calligramma;* but if the internal details which I have figured are constant it must, I should think, be specifically distinct from Dalman's species.

Position and Locality. *O. simplex* is a Caradoc species, and is stated by M'Coy to be rare in the grits of Carrickadaggan, New Cross, County Wexford; very common in the soft decomposing schists at Knockmahon, Tramore, County Waterford, in Ireland.

ORTHIS SALTERI, *Dav.* Pl. XXXVI, figs. 31—34.

Spec. Char. Of this species the internal cast only has been hitherto discovered, so that we can offer but a very incomplete description of its characters. In shape it is semicircular, and slightly wider than long. Ventral valve moderately convex; hinge-line shorter than the width of the shell; area triangular, rather broad; in the interior the saucer-shaped muscular depression is small. In the interior of the dorsal valve, under the two curved brachial lamellæ, may be seen a strong median ridge, which extends about two thirds of the length of the valve, while on either side the large concave adductor muscular impressions occupy a considerable space.

Length 6, breadth 7 lines.

Obs. The shape and size of the muscular scars, as well as the strong prominent median ridge, seem to distinguish this species from its Silurian congeners. It was discovered by Mr. H. Wyatt-Edgell in the Caradoc Sandstone at Horderley, in Salop. The description above given is taken from gutta-percha moulds made from internal casts: the original specimen is in the Museum of Practical Geology.

ORTHIS CRISPA, *M'Coy*. Pl. XXXVIII, figs. 5—10.

ORTHIS CRISPA, *M'Coy*. Synopsis Sil. Foss. Ireland, p. 29, pl. iii, fig. 10, 1846; and Brit. Pal. Foss., p. 216, pl. i H, fig. 43, 1852.
— — *Salter*. Siluria, 4th ed., p. 526, 1867.

Spec. Char. Subquadrate, or nearly semicircular, rounded or slightly indented in front; hinge-line as long as, or slightly less than the width of the shell. Ventral valve gently convex, with a slight mesial depression commencing at about the middle of the shell, and widening as it nears the front; area narrow; fissure triangular, open. Dorsal valve evenly convex, and deeper than the opposite one; hinge-area very narrow. Surface of both valves covered with numerous radiating, bifurcating, obtusely angular ribs, crossed by numerous equidistant, close, prominent, concentric, scale-like lines of growth.

Length 9, width 10, depth 4 (or more) lines.

Obs. This species is remarkable on account of its squarish shape, as well as from the numerous concentric scale-like lines which intercept the radiating ribs, and which impart to the surface some resemblance to *Orthis Bouchardii*. The number of radiating ribs varies in different specimens, from forty-five to fifty having been counted round the margin by Prof. M'Coy; but I cannot agree with him when he states "it is possible that *O. scabrosa*, Davidson, may be the adult of this species," both forms being perfectly distinct generically, as well as by their external shape and internal character, &c. The interior of *O. crispa* presents the usual characters of the genus *Orthis*.

Position and Locality. This shell occurs chiefly in the Caradoc, but has also been found by Mr. Hughes in the Lower Llandovery at a quarter of a mile south-east of Cwmrhyddan, in Wales. In the Caradoc it is not rare at Bettws-y-Coed, in Caernarvonshire; at Llanfyllin, and Meifod near Welshpool, in Montgomeryshire; and in Bala Limestone at Helms Gill, Dent, Kendal. In Ireland it occurs, according to Prof. M'Coy, at Bardahessiagh, Pomeroy, County Tyrone; but is especially abundant in the schists of Knockmahon, Tramore, County Waterford, &c.

ORTHIS UNGUIS, *Sow.* (sp.). Pl. XXXVII, figs. 16—22.

TEREBRATULA UNGUIS, *J. de C. Sow.* Sil. Syst., pl. xxi, fig. 13, 1839.
ORTHIS — *Salter.* Siluria, 4th ed., p. 527, pl. v, figs. 3, 4, 1867.

Spec. Char. Orbicular, as wide as long, or slightly transverse, broadest across the middle; lateral and frontal margin regularly rounded; hinge-line much shorter than the breadth of the shell. Ventral valve convex, slightly keeled along the middle; area triangular, about one fourth as high as long; fissure open; beak incurved, but scarcely projecting. Dorsal valve very slightly convex, or almost flat, longitudinally depressed along the middle; hinge-area very narrow. Surface of valves ornamented with from sixteen to about twenty-four angular ribs, which in some specimens bifurcate as they near the margin.

Length 6, breadth 6½, depth 4 lines.

Obs. The internal characters are those usual to the genus *Orthis,* and present nothing particular. It seems strange that Mr. J. de C. Sowerby should have mistaken it for a *Terebratula.* It is not a large shell, rarely exceeding five and a half lines in length, and usually occurs under the condition of internal casts and external impressions. In some examples all the ribs are simple, but in others they bifurcate near the margin, as may be seen in figs. 17 and 19 of our plate.

Position and Locality. It occurs in the Caradoc Sandstone at Horderley, Cheney Longville, and Gretton, in Shropshire. In Scotland it has been found in Limestone at Craighead Quarry, near Girvan, in Ayrshire.

ORTHIS PROTENSA, *Sow.* Pl. XXXVI, figs. 24—30.

ORTHIS PROTENSA and O. LATA, *J. de C. Sow.* Silurian System, pl. xxii, figs. 8—10, 1839.
— LATA, *Phillips* and *Salter.* Mem. Geol. Survey, vol. ii, p. 289, 1848.
— PROTENSA, *M'Coy.* British Pal. Foss., p. 224, 1852.
— LATA, *Morris.* Cat., p. 140, 1854.
— LATA, var. PROTENSA, *Salter.* Mem. Geol. Survey, vol. iii, pp. 276 and 361, 1866.
— PROTENSA (= O. LATA), *Salter.* Siluria, 4th ed., p. 526, pl. ix, figs. 22, 23, 1867.

Spec. Char. Transversely semicircular or semicylindrical, depressed, wider than long, very slightly rounded or nearly straight in front; hinge-line almost or quite as wide as the shell. Ventral valve very gently convex, depressed in the middle and towards the front; area narrow, fissure open. Dorsal valve rather more convex than the ventral valve, area linear. Surface of both valves marked by numerous thread-like, radiating, angular radii, which increase in number at various distances from the beaks by the means of bifurcation as well as by the interpolation of shorter and smaller ribs between the larger ones, so that three or four at times bifurcate. In the interior of the ventral valve the saucer-shaped muscular cavity is small. In the interior of the dorsal valve the cardinal process (not tooth, as it has been often misnamed) is situated between two short brachial processes, while the quadruple adductor scars are rather large and arranged in pairs, separated longitudinally by a widish flattened ridge.

Length 7, width 9, depth 2 lines.

Obs. Mr. Salter seems to have been the first to recognise that *O. lata* and *O. protensa*, Sow., were one species, and this view was subsequently admitted by the generality of palæontologists. Some authors have adopted the one, while others have preferred the other, designation; but as that of *protensa* has been more generally made use of, it will be here retained for the species. Although an abundant fossil in some localities, it is found generally in the shape of distorted internal casts and external impressions, the shell itself being rarely preserved; indeed it is often difficult to make out its exact shape, but when perfect it is more or less transversely semicircular, the valves presenting but a very small degree of convexity.

Position and Locality. *O. protensa* is stated in 'Siluria' to range from the Caradoc into the Llandovery, but it is chiefly, if not exclusively, from the Lower and Upper Llandovery that the shell has been procured. It occurs abundantly in the Lower Llandovery at Goleugoed, Llandovery, Mandinam, Caernarvonshire; also at Mathyrafal south of Meifod and Pen-y-Craig. Prof. M'Coy quotes it from the Bala Schists of Cader Dinmael, near Corwen, Denbighshire, also as very common in the Bala Limestone of Ash Gill, Westmoreland, and at Llangynyw Rectory, near Welshpool, in Montgomeryshire. Murchison mentions it likewise from Meadow Town, near Shelve, Salop. Mr. Hughes has found the shell abundantly in the Upper Llandovery at Pentan and Iron Cold Brook, Llandovery, also at Gorllwyn Fach, Myddfai, in Wales. Mr. Salter got it from Wooltack Park in the same formation. In the 'Synopsis of Sil. Fossils of Ireland' Prof. M'Coy quotes a variety (?) of this species from several localities in the Counties of Wexford and Wicklow.

ORTHIS TURGIDA, *M'Coy*. Pl. XXXII, figs. 12—20.

ORTHIS TURGIDA, *M'Coy*. Annals Nat. Hist., 2nd ser., vol. viii, p. 399, 1851; and Brit. Pal. Foss. in Camb. Mus., p. 229, pl. i H, figs. 20—24, 1852.
— — *Id.* Siluria, 4th ed., p. 527, 1867.
— — *Salter.* Memoirs of the Geological Survey, vol. iii, pp. 258, 268, 276, 1866.

Spec. Char. Semicircular, globose, slightly wider than long, rounded or nearly straight in front; hinge-line rather less than the width of shell; ventral valve very convex, and regularly arched in profile, slightly flattened or depressed along the middle; area moderately wide. Dorsal valve gibbous, sometimes hemispherical, at times depressed, but remaining remarkably tumid towards the margins. Surface of both valves covered with numerous fine thread-like striæ, increasing in number by bifurcation and interpolation as they near the margin. In the interior of the ventral valve the saucer-shaped muscular cavity occupies about one third of the width of the shell, and is obscurely divided along the middle by a slightly raised ridge. In the interior of the dorsal valve a prominent median ridge extends from the apex of the umbone to about half the length of the valve, while the deviating brachial processes form two triangular plates, which converge and become united to the upper half of the median ridge or septum, so as to enclose a lozenge-shaped space. The adductor or occlusor muscular impressions lie on either side of the lower half of the median ridge, each pair being again divided by a small oblique ridge. Two specimens measured—

Length 11, width 11, depth 9 lines.
" 8, " 9, " 6 "

Obs. This interesting species has been well described by Prof. M'Coy, who states that it occasionally attains one inch in length, and that from the great variation in the proportional depth of the ventral valve in different specimens he is uncertain which of the valves is the deepest, although he entertains little doubt that the dorsal one is so, and that in the adult shell the tumid form and deep short furrow in the rostral half of the dorsal valve distinguish it easily from all he knows. Some specimens that I have seen had their valves evenly convex, but the internal characters presented by the median septum, brachial processes, and shape of muscular scars, at once distinguished *O. turgida* from other species of Silurian *Orthis*. The internal cast of the dorsal valve is also easily recognisable on account of the short but wide slit left by the mesial ridge.

Position and Locality. *O. turgida* appears to be present in the Upper Llandeilo, Caradoc, and Lower Llandovery divisions of the Silurian system. Thus, Mr. Salter quotes it from Craig-y-Glyn in South Wales from the Upper Llandeilo flags; from the Caradoc at Dolwyddelan, Conway Falls, Bettws-y-Coed, in Caernarvonshire; at Cerrig-y-Druidion in Denbighshire, and at Llanfair in Montgomeryshire. In Lower Llandovery at Mathyrafal and Pen-y-Craig. Some large casts occur also in the Cambridge Woodwardian Museum from Craig-y-beri, and Mr. Hughes found it south of Ffairfach Station, both localities being in the Llandeilo flag division. In the Museum of the Geological Society will be found some good examples obtained from the Caradoc at Penllech, Ysputty Evan. Prof. M'Coy mentions, likewise, Llanarmon Fach in Denbighshire, Coed Sion Llangadoc, South Wales, Aber Hirnant, east of Bala, &c.

In Scotland it has been met with at Penwhapple Glen and Penkill in Ayrshire.

ORTHIS SAGITTIFERA, *M'Coy*. Pl. XXXVI, figs. 18—23.

ORTHIS SAGITTIFERA, *M'Coy*. Ann. Nat. Hist., 2nd ser., vol. viii, p. 398, 1851; and Brit. Pal. Foss., p. 227, pl. i H, figs. 15—19, 1852.
— — *Salter*. Mem. Geol. Survey, vol. iii, p. 268, 1866; and Siluria, 4th edit., p. 527, 1867.

Spec. Char. Rotundato-quadrate or semicircular, slightly wider than long, depressed; hinge-line as long as, or a little less than the shell's width; cardinal extremities obtuse; lateral margins almost parallel, front rounded. Ventral valve gently convex, and slightly longitudinally carinated along the middle; beak small, incurved, not projecting; area triangular, narrow; fissure wide, open. Dorsal valve moderately convex, deeper than the opposite one, with a narrow mesial sulcus extending from the extremity of the umbonal beak to about the middle of the shell; hinge-area very narrow. Surface of both valves radiated with very numerous fine, thread-like, bifurcated, raised striæ, no fasciculation. In the interior of the ventral valve is a prominent hinge-tooth on each side of fissure, supported by dental plates, which partly enclose a saucer-shaped muscular depression with raised margin, and divided longitudinally by a widish median ridge. In the interior of the dorsal valve a small cardinal process is situated between two diverging brachial processes, under which a longitudinal ridge extends to about half the length of valve, dividing into two pairs the quadruple adductor impression, each pair being likewise separated by a small oblique ridge.

Length 14, width 15, depth 4 lines.

Obs. The internal cast of the dorsal valve (fig. 21) is often recognisable by its arrow-shaped slits, which are due to the median ridge and brachial processes. Prof. M'Coy observes that "this species is, perhaps, most nearly allied to *O. turgida*, M'Coy, from which it is distinguished externally by its flatter ventral valve, with nearly straight profile, and a cardinal area less than half the height, and a much more obtuse apical angle. The striæ are thicker and coarser. Internally the difference is still greater, the present species having much shorter and wider muscular impressions in the ventral valve, and the characteristic broad-arrow-shaped impressions of the rostral portion of the dorsal valve, produced by the comparatively long, divergent, dental lamellæ [brachial processes], wholly separated from the mesial furrow. The gibbous dorsal valve, with its deep, narrow, mesial sulcus near the beak, coarser striæ, and totally different internal characters, separate it from the *O. retrosistria*, M'Coy, with which it also frequently occurs."

Position and Locality. It occurs in the Caradoc and Lower Llandovery, and is extremely abundant in the decomposing sandy Bala Schists of Aber Hirnant, east of Bala, Merionethshire. A fine series of specimens may be seen in the Cambridge Woodwardian Museum, collected by our veteran and celebrated geologist the Rev. A.

Sedgwick. It was also found by Mr. H. Wyatt-Edgell in the Caradoc at Troutbeck, but there much out of shape from the effects of cleavage. The same geologist informed me that he had found specimens in the Lower Llandovery, but I know it only from the Caradoc.

ORTHIS? HIRMANTENSIS, *M'Coy*. Pl. XXXII, figs. 5—9.

ORTHIS HIRMANTENSIS, *M'Coy*. Annals and Mag. of Nat. Hist., 2nd ser., vol. viii, p. 395, 1851; and Brit. Pal. Fossils, p. 219, pl. i H, fig. 11, 1852.
— — *Salter*. Mem. Geol. Survey, vol. iii, p. 267, 1866.
— — *Id*. Siluria, 4th ed., p. 526, 1867.

Spec. Char. "Truncato-orbicular, depressed; cardinal area very low, triangular, nearly twelve times wider than high; hinge-line slightly less than the width of the shell; cardinal angles slightly obtuse; lateral and frontal margins horizontal, almost uniformly curved; entering [dorsal] valve perfectly flat, with a slight longitudinal mesial depression near the beak; receiving [ventral] valve slightly and gently convex, most so along the middle, at about one third the length from the beak; both valves with numerous slightly unequal, prominent, angular, strongly fasciculated striæ, each of the primary ridges branching near the middle into from five to seven smaller, forming in some specimens slightly angulated, divaricatingly arched groups; eight or ten striæ at the cardinal angles, smaller and straighter than the rest, running nearly parallel with the hinge-line; separating sulci narrow, marked with very coarse punctures or little pits, and crossed by coarse, obtuse, transverse striæ; twelve to fourteen striæ in two lines, at four lines from the beak; internal cast of receiving valve radiated with coarsely punctured impressions of the external striæ. Cardinal teeth very short, thick, diverging at 80°.

"Width 1 inch, proportional length $\frac{70}{100}$, depth $\frac{16}{100}$." (M'Coy.)

Obs. I have not been fortunate in procuring satisfactory material with reference to this shell, which, adds Prof. M'Coy, "is an extremely beautiful species, remarkable for its flatness and broad divaricating bands of coarse, branched striæ, which are not at all arched along the hinge-line, as in the somewhat similar *O. retrorsistria* (in which the depth is greater, the striæ much more uniform, and the surface smoother, and the internal casts quite different)." I have, therefore, deemed it preferable to reproduce Prof. M'Coy's entire description, than to attempt an independent one of a shell I do not quite understand. It was even suggested by the Rev. H. Day that a *Strophomena* found by him abundantly in Lower Silurian shales at Fary Gill, Cautley, near Sedberg (see our Pl. XLVII, figs. 1—4), might represent the complete condition of the so-termed *Orthis Hirmantensis*, M'Coy. Under the uncertainty I feel concerning the generic and specific claims of M'Coy's shell, I have preferred to describe them separately, and especially so as *Stroph. Siluriana* has a concave dorsal valve, and is consequently a true *Strophomena*—certainly not an *Orthis* with a flat dorsal valve, as is stated to be the character of the so termed *Orthis Hirmantensis*. Some one or two small specimens of this last, sent to me by Mr. Davies, and obtained by him in the Valley of the Hirnant, east of Bala, in North Wales (figs. 8 and 9 of our plate), presented a very elongated aspect; and in an internal cast the vascular impressions were beautifully displayed, as will be likewise seen by a figure in my plate. I should be very glad to be able to study some good remains of the Hirnant shell, and shall feel obliged if any local geologist would kindly afford me the opportunity.

Position and Locality. This species occurs in the Caradoc or Bala division, and is said by M'Coy to be very abundant in the oolitic limestone and decomposing schists over the Bala Limestone at Aber Hirnant, east of Bala, North Wales; and in a similar limestone at Cwm-yr-Aethen; oolitic limestone of Maes-y-fallen, Bala, Merionethshire; rare in the limestone of Cerrig-y-Druidion, Denbighshire. Prof. Harkness kindly sent me the flat impression of a small dorsal valve he had obtained below the Graptolitic mudstones of Westerdale, Sedberg.

Orthis sarmentosa, *M'Coy*. Pl. XXXVI, figs. 35—38.

Orthis sarmentosa, *M'Coy*. Syn. Sil. Foss. Ireland, p. 34, pl. iii, fig. 17, 1846; and Brit. Pal. Foss., p. 227, pl. i H, figs. 25—28, 1852.

Spec. Char. "Transversely oblong, depressed; hinge-line as wide as the shell, ears rectangular; receiving [ventral] valve elevated towards the beak, which is prominent, flattened towards the margin; cardinal area large, triangular, inclining backward at 120°, its height (in narrow specimens) one fourth of the width; entering [dorsal] valve gently convex along the middle, depth greatest at one third the length from the beak, slightly exceeding that of the ventral valve, with a triangular cardinal area about half the height of that of the dorsal valve, but placed nearly in the plane of the lateral margins; both valves radiated with from fifty to sixty rather thick, flexuous, rounded ridges, frequently and irregularly branching between the beak and the margin; finer, closer, and less branched towards the sides; about five in two lines in middle of front margin. Internal cast of receiving [ventral] valve with two very long, strongly marked, dental lamellæ diverging at 40°, nearly straight, with a very slight inward curve at their extremities, forming the lateral boundaries of the very large triangular prominent pair of muscular impressions, which reach rather more than two thirds the length of the shell, finely sulcated longitudinally, and separated by a slender, indistinct impression of a mesial ridge. Surface exterior to the muscular impressions strongly marked by the external ridges; internal cast of entering [dorsal] valve with a moderate elliptical pit of the simple rostral tooth [cardinal process], and two short, triangular, strongly diverging impressions of the cardinal teeth [cardinal processes], immediately within and in front of which are the two obtuse, obliquely conical bosses produced by the muscular impressions, separated by an obtuse, short sulcus from a rounded mesial ridge, not defined in front or at the sides. Anterior pair of impressions invisible; surface sharply radiated with the external ridges." (M'Coy.)

Obs. I know nothing of this species, and it is ignored in the table of 'Siluria;' I am, therefore, obliged to reproduce Prof. M'Coy's description and figures. He further observes—"This species varies so much in form from compression in the schistose rocks that I can scarcely venture to give the proportions, but I believe the true form to be pretty nearly such as I have figured in the above work, namely, about three times wider than long [?], with a straight front margin and nearly rectangular sides; but some specimens [distorted by pressure ?] are as long as wide. The average length is about seven lines. This species is very easily recognised by the coarse, frequently branched, twig-like ridges in all the middle part of the shell, the lateral ones being more nearly straight, smaller, and frequently simple, and internally in the great length and distinctness of the prominent muscular impressions. The great number of the ridges separates it from the *O. Actoniæ*, to which, however, it has no real affinity in any of its internal or external characters. It is extremely common in the Bala Schists of Llyn Ogwen, North Wales." It seems to me questionable whether this so termed species can be retained, but for reference sake I have considered it desirable to reproduce M'Coy's statement and figures.

ORTHIS ÆQUIVALVIS, *Dav.* Pl. XXX, figs. 9, 10.

ORTHIS ÆQUIVALVIS, *Dav.* London Geol. Journal, pl. xxvii, fig. 5, 1847; and Bull. Soc. Géol. de France, 2nd ser., vol. v, p. 321, pl. iii, fig. 14, 1848.

Spec. Char. Shell almost circular, broadly rounded anteriorly, as well as at the cardinal extremities. Valves almost equally and moderately convex, without fold or sinus; hinge-line shorter than the breadth of shell; areas narrow, that in the ventral valve slightly the largest. External surface marked by numerous thread-like radiating striæ, which increase in number by the interpolation of a finer rib between each pair of the larger ones. The whole surface is likewise traversed by concentric lines.

Length 10, width 11, depth 5 lines.

Obs. This shell was named and figured by myself in 1847; subsequently another (American) shell received from Prof. J. Hall a similar denomination. *Orthis æquivalvis* is remarkable on account of the almost equal convexity of its valves. I have counted as many as 120 raised striæ round the margin of each valve.

Position and Locality. It was found for the first time by Messrs. Gray and Capewell in the Wenlock Limestone and Shales during the excavation of the Rushall Canal near Walsall. It was obtained, likewise, by the Rev. H. D. Day in Wenlock Shales at Buildwas, near Wenlock.

ORTHIS ALTERNATA, *Sow.* Pl. XXXI, figs. 1—8.

ORTHIS ALTERNATA, *J. de C. Sow.* Sil. Syst., p. 638, pl. xix, fig. 6, 1839.
STROPHOMENA ALTERNATA, *Phillips* and *Salter.* Mem. Geol. Survey, vol. ii, p. 380, 1848.
ORTHIS — and O. RETRORSISTRIA, *Salter.* Mem. Geol. Survey, vol. iii, p. 340, pl. xix, figs. 11—13, 1866.
— — *Salter.* Siluria, 4th ed., p. 526, 1867.

Spec. Char. Transversely semicircular and flattened, sometimes a little longer than wide; hinge-line slightly less than the breadth. Ventral valve gently convex, area narrow, fissure wide, open; beak not projecting. Dorsal valve nearly flat, or convex only along the middle, the lateral portions of the valve being slightly concave; hinge-area narrow. Surface of both valves finely radiated by numerous thread-like striæ, which increase in number as they approach the margin by bifurcation, as well as by the interpolation of smaller striæ, the whole surface being crossed also by numerous concentric lines of growth. In the interior of the ventral valve the saucer-shaped muscular cavity is formed of two elongated, deviating muscular depressions, with raised edges or margins. In the interior of the dorsal valve there is a small cardinal process between two small, curved, projecting, brachial processes, while under the cardinal process commences a median ridge which extends to about half the length of the valve, and thus separates the two pair of adductor impressions. Two specimens measured—

Length 11, width 14, depth 2 lines.
„ 13, „ 14, „ 2 „

Obs. This Strophomena-shaped shell was in 1839 described and figured by Mr. J. de C. Sowerby, and placed by him in the genus *Orthis*. In 1848 Messrs. Phillips and Salter considered it to be a *Strophomena* closely allied to *S. expansa,* but in 1866 the last-named palæontologist, relinquishing that view, replaced it with *Orthis,* stating at the same time that "the orginal figure by Sowerby in the 'Silurian System' is from the typical variety so common in the 'Jacobstones' of Shropshire; but the smaller and wider form figured here (from an unpublished plate in the possession of the Geol. Survey) is far more common in Wales, and we are able to show in it the large central tooth [cardinal process] in the dorsal valve, which proves it, notwithstanding its resemblance to *Strophomena,* a true *Orthis.* The very large ventral muscles are peculiar and characteristic. There is altogether a curious imitative appearance about this shell. Fragments have been constantly mistaken for *Strophomena expansa* or *Leptæna sericea.* To both genera it has relation." In this last view I quite concur, but must, for the reasons above given, retain it as an *Orthis.* Mr. Salter considered *Orthis retrorsistria,* M'Coy, to be a synonym of *O. alternata;* and although he may be correct in this view, the material in my possession is not sufficient to enable me to corroborate his statement.

Position and Locality. It appears to be common in Caradoc slate rocks throughout Wales and Shropshire. Murchison gives us the following localities:—Whittingslow, Soudley, and east flank of the Caradoc, Alt-yr-Anker, and the Maen Meifod, Lower Lickey Ridge, east flank of Berwyns, Mandinam Llandovery. In the Museum of the Geological Survey are good specimens from Ketch and Pentre Lymru, Llanfyllin, Cheney Longville, Penmachno, Caernarvonshire; south-east of Cerrig-y-Druidion, Glyn Ceiriog, Pentre-cwm-dda, and south of Glyn Diffwys in Denbighshire. At Llanfyllin, Meifod, Llanwddyn, north of Llangedwyn, and Llangynnog in Montgomeryshire; east and south-east of Bala Lake, and Pont-y-Glyn-Diffwys in Merionethshire; &c.

Var. RETRORSISTRIA, *M'Coy.* Pl. XXXVI, figs. 39—42.

ORTHIS RETRORSISTRIA, *M'Coy.* Brit. Pal. Foss., p. 224, pl. i H, figs. 12, 13, 1852.

This is considered by Mr. Salter to be a small variety of Sowerby's *Orthis alternata;* and as I have not had the opportunity of examining many specimens of the shell, I here reproduce Prof. M'Coy's figures and partly his description:—"Rotundato-quadrate, depressed, no mesial ridge or furrow in either valve; hinge-line nearly or quite as wide as the shell; cardinal angles slightly obtuse; cardinal area flat, triangular, six or seven times wider than high in ventral valve, only one third of this height in the dorsal valve. Ventral valve gently convex, greatest depth about the middle of the length. Dorsal valve flat round the margin, gently concave in the middle; both valves with a few concentric wrinkles of growth, about a line apart, and radiated with slightly irregular obtuse striæ, which branch into two or three at two or three intervals between the beak and margin, so that each of the strong primary ones forms from seven to ten at the margin, separated by a rather deeper sulcus from the adjoining ones, so as to produce a flat, indistinctly marked fasciculation; intervening sulci about the same size as the striæ (obscurely punctured in some specimens), which are straight in the middle, gradually assuming a divaricating curve on the sides, which is so great near the angles that a large number of the lateral striæ curve backward from the beaks to terminate along the distal half of each side of the hinge-line, instead of at the lateral margin; all the striæ are crossed by indistinct transverse lines of growth. The size of the striæ does not vary much in the various parts of the shell; from fourteen to seventeen may be counted in two lines, at four lines from the beak. . . . ."

Length 9, width 11, depth $1\frac{1}{2}$ lines.

Obs. The internal details are so like those in *O. alternata* that they need not be here repeated. Prof. M'Coy attaches great importance to the backward curving of many of the lateral striæ to terminate on the hinge-line, and observes that something of the same sort may be seen in a less degree in *O. subquadrata*, Hall.

Position and Locality. This variety is said to occur in great profusion in the Caradoc or Bala Flags of south end of Pen-y-Gaer, near Cerrig-y-Druidion; and Prof. M'Coy mentions it, also, as closely covering extensive surfaces of the beds on the Holyhead Road, Denbighshire; he quotes it also from Bala Flags at Hafod Evan, Penmachno, Caernarvonshire, also from the Bala Schists of Cefn-y-Coed, Llangedwyn, Montgomeryshire, and from many other localities in the same county, and in Merionethshire, of which he appends a list.

Mr. Davies, of Oswestry, who has so attentively explored the rocks of North Wales, informs me that the enumeration of localities in Sedgwick and M'Coy's 'Palæozoic Rocks and Fossils' constitutes an admirable guide-book to the Silurian fossils of North Wales, but that we must not forget that since 1834-38 the surface of the country in Wales has undergone very great alterations; for rocky escarpments covered with fossiliferous blocks have been planted and enclosed, wide tracts of mountain-moorland have been made into fields, the loose stones being buried or built into walls, and that quarries, once worked, as in the neighbourhood of Bala, have been abandoned and covered with debris.

Orthis confinis, *Salter*. Pl. XXXVI, figs. 1—4.

Orthis confinis, *Salter*. Quart. Journ. Geol. Soc., vol. v, p. 15, pl. i, fig. 4, 1848; and vol. vii, pl. vii, fig. 5, 1851.
— — *M'Coy*. Brit. Pal. Foss., p. 215, 1852.
— — *Salter*. Siluria, 4th ed., p. 526, 1867.

Spec. Char. Subquadrate or transversely semicircular, depressed; hinge-line slightly less than the width of shell. Dorsal valve gently convex, and rather more so than in the ventral one; this last being slightly longitudinally keeled along the middle, while a corresponding channel or depression in the dorsal one extends down the middle line from the umbone to about half the length of the valve. Area in the ventral valve narrow, vertical; narrower in the dorsal valve; fissure open; beak scarcely projecting. Both valves are closely covered with numerous radiating, thread-like striæ, some being a little stronger than others; the riblets increase likewise in number by bifurcation and interpolation, and often fasciculate in twos or threes. In the interior the muscular scars are rather small.

Length 10, width 13, depth 4 lines.

Obs. This species was well described and figured by Mr. Salter in 1848; but I believe that distinguished palæontologist was mistaken when he wrote that the valves were not crossed by any lines of growth, for in a well-preserved example now before me numerous close equidistant concentric lines, or slightly raised ridges, intersect the radiating ribs. He adds likewise that "the slight depth of the central channel, sometimes hardly visible, readily distinguishes our shell from *O. vespertilio,* which in the fasciculation of the striæ and general form it resembles; but the ribs in that are more numerous, closer, and broader than the interstices." Prof. M'Coy further observes—"The great difference which I have registered in the number and general characters of the radiating ridges may be traced in such a way among the Scottish specimens as leaves no doubt of the specific identity of the forms, some of the specimens, with more numerous ridges, having them nearly uniform in size, while some of the specimens with the more distant ridges have them more or less fasciculated, as in the extreme forms above alluded to; in all cases, however, the species seems very distinct by the narrow, very sharply defined, round linear ridges, and smooth, flat, wide interspaces; the casts are strongly marked with radiating ridges round the margin."

Position and Locality. According to Mr. Salter this species occurs in the Llandeilo at Bogang in Ayrshire, as well as in the Caradoc or Bala beds at Craig Head, near Girvan. I have seen it very abundant in rocks at Mullock Hill Quarry, near Girvan, in beds attributed to the Llandovery, for along with it occurred *Meristella angustifrons, Atrypa hemisphærica,* and other species belonging to that period. It has also been found at Knockdollian, three miles from Ballintrae, in Ayrshire, as well as at Ardmillan, and in the limestones of the Stincher River. Prof. M'Coy mentions the shell in the Bala Limestone of Llandeilo, Caermarthenshire (finely marked specimens), and in the limestone of Trownscoed Gaerfawr.

Orthis patera, *Salter,* MS. Pl. XXX, figs. 1—8.

Spec. Char. Semicircular, wider than long; hinge-line less than the width of the shell. Ventral valve moderately and evenly convex, area narrow; dorsal valve almost flat, area narrow; surface of both valves covered with very fine thread-like radiating striæ, here and there crossed by concentric lines of growth. In the interior of ventral valve the saucer-shaped muscular cavity is large and laterally margined by projecting edges, and is likewise divided longitudinally by a broadish flattened ridge. In the interior of the dorsal valve, on either side of the cardinal process, are two diverging projecting brachial processes, grooved along the middle; from under the cardinal process a short median ridge extends along the bottom of the valve and separates the adductor impressions. Two specimens measured—

Length 20, width 25, depth 6 lines.

„ 19, „ 20, „ 5 „

Obs. This is one of the largest of our British Silurian species of *Orthis*, and is easily distinguishable from its congeners by the remarkable flatness of its dorsal valve, as well as by the shape of its brachial appendages. It received the manuscript name of *patera* from the late Mr. Salter, which designation is here retained.

Position and Locality. It occurs under the conditions of external and internal casts and impressions in the Upper Caradoc at Corston Farm, Hopesay, from which locality a fine series of specimens may be seen in the Museum of Practical Geology.

ORTHIS BIFORATA, *Schloth*, (sp.). Pl. XXXVIII, figs. 11—25.

TEREBRATULITES BIFORATUS, *Schlotheim.* Petrefact., p. 265, 1820.
TEREBRATULA LYNX, *D'Eichwald.* Nat. Skizze von Podol., p. 202, 1830.
PORAMBONITES DENTATUS and P. BREVIS, *Pander.* Beitr. Geogn. Russl., p. 96, pl. ii, figs. 4, 5, 1830.
ATRYPA DORSATA? *Hisinger.* Leth. Suec., p. 76, pl. xxi, fig. 14, 1837.
SPIRIFER LYNX, *Von Buch.* Ueber Delth., p. 44, 1837; and Mém. Soc. Géol. France, vol. iv, p. 190, 1840.
— BIFORATUS, *D'Eichw.* Sil. Syst. in Esthl., p. 144, 1840.
DELTHYRIS BRACHYNOTA, *J. Hall.* Rep. 4th Geol. District N. York, p. 71, fig. 6, 1843.
SPIRIFER SHEPPARDI, *De Castelnau.* Ter. Sil. de l'Amérique du Nord, p. 42, pl. xiv, fig. 15, 1843.
— BIFORATUS, and varieties LYNX et DENTATUS, *De Verneuil* et *De Keyserl.* Geol. Russia, vol. ii, p. 135, pl. iii, figs. 3—5, 1845.
— TRIDENS, SP. LYNX, and SP. TEREBRATULIFORMIS, *M'Coy.* Syn. Sil. Foss. Irel., pp. 37, 38, pl. iii, figs. 25—27, 1846.
DELTHYRIS BIFORATUS, var. LYNX, *J. Hall.* Pal. N. York, vol. i, p. 133, pl. xxxii D, fig. i, 1847; and vol. ii, p. 65, pl. xxii, fig. 1, 1851.
ORTHIS BIFORATA, *Dav.* Bull. Soc. Géol. France, 2nd ser., vol. v, p. 323, pl. iii, fig. 25, 1848.
— — (= SPIRIFER SUBSULCATUS, *His.*), *De Vern.* Bull. Soc. Géol. France, 2nd ser., vol. v, p. 347, 1848.
SPIRIFERA — *Phillips* and *Salter.* Mem. Geol. Survey, vol. ii, p. 293, 1848.
PLATYSTROPHIA BIFORATA, *King.* Monogr. Permian Fossils, p. 106, 1849.
ORTHIS LYNX, *Quenstedt.* Handb. der Petref., p. 486, pl. xxxix, figs. 8—11, 1851.
SPIRIFERA BIFORATA, var. LYNX and var. FISSICOSTATA, *M'Coy.* Brit. Pal. Foss., pp. 192 & 193, 1852.
ORTHIS — *Dav.* General Introduction, pl. viii, figs. 146, 148, 1853.
— — *Salter.* Siluria, 2nd ed., p. 210, pl. xxxiii, fig. 4, 1859.
— LYNX, *Schmidt.* Sil. Form. Liv.- Ehst., &c., Archiv, vol. ii, p. 215, 1858.
— BIFORATA, *Lindström.* Gotland's Brachiopoder, p. 371, 1860.
— — *Salter.* Mem. Geol. Survey, vol. iii, pp. 259, 267, 276, 1866.

Spec. Char. Transversely semi-elliptical or subquadrate, wider than long, more or less globose, the length, width, and depth varying sometimes but little; hinge-line more often rather less than the width of the shell, sometimes slightly exceeding the general breadth, with short acute mucronate wings, or rounded terminations; in front the ventral valve is abruptly deflected and indents the opposite one; beaks in both valves much incurved and approximating. Ventral valve convex, with a wide deep medial sinus commencing at the extremity of the beak and widening as it nears the front. Area triangular, of moderate height, fissure open, beak angular, incurved Dorsal valve deeper than the opposite one, at times gibbous, with a wide longitudinal fold, commencing at the extremity of the umbonal beak and extending to the front; area a little less wide than in the opposite valve, fissure open. Surface of both valves ornamented with a greater or lesser number of radiating angular ribs; of these from one to five (and in some varieties more) furrow the medio-longitudinal sinus, while from two to six or seven compose the mesial fold. The valves are also crossed at intervals by numerous concentric, raised, subimbricating lines; the surface is also marked with small punctures. In the interior of the ventral valve a prominent hinge-tooth exists on each side of the fissure and is supported by strong dental plates, which enclose an elongated, oval, raised muscular cavity of moderate dimensions. In the interior of the dorsal valve no prominent cardinal process is observable, but two short brachial processes deviate from the extremity of the umbonal beak, and on the outer side of these are situate the hinge-sockets. The quadruple muscle forms four very distinct cavities, strongly margined and divided longitudinally and transversely by prominent cross-like ridges.

Length 11, width 13, depth 9 lines.

Obs. This important Silurian type has been often well described and illustrated, but palæontologists have differed considerably (as may be seen from a glance at the long list of synonyms) with reference both to the genus and the specific denomination the shell should retain. It has consequently been assigned to no less than six different genera and to ten or more species or named varieties. As to the genus, I think I was able to satisfactorily demonstrate in 1848 that its internal characters were those of *Orthis*, and I am glad to find that palæontologists very generally have followed my identification. Prof. King, in 1849, proposed to consider it the type of a new genus, *Platystrophia*, but no other palæontologist that I am aware of has adopted that view. For many years it was regarded and described as a *Spirifer;* but a glance at its interior appears to me sufficient to show that it cannot belong to that genus, any more than to *Terebratula*, *Atrypa*, or *Porambonites*. It is also an exceedingly variable shell, and as it occurs abundantly in America, and as it is there that it has attained its largest dimensions, I will append an extract from p. 133 of the first volume of the 'Palæontology of New York,' in which Prof. Hall clearly explains the cause of its extraordinary variability:—" It is impossible to assign any definite form or proportions to a shell as variable as this species. The cardinal line, in young shells, usually terminates in small acute ears extending beyond the width of the shell, while in other cases, and particularly in the older and more gibbous specimens, the cardinal line is less than the width of the shell, and its extremities are rounded. There are, somewhat rarely, exceptions to the above observation, where the cardinal line, in old individuals, still extends into small acute ears. The number of plications is very variable also; but there is usually a relation between the number of those on the sinus and medial lobe and those on either side. The greater or less number of these plications, however, has no reference to the form of the shell. This species, like many others of the Brachiopoda, is influenced by local circumstances, and, in its wide geographical distribution, presents varieties of form, or types peculiar to different localities, dependent apparently upon the condition of the ancient ocean-bed. In the dark carbonaceous Silurian limestones of New York it is almost always small, while in the lighter coloured calcareous mud or shale of the west it reaches a much greater size, and presents a greater variety of form. The eastern type of this species presents the following characters in its different stages of growth and development:—

"In the young shell there first appears three plaits in the sinus of the dorsal valve, with four on the corresponding medial lobe of the ventral valve; these four becoming two about one half or two thirds of the distance from the base to the beak. As the shell grows older another plait is developed on one side of the sinus, and a corresponding one on the medial lobe; but the five thus developed become two before reaching the beak. In the larger specimens of the New York type there is a fifth plait developed in the sinus, with six upon the corresponding medial lobe. The outer one on each side unites with the adjoining one about half way to the beak, thus making four plaits on the medial lobe, which finally unite in two before reaching the beak. The additional plaits of the medial lobe are developed laterally by a division of the outer one, which takes place at nearly regular intervals corresponding to the increasing size of the shell. The lateral plications in the sinus likewise disappear towards the beak, not by uniting with the adjoining ones, as on the opposite valve, but by gradual diminution till they are lost in the surface of the shell. The plications on each side of the mesial lobe aud sinus increase in like manner by the development of additional ones towards the margin of the shell; and from seven, the number usual in the smallest shells, they increase to ten or eleven, the greatest observed number in any specimen presenting the characters here given, the increase of lateral ones always keeping pace with the development of additional ones in the sinus and medial lobe . . . .

"The western types begin in like manner with three plications in the sinus and four on the mesial lobe, while the lateral plications are almost uniformly seven (sometimes six, rarely five). As the size increases, however, the medial plications do not, as a prevailing character, increase as in the eastern types, but remain still three on the sinus and four on the lobe, till the shells reach to four or five times the dimensions of the largest New York specimens. At the same time, also, the prevailing number of lateral plications is seven on each side of the sinus or lobe, and so long as the mesial plications remain three and four, so long the lateral ones are seven. As soon as there is even an appearance of a departure from this number on the mesial lobe and sinus, and where the rudiment of an additional plait is visible, we then find the lateral plaits to be nine or ten. These changes take place independent of the size of the shell or of its rotundity; all variations in the plaits of the sinus being accompanied by a change in the number of lateral plaits. This is illustrated in the figures of nearly equal dimensions, where the specimen fig. 1 A has three plaits on the sinus and four on the mesial lobe, and seven on each side; while fig. 1 G has a partial development of the fourth plait in the sinus, and an obscure rudiment of a fifth on the mesial lobe, and at the same time it has ten on each side of the sinus. Even irregularities in the development of the mesial plications are followed by irregularities in the lateral ones. A single specimen has two plications in the sinus and three on the mesial lobe, and also on one side of the slope of the sinus, as well as on the slope of the mesial lobe, a single plication, which is intermediate to the mesial or lateral series, and the lateral plaits, in this case, are six on one side and seven on the other."

It is, therefore, very difficult to admit varieties founded upon the number of ribs, and we have elsewhere shown how the number of plications varies in a similar manner in many forms, and especially in *Rhynchonella.*

M. de Verneuil has proposed to divide the Russian forms of the shell under description into several named varieties, and adds, with reference to Schlotheim's *Terebratulites biforatus,* which he maintains as the typical form of the species, that the description given by Schlotheim of his *T. biforatus* is so short that it might equally well apply to the three varieties which De Verneuil distinguishes, namely, var. *Lynx*, var. *dentatus*, and var. *chama.* But Von Buch, having seen in the Berlin Museum the authentic specimen upon which Schlotheim's species was established, explained to De Verneuil the differences which distinguish it from its principal varieties; these distinctive characters being only the presence of five ribs in the sinus, and a width proportionately greater. Nevertheless, adds De Verneuil, *O. biforatus* is provided, as are all the forms of the same group, with two areas and two triangular open fissures; the ventral [our dorsal] valve is also thicker than the dorsal [our ventral] one, and the number of the lateral ribs is about the same as in the var. *Lynx,* a variety close to the type, and in which one may commonly count eight or ten ribs on either side of the sinus.

Our British specimens seem to vary to so great an extent that I would scarcely know where to draw a line of demarcation between them. We certainly have the type *biforata* and the var. *Lynx,* but these two seem with us so intimately connected that I have combined them under Schlotheim's single designation; they are represented by figs. 11, 12, 13, and 14 of Plate XXXVIII.

We have, also, perhaps a well marked variety to which M'Coy has given the name of *fissicostata* (fig. 19, &c.), which that author describes in the following manner:—" General characters of the preceding varieties (*Sp. biforata*, var. *Lynx*, var. *dentata*). Four ribs on the rostral part of the mesial furrow, the two outer of which usually branch at four or five lines from the beak, the others branch irregularly lower down once or twice; lateral ribs varying from six to fifteen within three or four lines from the beak, branching irregularly, some into two, others into four, with age; surface crossed towards the margin with sharp striæ of growth. This variety does not seem to have been noticed either in Russia or America, yet it is extremely common in our old rocks; many show a difference, in the muscular impressions in the dorsal valve, from the variety *Lynx* in having the posterior pair much smaller than the anterior, and obliquely elongated, so that the division between them and the anterior pair is no longer a horizontal line forming a cross-shaped mark; other specimens, however, more distinctly preserved, seem to have the usual internal characters along with the divided ribs. So very variable are the ribs in size and number that extreme specimens which I have noted might be referred on the one side apparently to the *Sp. terebratuliformis*, M'Coy, and on the other to the *Sp. ovata*, M'Coy."

In Pl. XXXVIII I have endeavoured to represent specimens illustrating the principal modifications in shape presented by this species as occurring in Great Britain. In England it does not attain more than about half the size of some large American examples.

Position and Locality. Its vertical range seems to have been considerable. In 'Siluria' *Orthis biforata* is stated to occur in the Llandeilo, Caradoc, Llandovery, and Wenlock formations; and in all these, with the exception of the last, I have found it to occur abundantly. We can only name some of the principal localities, for to enumerate them all would require more space than can be given to the subject. I do not, however, know where it has been met with in the *Llandeilo* formation.

In the *Caradoc* it occurs at Bettws-y-Coed, in Caernarvonshire, and south-east of Cerrig-y-Druidion, south of Llangollen, Denbighshire; at Llanfyllin, Alt-yr-Anker, Meifod, Llanwddyn, and Pen-y-Craig, Llanwddyn, Montgomeryshire; west of Bala Lake, Pont-y-Glyn, Bryn Melyn Quarry and Bryn Bedwog, near Bala, Merionethshire, Diffwys, west of Corwen, Denbighshire. In the schists of High Haume, Dalton in Furness, Lancashire; also at Keisley, Westmoreland, &c.

In *Lower Llandovery*, at Cefn-Rhyddan, Llandovery; Mathyrafal, Pen-y-Craig, &c.

In *Upper Llandovery*, at Pentrefflymru, Presteign, Bogmine, &c.

In the *Wenlock Limestone and Shales* at Dudley, and at the Rushall Canal near Walsall, Staffordshire.

In Scotland it occurs in Caradoc Limestone at Craig Head Quarry, two miles north of Girvan, in Ayrshire.

In Ireland it abounds in many places, such as the Chair of Kildare, Carrictadaggan and Ballybro, Ballyeale, County Wexford; Bally Daniel Gorey, Grangegeeth, County Meath, &c., all in Lower Silurian rocks.

The variety *fissicostata*, M'Coy, abounds in the Caradoc at half a mile south of Brynbebedney, near Bala; Cwmgwenan Uchaf, and Ketch Bridge, near Llanfyllin; in the schists of Peniarth, Meifod, and Bala Sandstone of Alt-yr-Anker, Montgomeryshire; at Bala, Bryn Melyn, Aber Hirnant, Bala Schists of Gelli Grin, Merionethshire. In the impure Bala Limestone of Revenstone Dale and Ash Gill, Westmoreland; Plain-y-Cwm, west of Nantyr, Glyn Ceiriog, south of Llangollen, Denbighshire. In Coniston Limestone at Helm Gill, in the lake district, &c.

This shell is very abundant in the Upper and Lower Silurian rocks of many countries abroad.

It occurs in the neighbourhood of St. Petersburgh, Russia, and of Reval; in the Lower Silurian rocks of Bodahamn, in the Island of Oeland; at Malmökalven, in Scandinavia; at Wisby, in the Island of Gothland, &c.

In America Prof. Hall states that it occurs "in numerous and widely separated localities of the Trenton Limestone, being confined to rocks of this period in the United States, and unknown in New York above the Utica Slate, though this line of demarcation cannot be recognised in the west. Within the State of New York it is found at Middleville, Trenton Falls, Herkimer, Jacksonsburgh, and in other localities in the Mohawk Valley. It is also found at Turin, Watertown, and other places towards Lake Ontario, and is likewise known at several places in the Champlain valley (Tennessee); at Cincinnati and Oxford (Ohio); at Madison (Indiana); at Mineral Point (Wisconsin), and on the north-west shore of Lake Michigan, and towards Green Bay. It likewise occurs in several localities in Canada, east and west, showing a geographical distribution equal to the extent of the Lower Silurian strata of America."

ORTHIS INSULARIS, *D'Eichwald*. Pl. XXXVII, figs. 8—15.

TEREBRATULA INSULARIS, *D'Eichw.* Urwelt Russl., vol. ii, p. 49, pl. ii, figs. 6 *a*, *b*, *c*, 1842.
SPIRIFER — *De Verneuil.* Geol. of Russia, vol. ii, p. 149, pl. viii, figs. 7 *a*, *b*, *c*, 1845.
ORTHIS GALEA, *M'Coy.* Syn. Sil. Foss. of Ireland, p. 30, pl. iii, fig. 12, 1846.
— INSULARIS, *Phillips* and *Salter.* Mem. Geol. Survey, vol. ii, p. 289, 1848.
— — *Morris.* Catalogue, p. 140, 1854.
SPIRIFER — *D'Eichw.* Lethæa Rossica, Ancienne Période, vol. i, p. 697, 1859.
ORTHIS — *Salter.* Mem. Geol. Survey, vol. iii, pp. 256 and 268, 1866.
— — *Id.* Siluria, 4th ed., p. 526, 1867.
— — *Bigsby.* Thesaurus Siluricus, p. 105, 1868.

Spec. Char. Transversely oval or globulous, slightly indented in front, lateral margins rounded; hinge-line rather more than half the width of shell. Ventral valve very gently convex, with a deep longitudinal sinus, commencing at the extremity of the beak and gradually widening as it nears the front; area triangular, about one fourth as high as long; fissure open; beak small, slightly incurved, scarcely projecting. Dorsal valve very gibbous, much deeper than the opposite one, the umbonal beak being large, much inflated and projecting above the level of the beak of the ventral valve; hinge-area narrow, almost perpendicular to the dorsal area; a wide, slightly elevated, flattened, or rounded mesial fold extends from the extremity of the umbone to the front. In front the margin of the ventral indents that of the dorsal valve. External surface of both valves smooth, marked only by a few concentric lines of growth.

Length 12, width 13, depth 6 lines.

Obs. Although we are unfortunately unacquainted with its interior (some singularly shaped markings are seen on the internal cast of the dorsal valve, fig. 15), the double area and open fissure seem to denote that this shell should be placed in the genus *Orthis*, and not in either *Terebratula* or *Spirifer*, where it has been placed by D'Eichwald and De Verneuil. In 1846 Prof. M'Coy described the shell under the designation of *Orthis galea*, and it has generally been considered an *Orthis* by British palæontologists. In this species the largest and deepest valve seems to be the dorsal one. Some Irish examples from Portrane have attained thirteen lines in length by eighteen in width. In certain exceptional specimens the mesial fold, in the dorsal valve, becomes obsolete, and is replaced by a deepish longitudinal groove which divides the shell into two equal lobes (fig. 14).

Position and Locality. This species is said to range from the Upper Llandeilo, through the Caradoc, into the Llandovery. In the Upper Llandeilo (or Llandeilo flags proper) it occurs at Garn, in North Wales.

In the Caradoc of England and Wales it has been found at Llanfyllin, Montgomeryshire; and Llaphaiadr, Merionethshire. Mr. Hughes mentions having collected the shell at the River Sevin, Llettyrhyddod, and Cefnrhyddan, in Lower Llandovery; also at Iron Coldbrook, Llandovery, in Upper Llandovery. Profs. Phillips and Salter quote the species from Mandinam, Goleugoed, Castell Craig, and Gwyddon, in the Llandeilo district.

In Ireland *Orthis insularis* abounds in the Caradoc Limestone of the Chair of Kildare, County Kildare; and in the dark limestone and slates at Portrane, Malahide, County Dublin. It is believed also, by Mr. Young, to occur in the Caradoc Limestone of Craig Head Quarry, in Ayrshire.

On the Continent it has been found in Lower Silurian Limestone in the Island of Dago, according to D'Eichwald, as well as in several other Russian localities. M. de Verneuil quotes it from Lower Silurian rocks at Bryndlock, in the Gulf of Christiania, in Norway.

ORTHIS ? SPIRIFEROIDES, *M'Coy*. Pl. XXXVII, figs. 3—7.

STROPHOMENA SPIRIFEROIDES,		*M'Coy.*	Annals Nat. Hist., vol. viii, p. 402, 1851.
LEPTÆNA	—	*Id.*	Brit. Pal. Foss., p. 246, 1852.
STROPHOMENA	—	*Salter.*	Siluria, 2nd ed., p. 211, fig. 2, 1859; but in the table, p. 544, it is quoted as an *Orthis.*
ORTHIS	—	*Id.*	Mem. Geol. Survey, vol. iii, p. 268, 1866.

Spec. Char. Sub-rhomboidal, wider than long; hinge-line straight, nearly as long as the shell is wide; cardinal angles obtuse; sides rounded; front abruptly raised. Dorsal valve semicircular, rather deeper or more convex than the opposite one, and divided along the middle by a rather wide, convex, mesial fold; hinge-area linear. Ventral valve moderately convex, with a wide, sharply defined, flattened sinus; area triangular, narrow; fissure open (?); beak small, incurved. Surface of both valves closely covered with numerous, very fine, radiating, thread-like, raised striæ, which increase in number as they near the margin by bifurcation and by the interpolation of smaller striæ. In the interior of the ventral valve the hinge-teeth are supported by small dental plates, which enclose two elongated, oval, muscular scars, divided longitudinally along the middle by a narrow flattened median ridge. The adductor occupies the greater part of the middle or flattened ridge, and is flanked by two large divaricator impressions; and again, close to the dental plates, and on the outer side of these last, are two smaller scars, probably referable to the ventral adjusters. Above the adductor scar, or between it and the beak, rises a small cylindrical curved tube. In the interior of the dorsal valve a small bifid cardinal process is situated between the hinge-sockets, and under it the quadruple impression left by the adductor extends to about half the length of valve.

Length 10, width 12, depth 7 lines.

Obs. I feel greatly puzzled as to the genus to which this abnormal form should be referred. It is certainly neither a *Strophomena* nor a *Leptæna,* and I question very much if it be an *Orthis.* It differs in some respect from *Spirifer,* although not nearly to the extent imagined by Prof. M'Coy and Mr. Salter; nor would I, indeed, feel surprised if the future discovery of spiral appendages should oblige us to refer it to the last-named genus. The shape and position of the muscular scars have more the character of those of *Spirifer* than of *Orthis.* I will, however, follow Mr. Salter by provisionally leaving it with *Orthis,* as I cannot state affirmatively that it is a *Spirifer.* Messrs. M'Coy and Salter observe that it is so like *Spirifer radiatus* of the Wenlock Limestone as to be often mistaken for it; but it may be distinguished from that shell by a longer hinge-line, flatter sides, and coarser striation. One of its most interesting internal characters consists in the presence of a small, cylindrical, curved tube (fig. 5), somewhat similar in shape to the one which in *Athyris concentrica* and some other species is attached to the small foramen under the hinge-plate. In the internal casts of the ventral valve (figs. 4 and 5) this small tube seems to have originated just above the adductor, and to have curved upwards as represented in fig. 5. Its whole extent and position is well seen in some specimens, although only in the shape of a cast. I have never noticed a similar appendage in any species of *Orthis*, but indications of its existence have sometimes been noticed in certain species of *Spirifer*. The internal cast of the dorsal valve (fig. 6) is very remarkable, distinguishing the shell at once from any other with which I am at present acquainted. Mr. Salter also appears to have been very uncertain as to the genus to which the shell should be referred, for at page 211 of the second edition of 'Siluria' it is considered to be a *Strophomena*, and at page 544 an *Orthis*. The arrangement of the muscular scars, and the shape of the cardinal process remove it, I think, from *Orthis*.

Position and Locality. The vertical range given in 'Siluria' is the Llandeilo and Caradoc. In the Llandeilo Flags it has been found at Garn Arenig (Survey Mus.). In the Caradoc it is very abundant in the shape of external and internal casts at Llanfyllin, Pont Rhiwedog, Gaerfowr and Moely Garth, West Pool, Garnedd Uchaf, Bala. Mr. Salter and Prof. M'Coy quote it likewise from Dolwyddelan, south-west of Pwllheli, Penmachno, Caernarvonshire; Cerrig-y-Druidion, Denbigshire; Llanwddyn, Alt-y-Anker, Meifod, Welshpool, Montgomeryshire; east, west, and south-east of Bala Lake, Dinas Mowddwy, Llanrhaidr, Tan-y-Groes south of Bala, schists of Belli Grin, Bala, Merionethshire; schists of Beaver's Grove, Bettws-y-Coed, North Wales; schists of Rhiwargor, &c.

In Ireland it occurs in the Caradoc of Carrichadaggan, County Wexford; at the Chair of Kildare, &c. I am not acquainted with this shell either from Scotland or the Continent.

ORTHIS TRICENARIA, *Conrad* (?). Pl. XXXVIII, fig. 28.

ORTHIS TRICENARIA, *Conrad.* Proc. Acad. Nat. Sciences, vol. i, p. 333, 1843.
— — *J. Hall.* Pal. New York, vol. i, p. 121, pl. xxxii, fig. 8, 1847.
— — *Etheridge.* Catal. Foss. Mus. Prac. Geol., p. 8, 1865.
— — *Salter.* Siluria, 4th ed., p. 527, 1867.

Spec. Char. Almost circular, or semi-oval, about as wide as broad; hinge-line straight, nearly equal to the greatest width of shell, with angular cardinal extremities; sides and front rounded. Ventral valve regularly convex; beak incurved, but not produced; area wide; foramen triangular, open; surface of valves marked with about thirty-six rounded simple ribs, with interspaces between them of equal width.

Length $6\frac{1}{2}$, width $6\frac{1}{2}$ lines.

Obs. Of this species I have seen two or three ventral valves only, and consequently cannot offer a complete description of the shell. It was, however, identified as above by Mr. Salter. Prof. Hall tells us that in the American type the dorsal valve is flat, and regularly rounded from the extremities of the hinge-line; that its most striking character, and one which will serve to distinguish it from any other *Orthis* known to him in New York, is the great elevation of the ventral valve and the remarkably broad cardinal area; that the ribs are always simple, continuing distinct quite to the apex of each valve, and gradually enlarging towards the base. Its interior is not known.

Position and Locality. This shell was found by Mr. Salter and Mr. J. Thomson in the Caradoc Limestone of Piedmont Glen, near Girvan, in Ayrshire, the specimens being preserved in the Museum of Practical Geology. In 'Siluria' it is stated to occur both in the Caradoc and Llandovery (Lower, I suppose). In New York it is found in the lower part of the Trenton Limestone, associated with *Orthis testudinaria*, *Leptæna sericea*, *Atrypa triplex;* and at Middleville, and at Mineral Point (Wisconsin), apparently in a higher part of the same rock. It occurs also in Canada.

We have now described, very imperfectly it is true, all the British species of *Orthis* with which we are acquainted. I am aware that several other so-termed species have been proposed by different palæontologists; but as their descriptions and illustrations are very incomplete and obscure, it would be useless to attempt to reproduce them in the present state of our information. Among these we may mention *Orthis triangularis* (J. de C. Sowerby), the original drawing of which we have reproduced (Pl. XXXVIII, fig. 27). All that has seemingly been found of it is an incomplete cast of the interior of one valve; and this was obtained by Sir R. Murchison in the Caradoc Sandstone at Marrington Dingle, near Chirbury.

Orthis ? productoides, M'Coy ('Synopsis Sil. Foss. of Ireland,' p. 32, pl. iii, fig. 15), is another obscure fossil. I have seen the original example, which was kindly lent to me by Sir R. Griffith; but all the specimens are so incomplete and distorted that it is impossible, on such material, to arrive at any correct or useful specific identification. I have, however, reproduced Prof. M'Coy's illustration (Pl. XXXVIII, figs. 29 and 30). The fossil was obtained from the schists of Knockmahon, Tramore, County Waterford, Ireland.

Fragments also, which may, perhaps, eventually turn out good species, have been collected by different geologists; but until more complete and satisfactory specimens will have been found, it would be confusing the subject to attempt to describe them in this Monograph; nor can we admit, as well-determined Silurian species, a few of those that are recorded in the 'Synopsis of the Silurian Fossils of Ireland.'

Genus—ORTHISINA, *D'Orbigny*, 1849.

See "General Introduction," p. 104.

O. ADSCENDENS, *Pander* (sp.). O. ANOMALA, *Schlotheim* (sp.). O. VERNEUILII, *D'Eichwald* (sp.).

This genus seems well distinguishable from *Orthis* and *Strophomena* by its external and internal characters. Externally it has always its fissures entirely arched over and closed by a pseudo-deltidium, this last being generally, and during at least a portion of the animal's existence, perforated near its extremity by a circular foramen. The interior of both valves is also exceedingly remarkable, and I was able to illustrate their characters in the 'Geologist' for March, 1859, pl. iv, figs. 17—19, from some very perfect valves of *Orthisina anomala*, presented to me by Prof. D. Schmidt, of St. Petersburgh. A glance at these figures will at once convince any observer as to the necessity of retaining the genus *Orthisina* for the reception of these curious shells. In 1853, and for some time later, from an imperfect knowledge of the true character of *Orthisina*, I had, along with others, most erroneously combined with it in the same genus *O. crenistria* and *O. pelargonatus*, which have nothing to do with it, these last being representatives or types of Prof. King's genus, or sub-genus, *Streptorhynchus*.

I am acquainted with only one British species of the genus, viz. *Orthisina adscendens*, Pander, sp.; for, as has elsewhere been shown, the so-termed *Orthisina Scotica* of M'Coy does not belong to the genus, and is, in fact, nothing more than a variety of *Orthis calligramma*. I do not know, however, whether it would not have been more in accordance with the rules of priority, had D'Orbigny, instead of proposing a new genus, contented himself with Pander's generic denomination of *Pronites*, which had been proposed in 1830, for the shell in question.

ORTHISINA ADSCENDENS, *Pander* (sp.). Pl. XLIX, figs. 27—29.

PRONITES ADSCENDENS, P. PLANA, P. ROTUNDA, P. CONVEXA, P. ALTA, P. PRÆCEPS, P. TETRAGONA, P. LATA, P. EXCELSA, *Pander*. Beit. zur Geol. des Russ. Reiches, pl. xvii, figs. 2—6, pl. xviii, figs. 1—5 (according to M. de Verneuil), 1830.

ORTHIS ADSCENDENS, *Von Buch*. Mém. Soc. Géol. Fr., vol. iv, p. 211, pl. ii, fig. 10, 1847.

— PRONITES, *Id.* Beitr. zur Geol. Russl., p. 20, 1840.

— — *D'Eich.* Sil. Syst. in Esthl., p. 148, 1840.

— ADSCENDENS, *Id.* Urwelt Russl., part i, p. 15, 1840; and O. PRONITES, part ii, p. 145, pl. iv, fig. 1, 1842.

ORTHIS ADSCENDENS,		*De Verneuil* and *De Keyserl.* Geol. Russia, vol. ii, p. 203, pl. xii, fig. 3, 1845.
ORTHISINA	—	*M'Coy.* Brit. Pal. Foss., p. 231, 1852.
ORTHIS	—	*D'Eichw.* Lethæa Rossica, Période Ancienne, vol. i, p. 838, 1859.
ORTHISINA	—	*Salter.* Siluria, 4th ed., p. 527, 1867.

Spec Char. Rotundato-quadrate, slightly wider than long; sides almost parallel; front rounded; hinge-line either less than or somewhat exceeding the width of the shell; cardinal extremities rectangular or slightly prolonged, with angular terminations. Ventral valve convex or sub-pyramidal; greatest height at the point of the beak; without fold or sinus; area flat, about six times as high as long; fissure wide, triangular, entirely arched over by a convex pseudo-deltidium. Dorsal valve very moderately convex, much more shallow than the opposite one; hinge-line linear or rudimentary, with a narrow convex pseudo-deltidium closely juxtaposed to the one in the opposite valve. Surface of both valves covered with numerous, radiating, rounded, bifurcating, raised striæ, with interspaces of almost equal width; each valve crossed by concentric lines of growth, more numerous and close as they approach the margin.

Length 12, width 13, depth 6 lines.

Obs. This species has been well described by M. de Verneuil, Prof. M'Coy, and others. Pander had given it a great many names, out of which that of *adscendens* has been adopted by the generality of palæontologists. MM. de Verneuil and d'Eichwald are likewise of opinion that the *Orthis zonata* of Dalman and Hisinger may probably be referable to the same species. It is a variable shell, the dorsal, as well as the ventral valve, being much less convex in some specimens than in others, and, according to D'Eichwald, the dorsal valve is almost flat. There is also much difference in the comparative length of the hinge-line, which is shorter in some examples than in others. Prof. M'Coy observes that " Our specimens correspond precisely with Pander's type-figure above quoted; but if, as M. de Verneuil supposes, the various other species on that and the succeeding plate be only varieties " [I should say mere modifications in shape, as occur in every species], " it is obvious that there is considerable variety in the depth of the valves, and that the cardinal area does not invariably lean forwards to the extent mentioned above, but has sometimes even a slight backward inclination, as in the *Orthidæ* generally; and in this case, I think, there could be no doubt that the whole might be well referred to *O. zonata* of Dalman; but as I have not examined that species, I am unwilling (like M. de Verneuil) to make an uncertain approximation."

In Russian examples, as remarked by M. de Verneuil, all the external surface is covered with widish striæ and intervening spaces; these ribs are bifurcated, round, and scooped out like a tube, so that when they are worn on their surface, or obliquely cut by friction, they form a series of festoons round the shell, and especially so when the longitudinal lines, which cross the valves, protrude by their multiplication, in the shape of terraces. None of the few English examples however I have seen show that peculiarity; in them the radii are numerous, and augment considerably in number by bifurcation, as well as by the interpolation of additional smaller ribs between some of the larger ones. Our English specimens occur likewise under the shape of internal casts and external impressions, the shell itself having disappeared; but these last appear to agree with similar casts and impressions sent to me by M. de Volborth, from Pulkova, in Russia. In the internal cast of the ventral valve the sloping area, triangular prominence due to the large pseudo-deltidium, and deep median slit, which commences at the beak, and extends to about half the length of the valve, are features easily recognisable.

Position and Locality. Prof. M'Coy states that his specimens, or rather those found by Prof. Sedgwick, occur in the Upper Bala or Lower Llandovery at Cefn Coedog, Corwen, North Wales, and that the species is less commonly met with in the schists of Cyrn-y-Brain, west of Wrexham, Denbighshire. The best examples I have seen were found by Mr. Parrott in that portion of the west flank of the Berwyn Mountains which lies contiguous to the little village called Cynwyd, about three miles from Corwen, in Merionethshire. The upper beds, from which he obtained the best specimens, lie on the same horizon as the Cefn Coch beds, near Mynydd Fron Frys, near Cefn Cerrig, though six miles apart.

Abroad it is very abundant, at Pulkova, Pavlosh, Tzarskocelo, Jumalasari, &c., in the neighbourhood of St. Petersburgh, also in the sandstone of the River Vloia, Esthonia (?), &c.

Genus—Strophomena, *Rafinesque.*

See "General Introduction," p. 105.

As the etymology of the name (στρόφος, band, and μήνη, crescent) indicates, the generality of the species composing this genus are more or less semicircular, and widest at their long straight hinge-line. Their valves are more or less concavo-convex, regularly arched, geniculated, or depressed. It so happens, however, that the valve which is convex in some species is concave in others, and *vice versâ*. It differs also from *Orthis* in having a closed fissure; that is to say, the fissure in the ventral valve is always to a greater or lesser extent arched over by a convex pseudo-deltidium, while the projecting bifid cardinal process, which is also in some species partly covered by a narrow pseudo-deltidium, fills up the entire cavity of the fissure that may not have been arched over by the pseudo-deltidium of the opposite valve. A minute circular foramen exists also at the extremity of the beak in the ventral valve of some species, but becomes generally cicatrized at some period of the animal's existence.

In the interior of the dorsal valve the cardinal process is bifid or bilobed, each lobe, in some species, being channelled out along the centre, while in *Orthis* it is generally formed of one piece. In *Strophomena* it is situated directly between the dental sockets, or having between them and it a small prominent ridge or brachial process (?), for this last is scarcely developed where it exists, and forms a marked contrast to what we find in the same valve of *Orthis*. There are also four more or less distinctly defined muscular (adductor) depressions, which are longitudinally parallel to each other, and separated by ridges; while in *Orthis* these four divisions are placed in pairs one above the other. The differences in the interior arrangements of the ventral valve in the two genera are not so well marked; they form in both cases a more or less defined saucer- or fan-shaped depression, notched in front, and margined by a prominent rim. The external surface is either striated or more or less coarsely ribbed.

The genus *Strophomena* is represented by many species in our Silurian rocks; but for the full description of some of them material is still wanting, and will, no doubt, upon further search be forthcoming. In the mean time we have been compelled to provisionally separate certain forms which, when better known, may be considered as synonyms of some of the others.

Some few species of *Orthis*, it is true, by their exceptional shape, seem to lessen the value of the distinctive characters which so clearly separate the generality of species composing the two genera, but the interior muscular and other arrangements in both appear to be sufficiently distinct.

At p. 231 of his valuable manual, Dr. S. P. Woodward observes that there are no apparent brachial processes in the dorsal valve of *Strophomena*, and that it is possible that the spiral arms may have been supported at some point near the centre of the shell, as in *Productus;* and this may, perhaps, have been the case; but there appears also evidence, in some species, of the existence of rudimentary brachial processes, to which the oral arms may have been attached. This subject will, however, demand further study and research prior to arriving at any definite conclusion.

STROPHOMENA RHOMBOIDALIS, *Wilckens* (sp.). Pl. XXXIX, figs. 1—21; and Pl. XLIV, fig. 1.

CONCHITA RHOMBOIDALIS, *Wilckens*. Nachricht von seltenen Verst., p. 77, pl. viii, figs. 43 and 44, 1769.

"Die dritte Anomiten Art mit breiter Schlosskante," *Hupsch*. Naturg. des Niederdeutchlands, vol. i, p. 15, pl. i, figs. 7 and 8, 1781.

ANOMITES RHOMBOIDALIS, *Wahl*. Nov. Acta Upsal., vol. viii, p. 65, 1821.

PRODUCTA DEPRESSA, *Sow*. Min. Conch., p. 86, pl. cccclix, fig. 3, July, 1823.

— RUGOSA, *Hisinger*. Act. R. Ac. Sc. Holm., p. 333, 1826.

LEPTÆNA RUGOSA et L. DEPRESSA, *Dalman*. Vet. Akad. Handl., p. 106—107, pl. i, figs. 1 and 2, 1828.
— — — *Klöden*. Verst. Brandenb., p. 180, 1834.
STROPHOMENA RUGOSA, *Bronn*. Lethæa Geog., p. 87, pl. ii, fig. 8, 1835.
PRODUCTUS DEPRESSUS, *Defrance*. Dict. Sciences Nat., vol. xlvii, p. 353.
— — *Deshayes*. Second edit. of Lamarck's Anim. s. Vert., vol. vii, p. 380, 1836.
LEPTÆNA RUGOSA et L. DEPRESSA, *Hisinger*. Lethæa Suecica, p. 69, pl. xx, fig. 2—3, 1837.
— — *Fischer de Waldheim*. Oryct. Gouv. Moscow, p. 143, 1837.
STROPHOMENA RUGOSA, *Von Buch*. Ueber Delth., p. 70, 1837; Mém. Soc. Géol. France, vol. iv, p. 220, pl. xii, fig. 24, 1840.
LEPTÆNA DEPRESSA, *J. de C. Sow*. Sil. Syst., pp. 623 and 636, pl. xii, fig. 2, 1839.
— TENUISTRIATA, *Sow*. Id., p. 636, pl. xxii, fig. 2 *a*, 1839 (not *Orthis*, id., J. de C. Sow.).
— DEPRESSA, *d'Eichw*. Lethæa Rossica, période anc., vol. i, p. 867, 1859.
— RUGOSA, *Phil*. Palæoz. foss. Cornwall, &c., p. 57, pl. 24, fig. 95, 1841.
ORTHIS — *D'Eichw*. Sil. Syst. in Esthl., p. 162, 1840.
LEPTÆNA DEPRESSA, *De Koninck*. Foss. Carb. Belg., p. 215, p. 12, figs. 3—6; pl. 13, fig. 6, 1842.
STROPHOMENA DEPRESSA, *Vanuxem*. Geol. Rep. Third District N. York, p. 79, fig. 5, 1842.
— UNDULATA, *Id*. Ib., p. 139, fig. 3.
ORTHIS DEPRESSA, *Portlock*. Geol. Londonderry, &c., p. 450, 1843.
STROPHOMENA, — *Hall*. Geol. Report Fourth District New York, p. 77, fig. 5; p. 104, fig. 2, 1843.
ORTHIS RUGOSA, *C. F. Römer*. Rhein. Ueberg., pp. 85 and 90, 1844.
LEPTÆNA DEPRESSA, *De Verneuil*. Geol. Russia, vol. ii, p. 234, pl. xv, fig. 7, 1845.
— — *Dav*. London Geol. Journ., p. 54, pl. xii, figs. 12—16, 1847; and Bull. Soc. Géol. France, sér. 2, vol. v, p. 316, pl. iii, fig. 3, 1848.
STROPHOMENA TENUISTRIATA, *Hall*. Pal. New York, vol. i, p. 108, pl. xxxi *a*, fig. 4, 1847.
LEPTÆNA DEPRESSA, *Barrande*. Sil. Brach. Bohême, vol. ii, p. 82, pl. xxii, figs. 4—9, 1848.
— — *Phillips and Salter*. Mem. Geol. Surv., vol. ii, p. 283, 1848.
PRODUCTUS TWAMLEYII, *Dav*. Bull. Soc. Géol. France, sér. 2, vol. v, p. 315, pl. iii, fig. 1, 1848.
ORTHIS DEPRESSA, *Quenstedt*. Handb. Petref., p. 488, pl. xxxvii, fig. 20, 1851.
LEPTÆNA — *Hall*. Pal. New York, vol. ii, pp. 62 and 257, pl. xxi, fig. 8, and pl. liii, fig. 6, 1852.
LEPT. (SEPTAGONIA) DEPRESSA, *M'Coy*. Brit. Pal. Foss., p. 248, 1852.
STROPHOMEMA DEPRESSA vel RHOMBOIDALIS, *Dav*. General Int., pl. viii, figs. 165—174, 1853.
— — S. RUGOSA, et S. TENUISTRIATA, *Schmidt*. Sil. Form. Ehstl., Archiv. Nat. Liv.- Ehst. und Kurlands, vol. ii, p. 216, 1858.
— — et S. TENUISTRIATA, *Salter*. Siluria, 3rd edit., p. 20, fig. 20, and pl. v, fig. 15, 1859.

STROPHOMENA RHOMBOIDALIS, *Lindström.* Gotlands Brach., p. 371, 1860.
— — *Haswell.* Sil. Form. Pentland Hills, p. 33, pl. iii, fig. 3, 1865.
— — *Dav.* Trans. Geol. Soc. Glasgow, Pal. Ser., vol. i, p. 16, pl. ii, figs. 17—18, 1868.

Spec. Char. Shell more or less transversely semicircular or sub-quadrate; valves geniculated; hinge-line straight, and as long as the greatest width of the shell, with rounded cardinal angles, which are at times prolonged in the shape of expanded wings. The ventral valve is slightly convex at the beak, and away from this it becomes flattened to a certain distance; also with age, when the valve is suddenly bent downwards at almost right angles. The frontal margin is undulated, concave near the cardinal angles; it afterwards bulges out laterally, to form a slight outward curve in front. On the flattened portion of the disc there exists a variable number of slightly undulating and occasionally intercepted concentric wrinkles, which turn outwardly towards the cardinal angles, and thus follow the marginal curves. The entire surface is also covered with numerous radiating thread-like striæ; and a small circular foramen is generally observable, up to a certain age, close to the extremity of the beak, but it becomes obliterated or cicatrized in the adult. The dorsal valve is concave, usually following the curves of the opposite valve, and is similarly wrinkled and striated. In the interior of the ventral valve two diverging teeth articulate with corresponding sockets in the opposite valve. The muscular impressions (in this valve) are margined by a semicircular ridge, continued from the base of the teeth, and curving on either side, so as to produce a saucer-shaped depression; the adductor or occlusor leaves a scar on either side, close to a small median ridge, the cardinal or divaricator muscles filling on either side the anterior portion of the cavity; the ventral adjustor and pedicle muscles do not appear to have produced any very definite impressions, but it is highly probable that an attachment for these muscles existed in the posterior portion of the saucer-shaped depression above described, on the account of the fact that a small circular peduncular foramen is also observable at a small distance from the extremity of the beak; and this denotes that a pedicle muscle must have existed, although the foramen became closed as soon as the animal found that it could dispense with the moorings required during the early stages of its development. In the interior of the dorsal valve the cardinal process is divided into two lobes, and not connate with the socket-ridges. From the base of this a slight median ridge runs down and separates the two pairs of adductor or occlusor scars, which are bordered by prominent ridges. The vascular impressions consist of large primary vessels, which run at once direct from near the centre of the valve to a short distance of the frontal margin; some of the vessels bifurcate several times. Dimensions very variable; two specimens measured—

Length 14, width 20, depth 4 lines.
„ 15, „ 42, „ $4\frac{1}{2}$ „

Obs. The above specific description is taken from p. 120 of my 'Monograph of Carboniferous Brachiopods,' and it applies equally well to the Silurian as to the Carboniferous representatives of the species. I have here given all the principal synonyms and references to the Silurian form; and these can be completed by a reference to those recorded in the Carboniferous and Devonian Monographs. In Pl. XXXIX will be seen the principal modifications which the shell assumed during the Silurian period.

When formerly describing this species it escaped my notice that we were indebted to C. F. Wilckens (1769) for the first description, name, and figure of this important species. The fact is recorded by Wahlenberg at p. 66 of the eighth volume of the 'Nova Acta Acad. Upsaliensis,' published in 1821, but was overlooked by myself and almost every other palæontologist. During the Silurian period, and in some other specimens, the extension of the lateral portions of the shell was very considerable, as will be seen in figs. 1, 10, 11, 15. Some Swedish examples of the interior of the ventral valve (fig. 16) have exhibited in a most beautiful manner the impression of the coils of the oral arms affixed to the interior of the dorsal valve; and I found this to occur likewise in some of our British examples (fig. 14). Certain young shells are also remarkably square (fig. 6), while others have their front scooped out into three projecting lobes (fig. 4). *Leptæna tenuistriata*, J. de C. Sow., has also by many palæontologists been considered to be simply a variation in shape of *Strophomena rhomboidalis;* the striation is often irregular, but in some specimens the interspace between the more prominent thread-like radii is large and well marked, one or two smaller ribs or striæ filling up the interspace. Another variety (Pl. XLIV, fig. 1) has been found in the Caradoc of Craig-Head Quarry, near Girvan, in Ayrshire.

Position and Locality. This remarkable species ranges through the Caradoc, Lower and Upper Llandovery, Wenlock, and Ludlow formations. It passes up into the Devonian, and continues during the Carboniferous period. It is present in a great many localities. We will enumerate a few of the principal ones.

In the *Caradoc:* Carnedd Dafydd, Llyn Idwal, Snowdon, Bettws-y-Coed, &c., in Caernarvonshire; south-east of Cerrig-y-Druidion, Pont Hafod, Gynfor, and Cefn Coch, south-west and south of Llangollen, Denbighshire; Llanfyllin, Llanwyddyn, Meifod, Gaerfawr, Guilsfield, Welshpool, Montgomeryshire; east, west and south-east of Bala Lake, Brynbedwog, &c., in Merionethshire; Bird's Hill, Llandeilo; Keisley, Westmoreland, and Helms Gill Dent, in Coniston Limestone.

In *Lower Llandovery:* at Quaker's Burial Ground, Welshpool; Cefn, near Buttington; Mathyrafal Haverfordwest; Cwar Mawr, Cilgwyn; Blaenewm, Llandovery; Llettyrhyddan, &c.

In *Upper Llandovery:* at Builth; Penlan, Llandovery; Chirbury; Norbury; Malverns; May Hill; west of Crochley; Tortworth.

In the *Woolhope* beds of the Malverns.

In the *Wenlock Limestone and Shales* of Dudley, Linley's Lime-kilns near Walsall, Wenlock Edge; Buildwas; The Rock, May Hill; Woodgreen, Longhope, Beacon Hill Quarry, Sedgley; Dormington Wood, Woolhope.

In the *Ludlow* series: at Vinnal Hill, Ludlow, and Freshwater East; also in many localities (recorded by Phillips and Salter) in the Malvern, Abberley, Woolhope, May Hill, Tortworth, Usk, Builth, and Marlow districts.

In Scotland it occurs at Craig Head (Caradoc), and at Penkill and Mullock Hill, Ayrshire, in Llandovery rocks. In the Pentland Hills it is common in Wenlock Shales. In Ireland it is also found in the Caradoc of the Chair of Kildare; in Wenlock Shales at Ferriter's Cove, Dingle, County Kerry; and in a number of other localities, which will be found recorded at p. 25 of M'Coy's 'Sil. Foss. Ireland.'

Abroad it is very abundant in many Lower and Upper Silurian localities. It occurs in Gothland, Ostrogothia, Norway, Bohemia, Belgium (Gembloux), Russia, the Island of Anticosti, Canada, the United States, &c.

STROPHOMENA UNGULA, *M'Coy* (sp.). Pl. XLII, figs. 20 and 21.

LEPTÆNA (LEPTAGONIA) UNGULA, *M'Coy*. Ann. Mag. Nat. Hist., ser. 2, vol. viii, p. 404, 1851; and Brit. Pal. Foss., p. 249, pl. i H, figs. 36 and 37, 1852.

— — — *Salter*. Siluria, 3rd edition, pl. 543, 1859.

Spec. Char. Semi-oval, or slightly sub-quadrate, wider than long; hinge-line quite as wide as the shell; cardinal extremities almost rectangular; sides straight, and sub-parallel for half their length, then rounding into the convex frontal line. Ventral valve nearly flat, or very slightly convex until it nears the margin, when it becomes suddenly deflected to the margin. Area triangular, rather narrow; fissure arched over by a pseudo-deltidium; beak not projecting. Dorsal valve slightly concave, following the curves of the opposite valve; hinge-area linear. Surface of valves marked by a few concentric wrinkles (more apparent in some specimens than in others), and ornamented by numerous fine thread-like radii, with finer longitudinal lines in the interspace left between each two of the principal ribs. In the interior of the ventral valve the saucer-shaped muscular cavity is small, and longitudinally divided along the middle. Interior of dorsal valve not known.

Length 9, width 10, depth $1\frac{1}{2}$ lines.

Obs. Prof. M'Coy observes that "This so nearly resembles some of the small varieties of *Leptæna deltoidea* and the *L. camerata* (Conrad), as figured by Hall, that I should not have thought of separating them were it not for the very much finer striæ, which very easily separate the species from our British specimens of *L. deltoidea*. The foramen of the apex of the beak is also larger, the dental lamella more divergent, and the muscular impressions much wider. I find the peculiar hoof-like form and other characters of this little shell (unlike *L. deltoidea*) to be extremely constant."

Position and Locality. Strophomena ungula appears limited to the Caradoc or Bala Limestone. Prof. M'Coy states his shell to be gregarious, and to occur in extraordinary abundance, completely filling some beds of the limestone at Llansaintfraid, Glyn Ceiriog, south of Llangollen, Denbighshire; and the limestone of Selottyn Road, south of Llangollen. It has been found by Mr. Davies at Pontyglyn-Diffws-smiles, west of Corwen.

STROPHOMENA IMBREX, *Pander* (sp.), var. SEMIGLOBOSA, *Dav.* Pl. XLI, figs. 1—6.

§ 1. Typical or geniculated variety (*not hitherto found in Great Britain*).

PLECTAMBONITIS TRIANGULARIS, PL. IMBREX, PL. INVERSA, *Pander*. Beit. Geogn. Russl., p. 91, &c., pl. 19, figs. 11, 12, 13, 1830.
LEPTÆNA IMBREX, *De Verneuil*. Geol. Russia, vol. ii, p. 33, pl. xv, figs. 3 *a*, *b*, 1845.
ORTHIS — *Von Buch*. Mém. Soc. Géol. France, vol. iv, p. 223, pl. xii, fig. 37, 1840.
— — *Quenstedt*. Handb. Petref., p. 489, 1851.
LEPTÆNA — *D'Eichwald*. Lethæa Rossica, pér anc., vol. i, p. 866, 1859.

§ 2. Var. *semiglobosa*, Dav.

LEPTÆNA IMBREX, *De Verneuil*. Geol. Russia, vol. ii, p. 230, pl. xv. fig. 3 *c*, 1845.
— — *Dav*. London Geol. Journ., vol. i, p. 55, pl. 12, figs. 25—28, 1847; and Bull. Soc. Géol. France, 2nd ser., vol. v, p. 318, pl. iii, fig. 8, 1848.
— — *De Verneuil*. Bull. Soc. Géol. Fr., sér. 2, vol. v. p. 347, 1848.
STROPHOMENA — *Schmidt*. Sil. Form. Ehstl. &c., in Archiv Nat. Liv. &c., vol. 2, p. 215, 1858.
— — *Salter*. Siluria, 3rd ed., p. 251, figs. 6—7, 1859.
— — *Lindström*. Gotlands Brach., p. 372, 1860.
— — *Billings*. Geol. Surv. Canada, Pal. Foss., vol. i, p. 128, fig. 106, 1865.

Spec. Char. Broadly semicircular, as wide as long, or a little broader than wide; hinge-line straight, not quite as wide as the shell; sides and front rounded; cardinal extremities either rectangular or obtusely angular. Ventral valve very convex or gibbous, sometimes slightly geniculated, flattened at and near the cardinal extremities; area triangular, narrow; fissure arched over by a pseudo-deltidium. Dorsal valve concave, following the curves of the opposite one; hinge-area narrow, with an arched pseudo-deltidium corresponding to that in the ventral valve. External surface of both valves covered with numerous radiating, coarse, thread-like radii, of almost equal width in all their length, and separated from each other by interspaces five or six times as wide; the interspace being filled up with from five to eight very fine, hair-like, longitudinal striæ, and an occasional slightly larger riblet occupying the centre of the interspace, so that the principal ribs increase in number by interpolation at variable distances from the beaks. In the interior of the dorsal valve a bifid cardinal process, grooved along the middle, is situated between two small laminar processes, on the outer side of which is the hinge-socket. A narrow slightly projecting ridge extends along the middle of the valve to about its centre, and on either side are two parallel muscular (adductor) impressions, ramified and oval, those situated close to the central ridge being the smallest, and often the most prominent. Interior of the ventral valve is not known. Two specimens measured—

Length 25, width 29, depth $2\frac{1}{2}$ lines.
„ 24 „ 24 „ 2 „

Obs. Pander, who first named and described this species, had in view a shell with geniculated valves, and I am still uncertain whether we are correct in uniting to it the very gibbous or convex form which we find principally in the Upper Silurian formation. It is true M. de Verneuil has informed us of having found, in the same Lower Silurian rock which contains the typical form of Pander's species a specimen regularly convex ('Geol. of Russia,' pl. xv, fig. 3^c), and thus, as it were, connecting the geniculated with the convex variety. In our British Silurian rocks we have not yet discovered the typical geniculated form; and, as all our specimens are regularly convex, I think it will be advisable to distinguish this modification by a special designation. I therefore propose for the convex form the varietal name of *semiglobosa*. As will be seen from the list of references above recorded, the convex form has been hitherto constantly referred to *Strophomena imbrex*.

In the Caradoc or Bala Limestone of Craig Head Quarry, near Girvan, in Ayrshire, a smaller convex variety, much resembling our Upper Silurian form, has been found (figs. 5 and 6); but it presents the peculiarity of possessing a small circular foramen at the extremity of the beak of its ventral valve. Unfortunately, we do not know its interior; and, as the external shape and striation so exactly agree with that of the var. *semiglobosa*, we have left it provisionally with it. *Strophomena imbrex*, var. *semiglobosa*, is also apparently specifically distinct from *Strophomena Ouralinensis*, chiefly by its external sculpture; and I was informed by Mr. Salter that the specimen so named by Prof. M'Coy, and now in the Woodwardian Museum, is referable to the shell under description. It is from the Woolhope Limestone of Presteign, and is not the *Leptæna Ouralinensis* of De Verneuil. I know, however, little about this last-named shell, further than what is said of it by M. de Verneuil in the work on the 'Geology of Russia,' &c.

It must, therefore, still remain a question, subject to further discussion, whether our Silurian form may not be specifically distinct from Pander's species.

Position and Locality. Strophomena imbrex, var. *semiglobosa*, occurs chiefly in the Wenlock formation; but if the Ayrshire form already mentioned belongs to the same species, it is found likewise in the Caradoc-Bala rocks. In the Wenlock it occurs at the Rushall Canal, near Walsall, also in shale at the Dudley Tunnel. In the Museum of Practical Geology are specimens from Malvern and May Hill, and others from Chickley Common, Woolhope. It is also said to occur in the Upper Silurian (Wenlock) Shales of Ferriter's Cove in Ireland.

Upon the Continent it has been found by M. de Verneuil and Dr. Lindström in the Upper Silurian formation of Gothland; and by Prof. F. Schmidt at Salla, Kook, Maidel, and elsewhere in Ehstland. A shell closely resembling small specimens of the variety *semiglobosa* has been figured by Mr. Billings from Cape Robert, in Anticosti, obtained from the Hudson river group, but it may be necessary hereafter to separate both this last and the Ayrshire form, and to give them, if not specific, at least varietal designations. The want of interiors renders the final discrimination between these shells a difficult and uncertain subject.

STROPHOMENA EUGLYPHA, *Hisinger* (sp.). Pl. XL, figs. 1—5.

LEPTÆNA EUGLYPHA, *Hisinger*. Antecken., pl. vi, fig. 4, 1819.
— — *Dalman*. Vet. Akad. Handl., p. 108, pl. i, fig. 3, 1828.
— — *His.* Lethæa Suecica, p. 69, pl. xx, fig. 4, 1837.
— — *J. de C. Sow.* Sil. Syst., p. 622, pl. xii, fig. 1, 1839.
ORTHIS — *Von Buch*. Mém. Soc. Géol. France, vol. iv, p. 222, pl. xii, fig. 26, 1840.
LEPTÆNA — *Portlock*. Geol. Londonderry, &c., p. 454, 1843.
— — *Dav.* Lond. Geol. Journ., vol. i, p. 56, pl. xii, figs. 1—4, 1847; and Bull. Soc. Géol. France, sér. 2, vol. v, pl. iii, fig. 4, 1848.
— — *De Vern.* Ibid., p. 347, 1848.
— — *Phillips and Salter*. Mem. Geol. Surv., vol. iii, p. 284, 1848.
— — *Barrande*. Sil. Brach. Bohêm., vol. ii, p. 38, pl. xxiii, figs. 4—8, 1848.
LEPTÆNA (STROPHOMENA) EUGLYPHA, *M'Coy*. Brit. Pal. Foss., p. 243, 1852.
STROPHOMENA EUGLYPHA, *Schmidt*. Sil. Form. Ehstl., Archiv. Nat. Liv., &c, vol. ii, p. 215, 1858.
— — *Salter*. Siluria, 3rd edit., pl. xx, fig. 19, 1859.
LEPTÆNA — *D'Eichw.* Lethæa Rossica, pér. anc., vol. i, p. 867, 1859.
STROPHOMENA — *Lindström*. Gotl. Brach., p. 372, 1860.

Spec. Char. Semicircular, about as wide as long; hinge-line slightly less than the width of the shell; cardinal extremities obtusely rounded; dorsal valve geniculated, or flattened to about half its length, after which the valve is abruptly bent with a rapid curve, and at almost right angles to the flattened portion, with its sides slightly flattened and rounded in front; hinge-area very narrow, almost linear. Ventral valve concave, flattened in its rostral portion, and following the curves of the opposite valve; area triangular or sub-parallel, fissure narrow, covered with a pseudo-deltidium; beak not projecting. Surface of both valves ornamented with numerous, equal, thread-like radii, the interspace between each pair of ribs four or five times as great as the width of each rib, while three or four finer longitudinal radii occupy the interspace, becoming less numerous near the beaks. In the interior of the dorsal valve the cardinal process is small, bifid, and grooved; and the quadruple impression of the adductor muscle is divided into two pairs by a rounded median ridge. In the interior of the ventral valve the saucer-shaped muscular depression is large, forming two oval elongated depressions, surrounded by a raised margin, and between them is a smaller oval depression likewise divided in the middle by a narrow median ridge.

Length 22, breadth 22, depth 3 lines.

Obs. In 1847, while describing this species, I was the first to notice that the dorsal valve is convex and the ventral one concave—the reverse to what we had observed to be the case in *Strophomena rhomboidalis*. As stated by Prof. M'Coy, the *Strophomena* (*Leptæna*) *imbrex* of authors, which so closely resembles this species in general appearance (of course, the geniculated variety), has the ventral valve convex, while in the shell under description the same valve is concave, a similar difference obtaining in the other valve. These modifications, as stated by M'Coy, were well seen from the figures published by myself in 1847 and 1848. The interior surface of the valves, especially the rostral portion, or that which surrounds the muscular scars, is strongly granulated. In the young state the muscular impressions are very feebly defined. Almost invariably this (and every species) appears to be thickened considerably round the margin of the shell in advanced age, or when the animal has attained its full period of development.

Position and Locality. I am acquainted with *Strophomena euglypha* from the Llandovery, Wenlock, and Ludlow formations.

In the Lower Llandovery it occurs at Sevin, Llettyrhyddan, Llandovery, where it was collected by Mr. Hughes; and Prof. Ramsay obtained it at the Quakers' Burial Ground, Welshpool. At Penlan, Llandovery, it occurs in the Upper Llandovery. In the Woolhope Limestones at Littlehope. In Wenlock rocks near Llansannan, North Wales (beds above the Denbighshire grits). It is also abundant at Wenlock, Benthall Edge, Dudley, and several localities in the Malvern, Abberley, Woolhope, and Usk districts. In the Lower Ludlow of the Abberley and Usk districts. In the Aymestry Limestone at Dormington Wood, and at Leintwardine, Shropshire, &c. In the Upper Ludlow, at Hay Park, south-west of Ludlow, Chance's Pitch, Malvern, &c.

In Ireland at Ferriter's Cove, Dingle, County Kerry, &c. I do not know the shell from Scotland.

Abroad it occurs in Gothland, Norway, Bohemia, Esthonia, &c.

STROPHOMENA WALMSTEDTI, *Lindström*. Pl. XL, figs. 6—8.

STROPHOMENA WALMSTEDTI, *Lindström*. Proc. Roy. Acad. Stockholm, pl. xiii, fig. 16, 1860.
— — *Dav.* Trans. Geol. Soc. Glasgow, Pal. Ser., vol. i, p. 18, pl. iii, figs. 5 and 6, 1868.

Spec. Char. Shell elongated semicircular in shape, concavo-convex, flattened at the ears, its greatest breadth at the hinge-line, with mucronate wings; ventral valve convex, sometimes gibbous, with a narrow sub-parallel area, and small pseudo-deltidium in the middle; dorsal valve concave, following the curves of the ventral valve; area linear; surface of both valves covered with thread-like longitudinal ribs, while four or five finer striæ occupy the interspaces between each pair of the larger ones. The surface is also irregularly and coarsely wrinkled, especially so on the posterior half of the valves.

Length 21, width 20 lines.

Obs. *Strophomena Walmstedti* is easily distinguished from *St. euglypha* by the shape of its valves, which are not geniculated as in the last-named shell. Only a few incomplete internal casts, showing the internal character, have been hitherto discovered. The muscular impressions in the ventral valve are not unlike those of *St. euglypha;* but some small differences are noticeable in the dorsal valve.

Position and Locality. The first British specimen (cast) of this species was found by myself, during a visit to the North Esk, in the Pentland Hills, and more complete examples were subsequently obtained by Messrs. Henderson and Brown. It occurs there in bed "D," which has been attributed to the Wenlock series; and, according to Prof. Lindström, the British form entirely agrees with similar specimens found by him in Gothland. In Great Britain it has been hitherto obtained only in the condition of casts.

STROPHOMENA FUNICULATA, *M'Coy*. Pl. XL, figs. 9—13.

ORTHIS FUNICULATA, *M'Coy*. Sil. Foss. Ireland, p. 30, pl. iii, fig. 11, 1846.
LEPTÆNA — *Dav.* Lond. Geol. Journ., vol. i, p. 57, pl. 12, figs. 5—8, 1847; and Bull. Soc. Géol. France, sér. 2, vol, v. p. 317, fig. 5, 1848.
— — *De Verneuil.* Ibid., p. 347, 1848.

Leptæna funiculata. *Phillips* and *Salter*. Mem. Geol. Surv., vol. ii, p. 284, 1848.
— — *Barrande*. Sil. Brach. Bohême, p. 92, pl. xxi, figs. 21—23, 1848.
— (Strophomena) funiculata, *M'Coy*. Brit. Pal. Foss., p. 244, 1852.
Strophomena funiculata, *Lindström*. Gotl. Brach., p. 372, 1860.

Spec. Char. Semicircular, about twice as wide as long, with the greatest width at the long straight hinge-line; cardinal extremities prolonged into acute, angular, mucronate wings. Dorsal valve flat or very slightly concave to about two thirds of its length, when the valves become suddenly deflected at an obtuse angle to the flattened part; hinge-area linear, fissure arched over by a narrow convex pseudo-deltidium. Ventral valve slightly convex to about two thirds of its length, when it is suddenly bent upwards so to follow the curves of the opposite valve; area narrow, fissure arched over with a pseudo-deltidium. External surface covered with coarse, thread-like, radiating radii; a smaller riblet occupying the centre of the interspace left between each pair of ribs; the whole surface is likewise closely crossed by numerous, fine, concentric lines of growth. In the interior of the dorsal valve the cardinal process is small and bifid, each lobe being grooved along the middle. A small longitudinal ridge divides two elongated, oval depressions left by the adductor muscle. In the interior of the ventral valve are prominent hinge-teeth on each side of the fissure; the elongated oval muscular depressions are large, and occupy fully half the length of the valve; they are divided along the middle by a narrow ridge, and are margined by a raised rim. On either side of the posterior portion of the small median ridge are two smaller impressions (heart-shaped), which are due to the adductor or occlusor muscle, while the large impressions on either side of it are referable to the divaricator. The internal surfaces of the valves, close to the muscular impressions, are more or less strongly granulated, and traversed by radiating striæ. Two specimens measured—

Length 8, width 13, depth 1 line.
„ 6, „ 15, „ 1 „

Obs. This is an elegant species, which has many characters in common with *Strophomena euglypha*, so much so that it has sometimes been mistaken for the young of that species, although it is undoubtedly very distinct and has been so recognised by all palæontologists. It is, in fact, a much smaller and more transverse species, and the deflected portion of the shell is much smaller in comparison with the flattened part; the external sculpture differs also in its details; and, as remarked by Prof. M'Coy, "The close, obtuse, sub-uniform striæ easily distinguish this species from dwarf examples of *St. euglypha*, and the bilobed boundaries of the muscular impression in the concave or ventral valve are longer and narrower than in *St. euglypha*."

In 1847 I fully illustrated the internal and external characters of the species, and removed it from *Orthis* to *Leptæna*, a genus in which at that period the larger number of *Strophomenidæ* were classed.

Position and Locality. In 'Siluria' *St. funiculata* is restricted to the Llandovery and Wenlock periods. I am acquainted with the shell from the latter formation only. It is an abundant fossil at Dudley, Wenlock Edge, Benthall Edge, Lincoln Hill, &c. It also occurs in several localities, enumerated by Phillips and Salter, in the Malvern, Abberley, Woolhope, Usk, and Llandeilo districts; and it has been found at Moel Fodig in North Wales.

In Ireland it is found at Ferriter's Cove, Doonquin, Dingle, County Kerry.

Abroad it occurs in Gothland, Norway, Bohemia, &c.

STROPHOMENA DAYI, *Dav.* Pl. XLI, fig. 7.

Spec. Char. Shell small, semicircular, wider than long, broadest at the hinge-line, with small mucronate wings; slightly narrowing anteriorly; front rounded. Ventral valve slightly convex, flattened at the wings; hinge-area narrow; fissure small, covered with a pseudo-deltidium; beak very small, scarcely projecting. Dorsal valve slightly concave, flattened near the cardinal extremities; hinge-area linear. Surface of both valves ornamented with about thirteen (principal) thread-like radii, with very wide interspaces finely striated longitudinally. The middle of the interspace is usually occupied by a rather stronger rib, but not so wide as the principal ones. Interior not known.

Length 5, width 6, depth 1 line.

Obs. Two well-preserved examples of this small species were found by the Rev. H. E. Day in Wenlock Shale at Buildwas, near Wenlock. It is remarkable for the very slight convexity and concavity of its valves, as well as by its striation. I have named the shell after its discoverer, to whom I am indebted for the liberal loan of many valuable specimens from his collection.

STROPHOMENA DELTOIDEA, *Conrad.* Pl. XLII, figs. 1—5; and Pl. XXXIX, fig. 22.

LEPTÆNA DELTOIDEA, *Conrad.* Ann. Geol. Report, p. 115, 1838.
STROPHOMENA — *Id.* Ibid., p. 64, 1839; and p. 37, 1841.
— — *Vanuxem.* Geol. Report, p. 46, fig. 2, 1842.
— — *Emmons.* Geol. Report, p. 389, fig. 2, 1842.
LEPTÆNA — *De Verneuil.* Geol. Russia, vol. ii, p. 222, pl. xiv, fig. 5, 1845.
LEPTAGONIA PLICOTIS, *M'Coy.* Sil. Foss. Ireland, p. 25, pl. iii, fig. 5, 1846.
LEPTÆNA SEMIOVALIS, *Id.* Ibid., p. 26, pl. iii, fig. 6, 1846.
ORTHIS SUBLÆVIS, *Id.* Ibid., p. 35, pl. iii, fig. 19, 1846.

Orthis undata, var. β, *M'Coy.* Sil. Foss. Ireland, p. 36, pl. iii, fig. 21, 1846.
Strophomena deltoidea, *Hall.* Pal. New York, vol. i, p. 106, pl. 31 a, fig. 3, 1847.
Leptæna — *M'Coy.* Brit. Pal. Foss., p. 234, 1852; and var. β, undata, p. 234, pl. 1 h, figs. 38 and 39, 1852.
Strophomena — *Schmidt.* Sil. Form. Ehstl., Archiv Nat. Liv., &c., vol. ii, p. 215, 1858.
— — *Salter.* Mem. Geol. Surv., vol. iii, p. 269, 1866.

Spec. Char. Shell semi-elliptical, deltoid, or semicircular, broader than long, widest at the long straight hinge-line; cardinal extremities angular; front and lateral margins rounded. Ventral valve geniculated, or very slightly convex, even almost flat to about two thirds of its length, after which, by a sudden bend, it is abruptly arched and deflected at an obtuse angle to the flattened plane of the posterior portion of the valve; area triangular, about ten times as long as high; fissure large, arched over by a pseudo-deltidium. Dorsal valve following the curves of the opposite one, flattened posteriorly, and abruptly bent upwards near the margin; hinge-area narrow. Surface of both valves marked by fine, equal, radiating, thread-like radii; a wide interspace, four or five times as broad, intervening between each pair of ribs. This interspace is furrowed by five or six finer striæ; and a slightly larger one, originating at variable distances from the beaks, occupies the centre of the interspace. The flattened portion of each valve is likewise marked by numerous concentric undulations or wrinkles, which are more strongly defined as they approach the hinge-line. In the interior of the ventral valve a prominent tooth is situated on each side of the fissure; the saucer-shaped muscular cavity, extending to about one third of the length of valve, is divided into two lobes, margined by a raised ridge. In the interior of the dorsal valve there is a small bifid cardinal process, and an anchor-shaped elevation, of which a wide median ridge forms the principal stem. On either side are the muscular impressions, divided again by two smaller oblique ridges.

Length 10, width 15, depth 1 line.

Obs. This is a very remarkable species on account of its well-marked internal characters, which at once distinguish it from *St. euglypha*, *St. funiculata*, *St. imbrex*, and others of its congeners. Externally it bears some resemblance to *St. funiculata;* but in this last the dorsal valve is the concave one, while in *St. deltoidea* it is convex, and a similar difference exists in the ventral valves of both species. Prof. M'Coy observes, at p. 234 of his work on 'British Palæozoic Fossils,' that "This extremely variable species can scarcely be defined. Some of our Coniston specimens have scarcely a trace of transverse wrinkles, and have the profile gently arched from the beak to the length of the visceral disk, whence the front is rather more abruptly arched; the striæ being equal on the sides, but every 3rd, 5th, or 7th being larger than the rest on the middle of the shell, agreeing exactly with Hall's figs. 3*a* and 3*d*; with this variety it seems the *Leptæna complanata* of Sowerby should be united. From these the passage is most gradual, in specimens from the same locality, to those with a more abruptly deflected front, less convex visceral disk, and gradually developed, more or less regular, concentric wrinkles, agreeing with Hall's figs. 3*e* and 3*f* and fig. 4 of the same plate, referred by him to *L. tenuistriata* of Sowerby, from which all the varieties may be easily distinguished by the narrow rounded front, giving the semi-oval, instead of the rhombic, outline to the disk, and the inequality of the striæ, as well as the narrower, oblong, muscular impressions, and the distinct tubular perforation of the beak, with its corresponding mamilla on the apex of the cast. This latter variety seems to include the still more strongly pronounced form which I have called *L. semiovalis*, and found very constant in its characters in the Bala Limestone of the Chair of Kildare, in Ireland." He then suggests that the different varieties of this species might be separated into the different subgenera *Leptæna* and *Leptagonia*, showing these latter to be but sections of one genus.

Strophomena deltoidea has been well described by Prof. Hall, M. de Verneuil, Prof. M'Coy, and others; and some correct illustrations of the exterior and interior of our British specimens will be found in our accompanying plate.[1]

I have also ascertained, from a minute examination of the type of M'Coy's *Orthis sublævis*, kindly lent to me by Sir Richard Griffith, that it is nothing more than a small young example of the shell under description. *Leptæna plicotis*, M'Coy, is also another synonym of *Strophomena deltoidea;* but I am not so sure with reference to his *Orthis undata.*

Position and Locality. In 'Siluria' *Strophomena deltoidea* is limited to the Caradoc or Bala period. Messrs. Ramsay, Salter, and M'Coy found the shell at Cerrig-y-Druidion and Cyrn-y-brain, in Denbighshire; also at Bala, in Merionethshire; at Alt-yr-Anker, Meifod, in Montgomeryshire; and in sandstone at Horderly. It has been also obtained by Prof. Harkness in Caradoc Limestone at Keisley, in Westmoreland.

In Ireland it is found at Grangegeeth, County Meath, and at the Chair of Kildare, &c.

Abroad the shell is common in the Trenton Limestone at Trenton Falls and Sugar River, in Lewis County, and in the neighbourhood of Little Falls, &c., in the State of New York. It occurs at Paggart, in Esthonia, and at Reval; in Norway, and elsewhere.

[1] Prof. J. Hall observes, at p. 107 of the first vol. of his 'Pal. New York,' "It is certainly often very difficult to draw the line of distinction between this species and the *Leptæna alternata*, and more particularly so between this and *L. camerata.* Again, on the other hand, it approaches very close, in some of its forms, to the succeeding species *Lept. tenuistriata;* but these two, when well preserved, are clearly and decidedly distinct."

STROPHOMENA DELTOIDEA, var. β, UNDATA, *M'Coy*. Pl. XXXIX, figs. 23 and 24.

ORTHIS UNDATA, *M'Coy*. Sil. Foss. Ireland, pl. iii, fig. 21, 1846.
STROPHOMENA DELTOIDEA, var. β, UNDATA, *M'Coy*. Brit. Pal. Foss., p. 234, pl. i H, figs. 38 and 39, 1852.

I know so little of this shell, never having seen more of it than the specimens described by M'Coy, that I must content myself by reproducing his figures and observations. It was described by him, in 1846, from a large flattened, and, to my eye, obscure impression; but in 1852 the distinguished Irish palæontologist informs us that his species is a simple variety of *Strophomena deltoidea,* from which it would seem to differ in various ways, and until its interior is known I cannot say whether it is or not a variety of *St. deltoidea,* to which it is provisionally referred. "This apparently distinct shell, "observes M'Coy," is semioval, about one and a half inches long, with a narrow deflected border, rarely half an inch deep; the visceral disk gently convex, rugged, with twelve or fourteen very large, undulating, concentric wrinkles, sometimes much interrupted, and nearly obsolete (like the type I originally figured), crossed by radiating obtuse striæ, which vary singularly in size in the different specimens, alike in all other respects—one specimen having only ten striæ in two lines at four lines from the beak, and another having twenty-four, and many specimens having the intermediate numbers; the lines are often sub-equal, or in all the middle portion towards the margin every 5th or 7th considerably larger than the rest. In the specimens I originally described, the surface seemed smooth, except some faint traces which I mentioned of longitudinal striæ; the better specimens now before me are all distinctly striated, but so much alike in other respects that I have no doubt of their identity, the geological position of each being alike. The specimens of this variety, which show the dental lamellæ, seem to have them more divergent and the muscular impressions wider than in the typical form. Some specimens of this variety have upwards of twenty concentric rows of faint, interrupted, concentric undulations, giving a curious rippled appearance to the surface, from which I named the species, when I believed it distinct."

Position and Locality. Var. β, *undata.* Common in the Bala Limestone of Llandeilo, Caermarthenshire; of Llwyn-y-ci, north-west of Bala; of Pont-y-Glyn-Diffwys, west of Corwen; Bala Schists of Bryn Melyn, and Gelli Grin, Bala, Merionethshire; of Cyrn-y-brain, west of Wrexham, Denbighshire; Bala Sandstone of Alt-y-Anker, Meifod, Montgomeryshire; Bala Limestone of Coniston, North Lancashire; ? in olive shale of Coed Sion, Llangadoc, South Wales (M'Coy).

This is a much larger shell than *Strophomena deltoidea,* and it is very desirable that a good series of specimens showing the external and, above all, the internal characters should be sought for in the localities above recorded by Prof. M'Coy.

STROPHOMENA JUKESII, *Dav.* Pl. XXXVII, figs. 23—26.

Spec. Char. Semicircular, longer than wide, broadest at the hinge-line, with small mucronate wings. Ventral valve moderately convex, exterior marked by numerous exceedingly fine, radiating lines. Area triangular, of moderate breadth, and divided in the middle by a narrow convex pseudo-deltidium. In the interior the two small teeth for the articulating of the valves lie close to the hinge-line, on either side, at the base of the deltidium; the saucer-shaped muscular area occupies a space of about one fourth of the width of the shell; the vascular impressions are sharply defined, and consist of two principal trunks, of which the external branches are turned outwards and backwards, enclosing wide ovarian spaces, as well as the elevations formed by the mantle pressing upon the horizontally coiled spiral arms. On the side facing the margin of the valve the vascular trunks (above described) give off smaller bifurcated branches, which extend to the edge of the shell. Dorsal valve not known.

Length 10, width 15 lines.

Obs. Of this curious shell only a very few examples of the ventral valve have been hitherto discovered, and these chiefly under the condition of sharply marked internal casts. One curious feature of this shell is the coiled impressions left by the spiral arms, which bear some resemblance to those we find in certain Swedish examples of *Strophomena rhomboidalis* (see Pl. XXXIX, fig. 16).

Position and Locality. Mr. Baily informs me that he has paid two visits to the quarry at Grangegeeth, County Meath (Ireland), where *Strophomena Jukesii* is found, and that he attributes the rock to the Caradoc-Bala period. This remarkable species is named in honour of the late distinguished Director of the Geological Survey of Ireland.

STROPHOMENA ARENACEA, *Salter*, MS. Pl. XLII, figs. 6—8.

STROPHOMENA ARENACEA, *Salter*, MS. Cat. Mus. Prac. Geol., p. 36, 1865 (neither figured nor described).
— — *Id.*, MS. Mem. Geol. Survey, vol. iii, p. 361, 1866.
— — *Bigsby.* Thesaurus Siluricus, p. 121, 1868.

Spec. Char. Semicircular, widest at the hinge-line, with short semicylindrical ears; sides and front broadly rounded. Ventral valve convex; hinge-area narrow; beak small, incurved, scarcely projecting. Dorsal valve concave, following the curves of the opposite one. Surface of both valves marked by numerous, very fine, thread-like radii, with interspaces of about two or three times their width; the interspaces are longitudinally grooved by three or four finer lines. In the interior of the ventral valve are two narrow, long, oval muscular depressions, separated by a flattened ridge of moderate width.

Length 12, width 17, depth $1\frac{1}{2}$ lines.

Obs. I regret that the late Mr. Salter neither figured nor described his species. I briefly and very imperfectly describe the shell from specimens so labelled in the Museum of Practical Geology, and I am not quite sure whether Mr. Salter has not mixed up two different species upon the same tablet, as the internal casts (figs. 7 and 8) do not quite agree in shape with the exterior (fig. 6). It would be very desirable that more ample material should be sought for in the locality whence these specimens were derived.

Position and Locality. *Stroph. arenacea* is stated to occur in the Upper Llandovery, at Huntley Hill; Norbury; May Hill; Gunwich Mill, near Alfrick; Presteign; Malverns; Church Stretton; Tortworth, &c.

STROPHOMENA SIMULANS, *M'Coy*. Pl. XLII, figs. 9 and 10.

LEPTÆNA (STROPHOMENA) SIMULANS. *M'Coy*. Ann. Mag. Nat. Hist., vol. viii, p. 403, 1851; Brit. Pal. Foss., pl. i H, figs. 33—35, 1851.
STROPHOMENA SIMULANS, *Salter*. Mem. Geol. Survey, vol. iii, p. 269, p. 361, 1866.

Spec. Char. "Truncato-elliptical; hinge-line slightly exceeding the width of shell, forming short, rounded, semicylindrical ears, from a more or less pronounced indentation of the lateral margins; front wide, elliptically rounded, entering [dorsal] valve gently and slightly convex for about nine lines from the beak, and then more rapidly arched towards the receiving [ventral] valve, to a position sometimes nearly at right angles with the rostral portion; receiving [ventral] valve nearly as concave as the entering valve is convex externally, except near the beak, which is convex; cardinal area rather low, triangular, and nearly at right angles to the plane of the lateral margins; foramen broad, triangular, closed by the pseudo-deltidium, except at the apex, where there is a tubular perforation (leaving a little columnar stem-like portion of matrix projecting from the apex of the cast); cardinal teeth [cardinal process] very small, bifid, diverging at 115°; the dental lamellæ, originating from them, converge under the muscular impressions, so that their inner, gently incurved edges, touching the shell, diverge at about 65°; muscular impressions undulato-orbicular, about a fifth wider than long, reaching rather less than half the length of the shell; surface sometimes with a few oblique concentric plicæ on the ears, regularly radiated with very fine, slightly irregular striæ, about twenty-five to thirty in two lines at six lines from the beak, and at that distance usually every fifth, seventh, or ninth of the striæ larger than the others; but near the beak they often seem simply alternate in size, the intervening delicate sulci closely punctured" (M'Coy).

Length 12, width 18, depth 1 line.

Obs. I am not well acquainted with this species, not having been able to procure satisfactory specimens of the shell; so I have reproduced Prof. M'Coy's description and figures. That Palæontologist has further observed that his species, in size, form, striation, and tubular perforation of the apex of the beak, almost exactly resembles *Leptæna alternata* of Conrad, but differs from it in having the ventral or foraminated valve concave, instead of convex; the striation is also finer, flatter, and more uniform; and these features, together with the greater deflection or arching of the valves, also separate it from *Strophomena grandis* (M'Coy).

Position and Locality. Strophomena simulans, as far as we at present know, is restricted to the Caradoc and Upper Llandovery (?) formations; and is said to be not uncommon in the Bala Schists of Blain-y-Cwm, west of Nantyre, Cefn Coch, Glyn Ceiriog, Denbighshire; and in the Olive Schists of Goldengrove, Llandeilo, Caermarthenshire. At p. 361 of vol. iii of the 'Geol. Survey' it is recorded from the Upper Llandovery at Malvern, but this identification still requires confirmation.

In the Museum of the Geological Survey of Ireland are specimens from Carrickadaggan, County Wexford, and from Knockmahon, Tramore.

STROPHOMENA (?) RETROFLEXA, *Salter*. Pl. XLII, figs. 15—17.

ORTHIS RETROFLEXA, *Salter*, MS., (not of Pander). Catal. Fossils Mus. Pract. Geol., p. 8, 1865.

Spec. Char. Broadly semicircular, wider than long, greatest width at the hinge-line; cardinal extremities forming small mucronate wings; lateral and frontal margins rounded. Ventral valve moderately convex, without fold or sinus; area triangular, about nine times as long as high; fissure narrow, arched over by a pseudo-deltidium. Dorsal valve flat or slightly convex; hinge-area narrow, one fourth as wide as the ventral one. Surface of valves ornamented by very numerous, fine, thread-like radii, with a shorter and finer rib interpolated between each pair of the larger ones. Interior of valves not known.

Length 6, width $7\frac{1}{2}$, depth 3 lines.

Obs. On a tablet in the Museum of Practical Geology this species was erroneously labelled "*O. retroflexa* = ? *Gonambonites retroflexa*, Pander." The Russian author's species is, however, quite distinct, both in characters and shape, from the shell under description, and does not belong to the same genus. I have therefore retained the name *retroflexa*, Salter (not Pander); and have placed the species so named, with some uncertainty, in the genus *Strophomena.* It is not an *Orthis* any how; for its fissure is arched over with a pseudo-deltidium, such never being the case in the true *Orthides.* The dorsal valve being flat or slightly convex is likewise a feature not characteristic of *Strophomena,* but it may be here an exception to the rule; and until we are acquainted with its interior the shell cannot be definitely referred to its proper place.

Position and Locality. The specimens in the Museum of the Geological Survey were obtained from the Caradoc at the Chair of Kildare, in Ireland. It has also been found in rocks of a similar age near Girvan, in Ayrshire.

STROPHOMENA ANTIQUATA, *Sow.* (sp.). Pl. XLIV, figs. 2—13, and 21, 22.

ORTHIS ANTIQUATA, *J. de C. Sow.* Sil. Syst., pl. xiii, fig. 13, 1839.
— — *Dav.* Lond. Geol. Journ., vol. i, p. 62, pl. xiii, fig. 25, 1847.
LEPTÆNA LEWISII, *Dav.* Ibid., p. 59, pl. xii, figs. 22—24, 1847.
ORTHIS SCABROSA, *Dav.* Ibid., p. 61, pl. xiii, figs. 14, 15, 1847.
LEPTÆNA ANTIQUATA, *Dav.* Bull. Soc. Géol. France, ser. 2, vol. v, p. 319, pl. iii, fig. 11, 1848.
— — *Phillips* and *Salter.* Mem. Geol. Surv., p. 283, 1848.
STROPHOMENA ANTIQUATA, *D'Orb.* Bull. Soc. Géol. France, ser. 2, vol. v, p. 336, 1848.
LEPTÆNA (STROPHOMENA) ANTIQUATA, *M'Coy.* Brit. Pal. Foss., p. 241, 1852.
STROPHOMENA ANTIQUATA, *Salter.* Siluria, 3rd edit., pl. xx, fig. 18, 1859.
— SCABROSA, *Lindström.* Gotl. Brach., p. 372, 1860.
— ANTIQUATA, *Dav.* Trans. Geol. Soc. Glasgow, Pal. Ser., vol. i, p. 17, pl. ii, figs. 21—23, 1868.

Spec. Char. Varying much in shape, according to age and individual; truncato-elliptical, semicircular, or subtrigonal, wider than long; hinge-line nearly or quite as long as the shell is wide; cardinal extremities obtusely or acutely angular; sides usually rounded, and converging to sometimes a narrow obtusely rounded front. Ventral valve slightly concave, with a deeper depression along the middle, and gently convex at the beak. In some examples a small circular foramen exists close to its extremity. Area rather narrow, fissure in the centre, arched over by a triangular pseudo-deltidium. Dorsal valve moderately convex, gently curved in profile, flattened posteriorly, or in the vicinity of the umbonal beak and cardinal extremities; while a median elevation or fold rises, in some specimens, towards the middle of the valve, and becomes more elevated or pinched (as it were) as it nears the front, thus producing a raised rounded wave at the frontal margin. Hinge-area narrow, about one third of the length of that in the opposite valve, and possessing in the middle a convex pseudo-deltidium which corresponds with that in the opposite valve. External sculpture variable in its details, but always radiated by either a few or many coarse, thread-like, often waving radii, with interspaces between them of greater or lesser breadth; while a smaller and shorter riblet occupies the middle of the interspace. The entire surface of the shell is also crossed by strong, equidistant, scaly, prominent ridges, or imbricated lines of growth. In the interior of the ventral valve is a prominent tooth on each side of the fissure, and strong dental plates enclose a small saucer-shaped muscular cavity, with raised margin, which is longitudinally divided into two parts by a broadish flattened ridge. In the interior of the dorsal valve the bifid cardinal process is very small, and placed between two deviating raised laminæ, on the outer side of which are situated the sockets. Under the cardinal process is a small short septum, which divides posteriorly two laterally notched, curved, and slightly projecting plates, which afforded attachment to the adductor muscle. The whole internal surface of both valves is grooved by irregular radiating striæ.

Length 14, width 19, depth 6 lines.

Obs. This is a very variable shell. A small or young specimen only was briefly described in 1839 by J. de C. Sowerby. The adult form was not then known, but was subsequently discovered by myself at Benthall Edge; but not understanding the species then (1847) in all its modifications of shape, I erroneously proposed for the adult form the designation *scabrosa*. With age the shell thickens considerably, and loses much of that often elevated and pinched-up mesial fold which is so generally present in young and middle-aged specimens (fig. 3). Still, this last character is not even constant in young individuals, and I have before me several examples which show no more appearance of that fold than in Sowerby's original type; and in some examples the ventral valve is entirely flat (fig. 4), instead of being gently concave or sinuated along the middle. In one specimen (fig. 4) the dorsal valve was even geniculated. The thread-like radiating riblets vary also in number and closeness to a very considerable extent. In 1847, however, I was enabled to completely illustrate the internal characters of this species, as well as that of several others, from excellently well-preserved examples I was fortunate enough to pick up at a time when the refuse-heaps of the large quarry upon the summit of Benthall Edge had not been much explored by collectors. It must also be noted that in some adult examples the thread-like riblets bifurcate (fig. 11 *b*); and that the muscular saucer-shaped depression in the ventral valve, which is usually transverse oval (fig. 12), sometimes becomes lozenge-shaped (fig. 13). The vicinity of the muscular scars presents small granulations, which are well seen in the form of pits in some of the internal casts that occur in the Pentland Hills (fig. 8 *b*).

Position and Locality. Strophomena antiquata is stated in 'Siluria' to range through the Caradoc, Wenlock, and Lower Ludlow formations.

From the *Caradoc.*—M'Coy quotes it from the Coniston Limestone of Water-Head, Lancashire; the Bala Slates of Blaen-y-Cwm, Nantyre, Glyn Ceiriog, south of Llangollen, Denbighshire; Bala Slates of Llansantfraid; but I am not personally acquainted with specimens from these localities, and would urge an attentive search.

From the *Llandovery.*—I have seen examples from Haverfordwest; Mathyrafal Pen-y-Craig; Llangynwy; Gas-Works, Haverfordwest; all *Lower Llandovery.* In the Upper Llandovery it was found at Penlan, Llandovery, by Mr. Hughes. It occurs also at Bogmine.

The *Wenlock* Limestone and Shales, however, appear to be its principal place of abundance. It is not very rare at Benthall Edge, near Walsall, and at Woolhope, Wenlock Edge, Dudley, Rock Farm (May Hill), Longhope, and Dormington Wood, Penlan, Cardiff, &c.

In the *Lower Ludlow* at Ledbury, &c.

In Scotland at Penkill, Ayrshire (Llandovery), and the Pentland Hills (Wenlock Shales).

It is also stated to occur in Ireland; but I have not seen any Irish specimens.

Abroad it occurs in Gothland. The specimens described by Mr. Billings from Anticosti do not appear to belong to the Sowerbyan shell.

STROPHOMENA CORRUGATELLA, *Dav.* Pl. XLI, figs. 8—14.

ORTHIS CORRUGATA, *Portlock* (not of Conrad). Rep. Geol. Londonderry, &c., p. 450, pl. xxxii, figs. 17 and 18, 1843.
— UNDULATA, *M'Coy* (not of Vanuxem). Synop. Sil. Foss. Ireland, p. 36, pl. iii, fig. 22, 1846.
— CORRUGATA, *Phillips* and *Salter*. Mem. Geol. Survey, vol. ii, p. 291, 1848.
LEPTÆNA — *Barrande.* Sil. Brach. Böhmen; Naturw. Abhandl., vol. ii, pl. xxi, fig. 16, 1848.
— — *M'Coy.* Brit. Pal. Foss., p. 233, 1852.

Spec. Char. Semicircular, wider than long; hinge-line slightly exceeding the width of the shell, with slightly rounded acute-angular cardinal extremities; sides and front regularly rounded. Ventral valve moderately convex; area narrow; fissure small, arched over by a pseudo-deltidium; beak not projecting. Dorsal valve gently concave, but in some examples slightly convex or raised along the middle (fig. 10). Hinge-area linear. External surface radiated by a greater or lesser number of strong, narrow, prominent, thread-like riblets, with wide interspaces between the pairs. The number of riblets increases at variable distances from the beaks, by the interpolation of a smaller rib; and the whole interspace is furrowed with from four to seven fine longitudinal striæ. In addition to these, the entire surface between the longitudinal ribs is crossed by zigzag concentric irregular wrinkles, which vary in thickness according to the specimen. Interior not well known.

Length 10, width 15, depth 2 lines.

Obs. This beautiful species varies considerably in its external appearance, on account of its sculpture, which is closer and finer in some examples than in others. To the more closely striated and corrugated varieties (fig. 8) Portlock gave the name of *corrugata;* and M'Coy that of *undulata* to those specimens in which the ribs are fewer in number and the interspaces consequently wider (fig. 14). These extremes are, however, intimately connected by examples possessing every intermediate character. It will be necessary to alter the termination of Portlock's specific designation of *corrugata* to that of *corrugatella* if we desire to preserve the memory of his well-known name; for shortly before 1843 the term *Strophomena corrugata* had been applied by Conrad to an American shell specifically distinct from that of Portlock, in the 'Journ. Acad. Nat. Sci. Philadelphia,' vol. viii, p. 256, pl. xvi, fig. 8; and again by J. Hall in his 'Geol. Report Fourth District New York,' p. 73, fig. 2, 1843. The designation "*undulata*" had also been given by Vanuxem to a variety of *Strophomena rhomboidalis* previous to the publication of M'Coy's description (' Geol. Report Third District New York,' p. 139, fig. 3, 1842; see also J. Hall's 'Palæontology of New York,' vol. iii, p. 196).

In external shape and sculpture this shell also nearly approaches to *Leptæna* or *Strophomena interstrialis* and *Stroph. nobilis* (M'Coy) from the Middle Devonian Rocks of Devonshire; but this last appears to be a larger and more convex shell; but it may possibly be only a modification of the Silurian form (in the Darwinian point of view); and it is highly probable that, when more completely known, this may be found to be the case with many forms which we are at present unavoidably compelled to regard as distinct. There can be little doubt that future Palæontologists, with a more extended knowledge derived from the labours of their predecessors, will be able to reduce the number of so-termed species. To attempt too much at present, however, with these incompletely known shells would render us liable to err in the opposite direction.

Position and Locality. Strophomena corrugatella is at present known only from the Llandeilo and Caradoc formations.

In the *Llandeilo* at Goldengrove and Merigomish, Llandeilo District.

In the *Carodoc* at Keisley, near Appleby (Westmoreland). This locality, according to Prof. Harkness, is the equivalent of the Bala or Coniston Limestone, or Middle Caradoc, and corresponding to that of the Chair of Kildare.

It is also stated by Phillips and Salter to occur at Craig-y-Garcyd in the Usk District, and at Cwm Craig-ddu, near Builth.

In Scotland it has been found at Balclatchie and Penkill, near Girvan, in Ayshire.

In Ireland in the Caradoc of Deserccreat (Tyrone); the Chair of Kildare; Newtown (Waterford); Grangegeeth (Kerry), &c.

Abroad it is mentioned by Barrande from Bohemia, &c.; but we must be careful not to confound it with the *Str. corrugata* of Conrad, to which D'Eichwald and some other authors refer.

Strophomena Hollii, *Dav.* Pl. XLII, figs. 18, 19.

Spec. Char. Shell minute, wider than long, greatest breadth at the long straight hinge-line; cardinal extremities rectangular, lateral margins rounded, slightly indented in front. Ventral valve moderately convex, with a shallow longitudinal depression or sulcus along the middle; beak not produced, perforated with a minute circular foramen near to its extremity; area narrow; fissure wide. Dorsal valve not known. In the interior of ventral valve there is a prominent tooth on each side of the fissure; the saucer-shaped muscular cavity is deep, with a raised margin, and divided longitudinally by a prominent ridge, which extends along the middle; the small circular foramen lies under the extremity of the beak and close to the posterior edge of the muscular cavity. The remainder of the interior of the valve is divided into two deep cavities by a slightly raised mesial ridge.

Length 1, width $1\frac{1}{2}$ lines.

Obs. This little species occurs by thousands in a yellow Caradoc Shale at the Onny section; where it was first discovered by Mr. Lightbody, who forwarded me specimens. It is unfortunately very minute, and is found as internal casts. I could only make out that belonging to the ventral valve. Some traces or impressions of parts of the external surface have also been noticed, but the sculpture was very obscurely defined, and consisted of numerous fine striæ. No doubt, with diligent search in the locality, examples of the dorsal valve, and others exhibiting the external surface, will be discovered. In the mean time we can offer no more than a very incomplete description.

Strophomena Siluriana, *Dav.* Pl. XLVII, figs. 1—4.

Spec. Char. Shell thin, transversely semicircular, gently concavo-convex; hinge-line as long as, or a little less than the width of the shell; cardinal extremities angular, sometimes slightly protruding in the shape of mucronate wings; sides and front rounded. Ventral valve gently and uniformly convex; beak slightly incurved, but not projecting; area narrow, about ten times wider than high; fissure moderately wide, triangular, and partly arched over by a small pseudo-deltidium. Dorsal valve gently concave, following the curves of the opposite valve; hinge-area very narrow. External surface marked by numerous unequal, radiating, fasciculated, raised striæ. The ribs on leaving the beaks are few in number and strong, with wide interspaces between them; each primary rib extends straight to the margin and remains the most prominent ridge in each cluster. At a little distance from the beaks most of the ribs commence laterally to bifurcate into two or three; and, as these approach the margin, they split again into numerous smaller divisions, so that close to the margin each of the primary ribs has become, during its progress, divided into seven, ten, or more small ribs; and these have arranged themselves into clusters with the parent or original rib. The whole surface of each valve is likewise closely intersected by very fine, equidistant, concentric, raised lines.

Interior not well known. Cardinal process divided into two deviating lobes.

Length 10, width 12, depth $1\frac{1}{2}$ lines.

Obs. This species was found by the Rev. H. G. Day and by Mr. Hughes abundantly in the Lower Silurian Shales (Bala?), at Fairy Gill, Cautley, near Sedberg, in Yorkshire; and I am indebted to them for the communication of a numerous series of specimens of all ages. The shell varies considerably according to age, especially in the greater or lesser length of its hinge-line, and in the strength and fasciculation of its ribs. In young specimens these last seem to be comparatively stronger, fewer in number, and wider apart, becoming so numerous in the adult condition that about one hundred may be counted round the margin of many of the specimens. The Rev. H. Day supposed it possibly referable to *Orthis Hirnantensis* (M'Coy); but if so, the distinguished Irish Palæontologist's description would hardly agree with that here given of the shell under investigation, for our species is certainly a *Strophomena,* and its smaller valve is decidedly concave, and not perfectly flat as that of *Orthis Hirnantensis* is said to be. The ribbing is also less delicate than in the latter. I will not, however, positively affirm that Mr. Day's first impression was incorrect; but if correct, *O. Hirnantensis* would not be an *Orthis,* and M'Coy's description would not suit his species.

STROPHOMENA PECTEN, *Linn.* (sp.). Pl. XLIII, figs. 1—11.

Lister, Hist. Animal. Angliæ, pl. ix, fig. 49, 1678; and Appendix ad Librum iii, de Conchitis, &c., 447, i, 1688.

ANOMIA PECTEN, *Linné.* Syst. Nat., editio duodecima, vol. i, pars 2, p. 1152, 1767.

TEREBRATULA PECTEN, *Bruguière.* Encycl. Méthod., pl. ccxliv, fig. 8, 1789.

TEREBRATULITES PECTEN, *Schlotheim.* Petrefact., p. 255, No. 8, 1820.

ANOMIA — *Wahlenberg.* Nova Acta Upsal., vol. viii, p. 66, 1821.

— — *Turton.* Transl. of Linné's Syst. Nat., vol. iv, p. 282, 1802.

TEREBRATULA — *Fischer.* Prog. Tereb., p. 50, fig. 1, 1809.

ANOMIA — *Dillwyn.* Index to Martin Lister's Methodica Conchyl., &c., p. 447, 1823.

ORTHIS — *Dalman.* Vet. Akad. Handl., p. 110, pl. i, fig. 6, 1828.

— — *Hisinger.* Lethæa Suecica, p. 70, pl. xx, fig. 6, 1837.

— — *Portlock.* Geol. Londonderry, &c., p. 453, 1843.

— — *Dav.* Lond. Geol. Journ., vol. i, p. 61, pl. xiii, figs. 18—23, 1847; and Bull. Soc. Géol. France, ser. 2, vol. v, p. 320, pl. iii, fig. 16, 1848.

STROPHOMENA — *Phillips* and *Salter.* Mem. Geol. Surv., vol. ii, p. 381, 1848.

Orthis pecten, *Quenstedt.* Handb., p. 487, pl. xxxix, fig. 16, 1851.
Leptæna (Strophomena) pecten, *M'Coy.* Brit. Pal. Foss., p. 245, 1852.
Strophomena pecten, *Schmidt.* Sil. Form. Ehstl.; Arch. Nat. Liv- Ehst- und Kurland, vol. ii, p. 214, 1858.
Anomia — *Hanley.* Ipsa Linnæi Conch., p. 125, 1855.
Leptæna — *D'Eichwald.* Lethæa Rossica, Pér. Anc., vol. i, p. 867, 1859.
Strophomena — *Salter.* In Siluria, 3rd ed., p. 251, fig. 3, 1859.
Orthis minuta, *Haswell.* Sil. Form. Pentlands, pl. iii, fig. 1, 1865.
Strophomena pecten, *Dav.* Pal. Trans. Geol. Soc. Glasgow, vol. i, p. 18, pl. iii, figs. 1—4.
— — *Lindström.* Gotland's Brach., p. 373, 1860.

Spec. Char. Shell transversely semicircular, broadish at its long straight hinge-line, sides and front rounded; cardinal extremities forming, with the lateral portions of the valve, sharp acute angles. Valves much compressed. Ventral valve slightly convex at the beak, but becoming gradually and gently concave as it approaches the margin; area triangular, of moderate width; fissure in the middle arched over by a pseudo-deltidium; beak very small, scarcely projecting. Dorsal valve slightly convex, and flattened near its cardinal extremities; hinge-area linear, but with a small corresponding pseudo-deltidium in the middle, so that the two, when combined, form a lozenge-shaped arch, widest and most elevated at the hinge-line and tapering on all sides as it recedes near the extremities of the beaks. Valves covered with numerous, thread-like, radiating, nearly equal ribs, which increase rapidly in number by the insertion of one or two additional and finer radii in the interspace left between each pair of larger ones; the whole surface is likewise closely crossed by numerous equidistant, slightly projecting, concentric ridges or lines of growth. In the interior of the dorsal valve a small bifid cardinal process is situate between two slightly projecting brachial (?) processes; a short median ridge separates the obscurely marked muscular impressions. In the interior of the ventral valve the muscular impressions are scarcely defined.

Length of a very large example 23, width 40, depth 3 lines.

Obs. This species, although not then specifically named or described, was known to Martin Lister as far back as 1687, a recognisable but incomplete figure having been appended to his small work 'Historiæ Animalium Angliæ, Tres Tractatus (de Araneis, de Cochleis terrestribus, et de Cochleis marinis),' London, 1678, pl. 9, fig. 49, and the shell is stated to be fossil at Halifax. The figure was subsequently reproduced by the same author, and in 1789 by Bruguière. Linné was, however, the first to briefly describe the shell, and his specific designation of "*pecten*" has been retained for it by all subsequent naturalists. Linné says of his shell, "semiorbicular, depressed, with numerous striæ; one valve flat: Lister, 'An. Angl.,' p. 243, pl. ix, fig. 49: found in a fossil state; shell with a transverse line near the hinge." Since the time of Linnæus it has, however, been referred to the genera *Terebratula*, *Orthis*, *Leptæna*, and *Strophomena*; but with the first three it has no relation, and evidently belongs either to *Strophomena* or to King's sub-genus *Streptorhynchus.* Several Palæontologists, such as Fischer de Waldheim (in 1809), and J. de C. Sowerby (in 1839), have referred specimens to Linné's species which evidently do not belong to it; and Mr. Sharpe long ago pointed out that the shell in pl. xx, fig. 4, of the 'Silurian System,' erroneously referred to *Strophomena pecten,* in reality belongs to *Str. expansa,* a perfectly distinct species. I fear, likewise, that Baron von Buch has confounded the Carboniferous *Streptorhynchus arachnoideus* with the Linnean form. I have also determined beyond doubt that the *Orthis minuta* of Haswell is only a very young shell of the species under description. Good describable interiors of *Strophomena pecten* have not yet been discovered. It is evident that the muscles left but feeble impressions upon the inner surface of the shell. *Orthis semicircularis,* Sow., is a young shell of the species under description.

Position and Locality. In 'Siluria' *Strophomena pecten* is stated to range throughout the Caradoc or Bala, Llandovery, and Wenlock formations. In the Caradoc it is said to occur at Clyn Ceiriog; Llangollen, Denbighshire; and Ravenstone Dale. Also in the dark limestone of Coniston, Lancashire (Sharpe), &c. In the Llandovery, at Hope Quarry, Minsterley; Capel Cerrig; Huntley Hill; May Hill, &c. At Littlehope in the Woolhope Limestone. In the Wenlock, at Dudley, the Bell, near Walsall; Benthall Edge, and at Shucknall Hill, Woolhope, in the Aymestry Limestone, &c. &c.

In Scotland it is very abundant in the Wenlock Shales of the Pentland Hills.

In Ireland it occurs at Ferriters Cove and in other localities.

Abroad it has been found in the islands of Gothland and Oesel; Ostrogothia; Klinleberg, Norway; the Ural; Tennessee; New York, &c.

STROPHOMENA ORBIGNYI, *Dav.* (sp.). Pl. XLII, figs. 12—14.

ORTHIS ORBIGNYI, *Dav.* Bull. Soc. Géol. France, ser. 2nd, vol. v, p. 320, pl. iii, fig. 17, 1848.
STROPHOMENA — *Salter* and *Etheridge.* Cat. Mus. Prac. Geol., p. 41, 1865.

Spec. Char. Semicircular, wider than long, greatest breadth at the long straight hinge-line; cardinal extremities pointed, and slightly extended into mucronate wings; sides rounded; front very slightly convex, sometimes almost straight. Ventral valve gently convex; area triangular, narrow; fissure arched over by a pseudo-deltidium; beak small, not projecting. Dorsal valve very slightly concave. Surface of valves marked by numerous strongish radii, with wide interspaces, with which are interpolated, at various distances from the beaks, one or two smaller striæ. The valves are likewise crossed by a few concentric lines of growth. In the interior of the ventral valve the saucer-shaped depression is rather large and longitudinally divided along the middle by a ridge. Interior of dorsal valve not known.

Length 13, width 20 lines. More often only half that size.

Obs. In 1848 I described this shell as an *Orthis;* but its true place is with *Strophomena.* In shape it most approaches *Stroph. pecten;* but differs from it in the shape of its muscular impressions, as may be at once perceived by comparing the interior of the ventral valve in both species. D'Eichwald, in his 'Lethæa Rossica,' p. 365, considers it to be a variety of *St. pecten,* or rather of the *Orthis filitexta* of Hall.

Position and Locality. I found several examples of the ventral valve in the Wenlock Limestone at Dudley; and a large incomplete specimen from the same locality (fig. 13) may be seen in the Museum of Practical Geology.

STROPHOMENA FILOSA, *J. de C. Sow.* (sp.). Pl. XLIV, figs. 14—20.

ORTHIS	FILOSA,	*J. de C. Sow.* Sil. Syst., pl. xiii, fig. 12, 1839.
—	—	*M'Coy.* Synop. Sil. Foss. Ireland, p. 30, 1846.
—	—	*Dav.* Lond. Geol. Journ., vol. i, p. 62, pl. xiii, fig. 24, 1847.
LEPTÆNA	—	*Dav.* Bull. Soc. Géol. France, ser. 2, vol. v, p. 318, pl. iii, fig. 9, 1848.
ORTHIS	—	*Phillips* and *Salter.* Mem. Geol. Surv., vol. ii, p. 288, 1848.
STROPHOMENA	—	*Salter.* Mem. Geol. Surv., vol. ii, p. 380, 1848.
LEPTÆNA	—	*M'Coy.* Brit. Pal. Foss., p. 243, 1853.
STROPHOMENA	—	*Salter.* In Siluria, 3rd ed., pl. xx, fig. 21, 1859.
—	—	*Schmidt.* Sil. Form. Ehstl.; in Arch. Nat. Liv- Ehst- und Kurland, p. 216, 1858.
LEPTÆNA	—	*D'Eichwald.* Lethæa Rossica, p. 873, 1859.
STROPHOMENA	—	*Lindström.* Gotland's Brachiopoder, p. 373, 1860.
—	—	*Salter.* Mem. Geol. Surv., vol. iii, p. 279, 1866.

Spec. Char. Semicircular, much depressed, wider than long, greatest width at the hinge-line; cardinal extremities sometimes slightly prolonged into angular mucronate wings; lateral and frontal margin rounded. Ventral valve very slightly convex, almost flat; area narrow; fissure small, arched over by a pseudo-deltidium; beak not protruding. Dorsal valve very slightly concave or flat; hinge-area linear—surface of both valves covered with numerous, thread-like, raised radii; a smaller riblet interpolated between each pair of the larger ones. In the interior of the ventral valve a small hinge-tooth is seen on each side of the fissure; muscular impressions large, fan-shaped, and arranged in four longitudinal oval depressions; a narrow median ridge extends along the middle of the valve for about one third of the length of shell. In the interior of the dorsal valve the bifid cardinal process is very small; muscular impressions obscurely defined.

Length 16, width 22, depth $1\frac{1}{2}$ lines.

Obs. This species is remarkable on account of the very slight convexity and concavity of its valves; indeed, it is often almost entirely flat, so that the space left free between the valves for the occupation of the animal is exceedingly small. Its ribs, or radii, are also very fine and numerous; the muscular depressions in the ventral valve are very broad anteriorly, and fan-shaped; and in this respect peculiar to the species (figs. 19, 20).

Prof. M'Coy states that the general surface is very coarsely punctate, and marked, especially near the margins, with the external radiating striæ.

Position and Locality. The vertical range of this species seems to be limited to the Wenlock and Ludlow divisions. In the Wenlock Limestone and Shales it is abundant at Burrington, Oldcastle (Murchison's locality), at Dudley, Benthall Edge, Usk, Llandovery, Lindsway Bay. At Bryn-mawr, Capel-y-rhiw; Mynydd Tryfan (in beds above Denbighshire Grits). In the Aymestry Limestone at Leintwardine. In the Upper Ludlow, south-west of Hazle, Woolhope, Bringwood Chase, Ludlow, Burton and Brockton, near Wenlock, Tulithwaite Hall, Underbarrow, Kendal, Westmoreland, &c. Prof. Phillips enumerates also many localities in the Malvern, Abberley, Woolhope, and Usk districts.

In Ireland it is stated by M'Coy to occur in Upper Silurian rocks at Doonquin, Dingle, County Kerry, and at Ferriters Cove, Dingle. I have not yet seen any Scottish specimens, but expected to have met it in the Pentland Hill section.

Upon the Continent it has been found in Westrogothia, Gothland.

D'Eichward states that it occurs in the Orthoceratite Limestone of Tosna, in the Government of St. Petersburgh.

STROPHOMENA APPLANATA, *Salter*. Pl. XLIII, figs. 12—14.

ORTHIS (?) APPLANATA, *Salter*. Synops. Sil. Foss. Ireland, pl. v, fig. 1, 1846.
STROPHOMENA — *Phillips* and *Salter*. Mem. Geol. Surv., vol. ii, p. 380, 1848.
— — *Salter*. Appendix, Mem. Geol. Surv., Sheet 32, Scotland, p. 138, 1861.
— — *Haswell*. Sil. Form. Pentlands, p. 34, pl. ii, fig. 18, 1865.
— — *Dav*. Pal. Trans. Geol. Soc. Glasgow, vol. i, p. 19, pl. ii, figs. 19, 20, 1868.

Spec. Char. Semicircular, much compressed, greatest width at hinge-line. Cardinal extremities prolonged into acutely angular mucronate wings. Ventral valve very slightly convex; area narrow; fissure arched over by a small pseudo-deltidium. Dorsal valve very gently convex or almost flat. Surface of valves ornamented with numerous thread-like radii, the ends of which project beyond the margin; one or two smaller radii likewise partly occupy the wide interspace left between each pair; and the entire surface of both valves is closely crossed by delicate ridges of growth. Interior not known.

Length 7, width 15 lines; but usually much smaller.

Obs. This shell was described for the first time in 1846. It is both smaller and flatter than *Str. pecten,* a closely allied species. Mr. Salter observes that the ribs project like those of *Venericardia,* and produce a pectinated margin; and that the small size of the shell appears constant.

I have examined many specimens of this small species from the Pentland Hills, where it is associated with individuals of *Stroph. pecten* of all ages, and can always be distinguished by its pectinated margin.

Position and Locality. In 'Siluria' it is stated to occur in the Llandovery and Wenlock formations. I am acquainted with the shell from the last-named strata only. In England it is mentioned by Phillips and Salter as being found at Craig-y-Garcyd, Usk.

In Scotland it abounds in Wenlock Shales in certain spots along the banks of the North Esk in the Pentland Hills, and not far from the reservoir bearing that name. It was discovered for the first time in Scotland by Mr. A. Geikie; but although I searched the locality for several hours, in company with Messrs. Haswell and Brown of the Geological Society of Edinburgh, no specimen with the shell itself was ever discovered.

In Ireland it is stated by Mr. Salter to be abundant in slabs at Cooling, Cong, in company with *Orthis,* or rather *Strophomena corrugata,* Portlock. This statement will, however, require confirmation, for the last-named shell is a Caradoc species, and I question whether *St. applanata* has been found so low down in the series.

STROPHOMENA ORNATELLA, *Salter,* MS. Pl. XLIII, figs. 16—20.

STROPHOMENA ORNATELLA, *Salter* and *Lindström.* Nomina Foss. Sil. Gotlandiæ, p. 5, 1867.

Spec. Char. Semicircular, wider than long, very slightly concavo-convex, much depressed; greatest breadth at the hinge-line; cardinal extremities pointed, forming small mucronate wings. Ventral valve very slightly convex; area narrow, fissure arched over by a pseudo-deltidium; beak not projecting. Dorsal valve almost flat, or very slightly concave; hinge-area linear. Surface of both valves beautifully marked with numerous thread-like ribs, radiating from the beaks to the margin, and leaving very wide interspaces between them, which are occupied by two or three smaller ribs, commencing at variable distances from the beaks, and extending to the margin; concentric lines of growth few in number. In the interior of the ventral valve there is a small hinge-tooth on each side of the fissure; the muscular impressions assume the shape of two elongated oval depressions, notched in front, and surrounded by a narrow raised elevation. A small median ridge extends from under the fissure for about one third of the length of the valve. In the interior of the dorsal valve the cardinal process is bifid, each lobe being scooped out along the middle; on either side of these are the hinge-sockets, margined and separate from the cardinal process by a narrow projecting lamella or ridge. Muscular impressions obscurely defined; four longitudinal rounded ridges extend a little way from under the cardinal process towards the centre of the valve.

Length 7, width 9, depth 1 line.

Obs. This elegant smallish species was named *ornatella* by Messrs. Salter and Lindström, but neither of them described or figured their species. It had been often mistaken for young examples of *Strophomena filosa*, but from this it is easily distinguishable both by its external sculpture and by the shape of its muscular and other internal impressions. It is a much smaller species, and the radii are comparatively stronger. It varies according to the length of its hinge-line, this last being shorter in some specimens than in others.

Position and Locality. Strophomena ornatella occurs in great abundance as internal casts and external impressions in the Upper Ludlow at Whitecliff and Coppice, Ludlow.

In the Island of Gothland it was found by Dr. Lindström with its shell almost complete; but there it is an uncommon fossil.

STROPHOMENA WALTONI, *Dav.* (sp.). Pl. XLII, fig. 11.

LEPTÆNA WALTONI, *Dav.* Lond. Geol. Journ., vol. i, pl. xxvi, fig. 3, 1847; and Bull. Soc. Géol. France, ser. 2nd, vol. v, p. 317, pl. iii, fig. 6, 1848.

Spec. Char. Semicircular, regularly concavo-convex, broadly rounded; hinge-line a little shorter than the breadth of the shell; area narrow; pseudo-deltidium small. Ventral valve slightly convex; dorsal valve gently concave. Surface of both valves marked by numerous, fine, radiating, thread-like striæ, with a still finer raised line in the interspace between each pair of the larger striæ. Interior not known.

Length 9, width 11, depth 1 line.

Obs. This species was discovered by Mr. Walton in the Wenlock Shales at Falfield. Several other examples were likewise collected by Lord Ducie.

STROPHOMENA HENDERSONI, *Dav.* Pl. XLIII, fig. 15.

STROPHOMENA HENDERSONI, *Dav.* Trans. Geol. Soc. Glasgow; Pal. Series, Fasc. 1, p. 19, pl. ii, fig. 24, 1868.

Spec. Char. Semicircular, wider than long, greatest breadth at the hinge-line; ventral valve very slightly convex; dorsal valve gently concave. Surface covered with numerous, exceedingly fine, hair-like, radiating, raised striæ, closely imbricated by still finer and closer concentric lines.

Length 5, width 7 lines.

Obs. Of this species I have seen two examples, which were obtained by Mr. J. Henderson in Wenlock Shales, North Esk, Pentland Hills, Scotland. This shell is remarkable on account of the extreme minuteness of the imbricating striæ which adorns its external surface. The interior has not been yet discovered.

STROPHOMENA GRANDIS, *Sow.* (sp.). Pl. XLVI, figs. 1—3 and 5, 6.

ORTHIS GRANDIS, *J. de C. Sow.* Sil. Syst., pl. xx, figs. 12 and 13, 1839.
— — *M'Coy.* Sil. Foss. Ireland, p. 31, 1846.
LEPTÆNA (STROPHOMENA) GRANDIS, *M'Coy.* Brit. Pal. Foss., p. 244, 1852.
STROPHOMENA GRANDIS, *Salter.* In Siluria, 3rd ed., pl. vi, figs. 6 and 7, 1859.
LEPTÆNA — *Morris.* Catal. Brit. Foss., p. 137, 1854.
— — *D'Eichwald.* Lethæa Rossica, vol. i, p. 864, 1859.

Spec. Char. Semi-oval, or truncato-elliptical, wider than long; hinge-line either slightly shorter than, or as long as, the shell is wide; cardinal extremities rectangular, or obtusely angular; sides and front rounded. Ventral valve slightly convex at the beak, but becoming gently concave about the middle and towards the margin; area narrow; fissure arched over by a small pseudo-deltidium. Dorsal valve gently convex; area narrow. Surface of both valves ornamented with numerous, strong, prominent, thread-like radii, with one or two smaller and shorter ones filling up the interspace left between the principal pairs. The surfaces of the valves are crossed by numerous, close and fine, concentric, raised lines. In the interior of the ventral valve the muscular impressions are rather narrow, elongated, and divided in the middle by a rounded ridge (fig. 3). Interior of the dorsal valve not known.

Length 22, width 27, depth 3 lines.

Obs. This species is at once distinguished from *Strophomena expansa* and *St.*

compressa, by its convex valve being the dorsal one; while it is the ventral one that is convex in the last-named species. It differs also by several internal characters in both valves. In the ventral one the muscular impressions are narrow, while they are broad and saucer-shaped in *St. compressa* and *St. expansa*. Prof. M'Coy states that it is also distinguished from *O. expansa* by its much coarser striæ. In some specimens the ventral valve is almost flat. D'Eichwald is of opinion that the *Leptæna heraldica* and *L. exclamatoria* of Kutorga are synonyms; but I do not know enough of those two species to be able to venture an opinion. Perhaps the *Orthis cancellata* of Portlock might be a variety of this shell (it is so considered at p. 545 of the 3rd edition of 'Siluria,' 1859); but here again I must confess my ignorance, not having been able to examine the specimen upon which the species was founded. The shell named *Orthis grandis* (Sow.). by Portlock ('Rep. Geol. Londonderry,' p. 452, pl. xxxii, fig. 25, 1843) does not belong to Sowerby's type, but it is referable to *Orthis porcata*, M'Coy. Better specimens of *Stroph. grandis* should be sought for, so as to enable Palæontologists to complete its description.

Position and Locality. *Strophomena grandis* occurs chiefly in the Caradoc at Horderley, Soudley, Acton Scott, and near Church Stretton; at Dolwyddelan, Boduan, Caernarvonshire; Bala, Merionethshire; and Pwll-y-wrach-uchaf and Llanfyllin, Montgomeryshire. Mr. Salter informed me that the specimens from May Hill, labelled *St. grandis* by M'Coy, in the Woodwardian Museum, are only fragments of *St. euglypha* and *St. filosa*.

In Ireland it occurs at Tirnasken and Badahessiagh, Pomeroy, Tyrone; also at Desertcreat, &c.

In Scotland, near Girvan, in Ayrshire.

M. d'Eichwald mentions it as found in Russia.

Strophomena expansa, *Sow.* (sp.). Pl. XLV, figs. 1—10.

Orthis expansa, *J. de C. Sow.* Sil. Syst., pl. xx, fig. 14, 1839.
— pecten, *Id.* (not Linné). Pl. xxi, fig. 9.
— expansa, var. concentrica, *Portlock.* Rep. Geol. Londonderry, &c., p. 452, pl. xxxvii, fig. 1, 1843.
— rugifera — *Id.* p. 453, pl. xxxvii, figs. 2 *a*, 2 *b*, 1843.
Strophomena expansa, *Phillips* and *Salter.* Mem. Geol. Surv., vol. ii, p. 377, 1848.
Orthis — *M'Coy.* Brit. Pal. Foss., p. 217, 1852.
Strophomena — *Salter.* Siluria, 3rd ed., p. 210, fig. 2, and pl. vi, fig. 4, 1859.

Spec. Char. Semicircular, much depressed, rather wider than long; hinge-line nearly or quite as long as the shell, with rectangular or obtusely angular extremities;

sides and front rounded. Ventral valve very slightly convex; area narrow, eighteen to twenty times wider than high; fissure covered with a narrow pseudo-deltidium. Dorsal valve very slightly concave, or almost flat. Surface of valves covered with numerous, rounded, raised, thread-like radii, with interspaces of greater width, in which are one or two smaller ribs, commencing at various distances from the beaks, and extending to the margin; the whole surface is likewise crossed by numerous, close, equidistant, concentric ridges, as well as by a few deeper lines of growth. In the interior of the ventral valve is a prominent tooth on each side of the fissure, supported by small dental plates, which enclose a very large, saucer-shaped, muscular cavity or depression, divided along the middle, and radiated by numerous ridges and furrows. The vascular impressions consist of two primary trunks, which run parallel direct from the anterior portion of the muscular depressions to the frontal margin, and give off laterally, at intervals, all along their extent, horizontal bifurcating branches towards the lateral margins of the valve (fig. 6); the first or posterior branch on each side is reflected round the ovarian space, which is contiguous to the muscular cavity. In the interior of the dorsal valve the cardinal process is bifid, each lobe being grooved or excavated along its middle; on the outside is situated the dental socket, surrounded by a raised elevation. Under the cardinal process is a small median ridge, which separates the adductor muscular impressions into two pairs, each pair being again divided by a flattened ridge (fig. 10).

Length 26, width 30, depth 2 lines.

Obs. I cannot help expressing some surprise that so able an observer as is Prof. M'Coy should not at once have perceived that the shell under description was not an *Orthis,* but a *Strophomena,* the concavo-convex aspect of the shell, the fissure closed by a pseudo-deltidium, the bifid cardinal process, the position and shape of the muscular scars, all denoting that Sowerby's species could not possibly be an *Orthis;* and still more so, as further on he rightly recognises the genus of the closely allied form *Strophomena compressa.* *Strophomena expansa* attained large dimensions, relatively to other species of this genus in our British Silurian rocks. Sowerby figured the exterior of one of its valves under the designation of *Orthis pecten,*—a species not positively known to occur so low down in the series, and differing from the former very materially in the shape of its muscular and other internal impressions. *Orthis expansa*, var. *concentrica,* Portlock, is also another form of this variable species. *Strophomena expansa* is described at considerable length by Mr. Salter at p. 378 of the second volume of the 'Memoirs of the Geol. Survey,' from which I will transcribe some passages. "The surface along the hinge-line is sometimes corrugated in oblique folds; and, I believe, in this state [this species] is the *Orthis rugifera*, Portlock; the raised threads, interlined by three or five fine ones, of which the central one afterwards becomes a strong thread, are arched upwards towards the sides, not radiated in straight lines; and the central triangular portion at the beak, marked off by the two diverging hinge-plates, is raised up a little on the exterior. The most remarkable character resides in the muscular impressions, which are subrhomboidal, and formed of numerous radiating ridges and furrows distinct and strong to the very end, while in *Strophomena compressa,* the nearest ally, the upper edge alone of the muscles is visible, the muscles themselves hardly producing any mark." This last statement, however, is exaggerated; for, as may be seen from the drawing of *St. compressa* in Pl. XLVI, fig. 10, these marks are often clearly defined, although not so strongly grooved as in the shell under description. "The interior, too, is smooth, and not granulated in lines as in *St. compressa;* the vascular impressions, when present, radiate from the central ridge a little below the base of the muscles, and curve outwards and upwards to the margin, forking two or three times; the space between the top one and the muscles pitted; the striæ are only visible round the edge interiorly. The hinge-teeth in the dorsal valve are large and prominent" (he should have said *the bifid cardinal process,* as this part does not serve as a tooth, but affords a point of attachment to the attenuated extremity of the divaricator or cardinal muscle[1]), "and supported on a thick central rib or plate, which divides the muscles; . . . . . . there is also an accessory tooth, long and narrow, on each side of this pair." Here, again, Mr. Salter is wrong, for the narrow plate, which he calls a tooth, has nothing to do with the articulation of the hinge further than to limit on one side the socket-wall.

According to Prof. M'Coy, *Orthis alternata,* Sow. ('Sil. Syst.,' pl. xix, fig. 6), is a synonym; but the generality of Palæontologists have retained them as distinct forms.

Position and Locality. Strophomena expansa occurs in the Carodac and Lower Llandovery. In the former it is abundant at Meifod, near Welshpool; Hope Bowlder, Soudley, near Church Stretton; near Llanfyllin; Harnage, south-east of Shrewsbury; Port Rhiwaedog, in the Hirnant Valley, near Bala; Carnedd Dafydd; Bettws-y-Coed; Dolwyddelan; Pwllheli, Caernarvonshire. South-east of Cerrig-y-Druidion; Llangollen, Denbighshire. Cader Dinmael, Montgomeryshire; east, west, and south-east of Bala Lake; Llanrhaiadr, Merionethshire, &c.

In the Lower Llandovery at Mathyrafal; quarter of a mile south-east of Cwmrhyddan; Cwar Mawr, Cdgyn Road, &c.

In Ireland at Desertcreat and Bardahassiagh, Tyrone; Grangegeeth; Lombay Island; Knockmahon, Tramore, &c. I believe it also occurs in rocks of the Caradoc period near Girvan, in Ayrshire.

Many more English and Welsh localities are enumerated by Prof. M'Coy; but, as I have not seen specimens from those localities, I merely refer the reader to p. 218 of the

[1] In his admirable memoir on the 'Organization of the Brachiopoda,' Mr. Hancock thus describes the position of this muscle:—"The *divaricator* (or 'cardinal muscles' of some authors) arise from the ventral valve, one on each side, a little in advance of, and close to the united bases of the occlusors (adductors). These extremities are large, fleshy, and of a reddish-yellow colour; they rapidly diminish in size, and attain the appearance of white, glistening tendons; and having the intestine between them converge as they pass backwards and upwards towards the cardinal process, into which their superior, attenuated extremities are inserted in close continuity."

Professor's work on 'British Palæozoic Fossils,' some uncertainty existing in my mind as to this species having really been obtained from some of the localities there quoted.

Strophomena compressa, *Sow.* (sp.). Pl. XLVI, figs. 7—10.

Orthis compressa, *J. de C. Sow.* Sil. Syst., pl. xxii, fig. 12, 1839.
Strophomena compressa, *Phillips* and *Salter.* Mem. Geol. Surv., vol. ii, p. 379, 1848.
Leptæna — *M'Coy.* Brit. Pal. Foss., p. 242, 1852.
— — *D'Eichwald.* Lethæa Rossica, vol. i, p. 873, 1859.
Strophomena — *Salter.* Siluria, 3rd ed., p. 100, fig. 7, and pl. ix, fig. 16, 1859.

Spec. Char. Semicircular or squarish, wider than long; hinge-line either slightly exceeding the width, with short rounded ears; or rather less than the width, with obtusely angular extremities; sides and front margin rounded; ventral valve gently convex; area narrow; fissure small, arched over by a pseudo-deltidium. Dorsal valve nearly flat, or rather very gently concave; hinge-area narrow. External surface of both valves marked with numerous, fine, thread-like, slightly projecting radii, with one or two riblets between each pair of the principal radii, these last becoming larger and closer in their turn, with punctures along the intervening furrows. The whole surface is closely imbricated by equidistant, concentric, prominent ridges. In the interior of the ventral valve the muscular scars are large, and form two wide lobes, separated in the middle by a flattened ridge. In the interior of the dorsal valve the cardinal process is bifid, and placed between two small deviating plates; the muscular scars below being separated by a median ridge.

Length 14, width 19, depth $1\frac{1}{2}$ lines.

Obs. As was justly observed by Mr. Salter, it must be confessed that in general form, size, and convexity, this shell closely approaches the last, but the striation is far more irregular. I may also point to the great general resemblance of the internal details; and I should not be at all surprised if it were no more than the Llandovery descendant of the Caradoc *Strophomena expansa.* It is, however, a smaller shell; and, as Palæontologists generally have considered it distinct, I shall retain it so provisionally. Indeed, Prof. M'Coy appears to feel quite sure that it is so, for he states, at p. 242 of his work on 'British Palæozoic Fossils,' "The great compression of the valves, thinness of the shell, the marked concentric waves of growth, thread-like subequal striæ, and large punctures, easily distinguish this in wellmarked specimens from *Orthis expansa* or *O. alternata,* as well as the difference in the cardinal area, and foramen, and muscular impressions, and simple rostral tooth." (I question the accuracy of these last so-termed differences; the tooth, or rather cardinal process, is bifid, and there is not that great difference in the muscular impressions.) "I have little doubt" (continues M'Coy) "the shell figured by Sowerby as the *O. anomala* (Schloth.), 'Sil. Syst.,' pl. xxi, fig. 10 [see our Pl. XLVI, fig. 16], is a very old specimen of this species, elongated by compression, which has also increased its convexity. Such specimens are not uncommon, indicating apparently the thickening adult state, in which it often shows an approach to *Strophomena grandis,* when, as sometimes happens, some of the striæ in part of a specimen become more prominent than the others." I consider, on the contrary, the difference between *Stroph. compressa* and *St. grandis* to be much greater than between it and *St. expansa.* Mr. Salter would place that undeterminable specimen, named *Orthis pseudo-pecten* by M'Coy, among the synonyms of *Strophomena compressa.* This synonyma would, however, require much consideration prior to being definitely accepted; and I much regret that the material at my command for examination, in connection with *St. grandis, St. compressa,* and *St. expansa,* has not been greater. Good examples of all three should still be sought for and carefully compared.

Position and Locality. Stroph. compressa is stated to occur in the Caradoc and Upper Llandovery formations, but especially in the latter. From the Caradoc: in Sandstone at Horderly west, Bala Schists and Limestone of Craig-y-glyn, north of Rhaider, near Llanarmonfach, east of the Berwyns; Bala Schists of Moel Uchlas, Montgomeryshire, &c. (M'Coy).

In the Upper Llandovery at Presteign; Marloes Bay; Norbury, Chirbury; Hope Quarry, Minsterly, Damory Bridge, Tortworth; May Hill.

In Ireland, according to Prof. M'Coy, it occurs in the coarse Schists of Bardahassiagh, Pomeroy, County Tyrone; at Cappacorcogne Cong, County Galway; and in several other places; but these require verification.

Variety (?)—Llandeiloensis. Pl. XLVI, figs. 11—14.

This variety is of an elongated semicircular shape; the hinge-line is quite as long as the shell is wide, with sharply angular extremities. Ventral valve very slightly convex, flattened at the ears; area narrow; fissure wide; beak not projecting. Dorsal valve slightly concave; hinge-area linear. Surface of both valves covered with numerous, fine, thread-like radii, a smaller and shorter one being interpolated between each two of the principal ones. In the interior of the ventral valve the saucer-shaped muscular depression is very large, occupying fully a third of the inner surface of the valve, and is separated along the middle into two lobes by a narrow median ridge, margined at its posterior portion by two slender ridges (fig. 14). In the interior of the dorsal valve a small bifid cardinal process is situated between two slender plates, on the outside of which is the socket. Under the cardinal process a rounded ridge separates the obscurely marked muscular impressions (fig. 13). The whole inner surface of both valves is furrowed by numerous fine striæ, as well as by some few concentric lines of growth.

Length 12, width 13, depth 1 line.

Obs. This variety (?) of *Strophomena compressa* seems to me to differ more from its type than *St. compressa* differs from *St. expansa.* It belongs also to a lower geological stage. I have consequently thought it preferable to distinguish (at least provisionally) it by a varietal designation. It is of a more lengthened semicircular form than is *St. compressa,* and its interior details vary in several particulars.

Position and Locality. This form occurs in the Upper Llandeilo Flags at Lann Mill, near Llandeilo, Caermarthenshire. It was also found by Mr. Morton at Bog-Mine, near Shelve, and in some other localities.

As *Strophomena compressa* lived in the Caradoc and Llandovery periods, this shell, if a variety of that species, would be its most ancient form.

STROPHOMENA FLETCHERI, *Dav.* (sp.). Pl. XLVII, figs. 5 and 6.

LEPTÆNA FLETCHERI, *Davidson.* London Geol. Journ., vol. i, p. 12, pl. xii, figs. 9 and 10, 1847; and Bull. Soc. Géol. France, ser. 2, vol. v, pl. iii, fig. 12, 1848.
— — *De Vernenil.* Ibid., p. 347.

Spec. Char. Semicircular, wider than long, greater breadth at the straight denticulated hinge-line; cardinal extremities extended into pointed mucronate wings; sides and front rounded. Ventral valve very obliquely and moderately convex; beak small, incurved, scarcely projecting; area very narrow; fissure small, arched over by a convex pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; hinge-area linear. Surface of both valves covered with numerous, but very slightly defined, thread-like radii, which increase in number by the interpolation of smaller striæ. Interior not known.

Length 7, width 12, depth 1 line.

Obs. In 1847 I described this species as a *Leptæna,* but I think it will be more correctly placed with *Strophomena.* It is easily distinguished from *Leptæna transversalis* (with which species it has been erroneously confounded by Mr. Salter), both by its shape and its striation. In *L. transversalis* the beak is very prominent and greatly incurved, while in *Strophomena Fletcheri* it is very small and scarcely projecting. The convexity and concavity of its valves are also much less than in *Leptæna transversalis ;* and it was at once recognised as quite distinct by MM. de Verneuil and D'Orbigny in 1848. In form it resembles *L. Humboldtii*, De Verneuil; but it has the ventral valve less convex, the cardinal area narrower, and the radiating striæ slightly different.

Position and Locality. I found several examples of this shell at Benthall Edge, near Iron-Bridge, in Wenlock Limestone.

Genus—LEPTÆNA, *Dalman*.

(See 'General Introduction,' p. 108.)

The species composing this genus (or sub-genus) are more or less semicircular, and concavo-convex or involute. It is distinguished from *Strophomena* by the large, elongated, thickened muscular impressions in the dorsal valve, as seen in such species as *Leptæna transversalis, L. sericea, L. tenuicincta,* &c.; and the valves are usually finely striated. The species are not nearly so numerous as those of *Strophomena*; but it is a widely spread genus.

LEPTÆNA TRANSVERSALIS, *Wahlenberg*. Pl. XLVIII, figs. 1—9.

ANOMITES TRANSVERSALIS, *Wahl.* Acta Upsal., vol. viii, p. 64, No. 4, 1821.
LEPTÆNA — *Dalman.* Vet. Akad. Handl., p. 109, pl. i, fig. 4, 1828.
— — *Hisinger.* Lethæa Suecica, p. 69, pl. xx, fig. 5, 1837.
— — *Von Buch.* Ueber Delthyris, &c., 1837; and Mém. Soc. Géol. France, vol. iv, p. 222, pl. xii, fig. 25, 1840.
— — *J. de C. Sow.* Sil. Syst., pl. xiii, fig. 2, 1839.
— DUPLICATA, *Id.* Ibid., pl. xxii, fig. 2, 1839.
— TRANSVERSALIS, *M'Coy.* Sil. Foss. Ireland, p. 28, 1846.
— — *Dav.* Lond. Geol. Journ., vol. i, p. 57, pl. xii, figs. 17—19, 1847; and Bull. Soc. Géol. France, ser. 2, vol. v, p. 318, pl. iii, fig. 10, 1848.
— DUVALII, *Dav.* Lond. Geol. Journ., vol. i, p. 58, pl. xii, figs. 20 and 21, 1847.
— TRANSVERSALIS, *Phillips* and *Salter.* Mem. Geol. Surv., vol. ii, p. 286, 1848.
— — *Barrande.* Brach. Böhmen; Natur. Abhandl., vol. ii, p. 73, pl. xxi, figs. 19 and 20, 1848.
ORTHIS — *Quenstedt.* Handbuch, p. 488, pl. xxxix, fig. 18, 1851.
LEPTÆNA — *Hall.* Pal. New York, vol. ii, p. 256, 1852.
— — *M'Coy.* Brit. Pal. Foss., p. 240, 1852.

LEPTÆNA TRANSVERSALIS, *Schmidt.* Sil. Form. Ehstl.; Archiv, &c., p. 216, 1858.
— — *D'Eichw.* Lethæa Rossica, vol. i, p. 869, 1859.
— — *Salter.* Siluria, 3rd ed., pl. ix, fig. 17 *d*, and pl. xx, fig. 17, 1859.
— — *Lindström.* Gotland's Brach., p. 374, 1860.
— — *Salter.* Mem. Geol. Surv. Scotland (sheet 32), p. 138, pl. ii, figs. 8 and 9, 1861.
— — *Haswell.* Sil. Form. Pentlands, p. 35, pl. ii, fig. 17, 1865.
— — *Salter.* Mem. Geol. Surv., vol. iii, pp. 276, 277, 1866.
— — *Dav.* Geol. Soc. of Glasgow, Pal. Trans., vol. i, p. 19, pl. iii, fig. 13, 1868.
— — *Bigsby.* Thesaurus Siluricus, p. 97, 1868.

Spec. Char. Semicircular, or transversely fusiform, wider than long; hinge-line nearly or quite as long as the shell's width; cardinal extremities obtusely or acutely angular, but more often short, with rounded semicylindrical ears. Ventral valve very convex, convoluted at the beak, which is sometimes large and greatly incurved; area narrow; fissure partly arched over by a narrow, convex pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; hinge-area very narrow, almost linear, with a projecting trilobed cardinal process in the middle. Surface of both valves covered with radiating, thread-like, equal-sized riblets, about half a line apart near the margin, the interspace between each pair being occupied by from five to seven very fine parallel striæ. In the interior of the ventral valve is a prominent tooth on each side of the fissure; the muscular impressions forming two more or less elongated, deviating, oval depressions. In the interior of the dorsal valve, under the trilobed cardinal process, at about one third of the width of the inner surface is occupied by the muscular impressions or projections, which are divided into three almost equal portions. The central division is occupied by two rounded longitudinal ridges, with a smaller one in the centre (fig. 7), while on either side the muscular scar is surrounded by a raised ridge, the interspace between its sub-parallel sides being occupied by a projecting rounded ridge. There exists also a sub-convex margin around the lateral and frontal portion of the valve. Vascular impressions are visible near the margin in both valves, as well as numerous rows of tubercules, which give the cast a punctured appearance.

Proportions varying according to the specimen.

Length 9, width 11, depth 1 line.

Obs. This is a well-known and rather common species; and appears to have been first noticed by Wahlenberg, who in 1821 described it in the following few words—" *Anomites transversalis* laevissimus semiorbicularis, cardine rectilineo indiviso latitudinem testae excedente; in Gothlandia et Osmundsberg Dalecarliae proveniens, diu *A. truncatus* audivit. Differt autem certissime cardinis linea in media testa non interrupta, laevitate superficiei exterioris," &c. It was not figured, however, until 1827. It is a very variable shell; and, as remarked by M'Coy, it is considerably more globose than *Leptæna sericea*, and is distinguished from it moreover by the shape of its muscular impressions. Some examples are extremely elongated or spindle-shaped (*Lept. Duvalii*, Dav.); while others are almost as long as broad. *Strophomena Fletcheri*, which was confounded with it by Mr. Salter, is a completely distinct species. At p. 267, vol. iii, of the 'Memoirs of the Geol. Survey,' Mr. Salter proposes to designate a variety of *L. transversalis* by the name of *undulata* (which would include *Lept. quinquecostata* of M'Coy, in part); but as he did not figure or describe his variety, nor inform us what part of *L. quinquecostata* is to be included in it, I cannot possibly adopt the designation. It is said to occur at Alt-yr-Anker, Meifod, and Llanfyllin, in the Caradoc.

Position and Locality. Leptæna transversalis occurs in the Caradoc, Llandovery, and Wenlock formations.

In the Caradoc at Glyn Ceriog, Denbighshire; at Bala, &c., Merionethshire; at Helm Gill, Dent, in Coniston Limestone, &c.

In Lower Llandovery at Mathyrafal; Pen-y-Craig, Llangynyw; at Ridge, behind Penroch, and Cefnrhyddan, Llandovery; at a quarter of a mile south-east of Cwmrhyddan; Castellmadoc, south of Cilgwyn Road, &c. Also in Upper Llandovery at Robeston Wathen, Pembrokeshire.

In the Woolhope beds south of Woolhope.

In the Wenlock Limestone and Shale at Dudley, Benthall Edge, Buildwas, near Wenlock; Rushall Canal, near, Walsall; Sibdon, Shropshire, &c.

In Scotland it occurs in Lower Silurian beds at Penwhapple Burn and Penkill, near Girvan, in Ayrshire; also in the Wenlock Shales of the Pentland Hills.

In Ireland it is stated by M'Coy to be found in the Slates of Ardaun Cong, County Galway; but as *Leptæna sericea* and some other allied forms have been so often confounded with *Lept. transversalis,* one must be careful in recording for it Lower Silurian localities. It was, however, found in Upper Silurian at Ferriters Cove.

Abroad it is common in the Upper Silurian beds of Gothland; and in Norway, Esthonia, Bohemia, the United States, the Island of Anticosti (*Plectambonites arca* and *Pl. tenera* of Shaler), and in many other localities.

Variety—Youngiana, *Dav.* Pl. XLVII, figs. 19 and 20.

This appears to be an ancient variety, or perhaps the original progenitor, of *Leptæna transversalis.* This shell is almost circular, or as wide as long, with a hinge-line slightly shorter than the greatest width of the shell. Some specimens are even slightly longer than wide. It measures ten lines in length, by about the same in width; and the ventral valve is very convex or involute. In certain examples the concentric lines of growth form, on the exterior of the ventral valve, undulating ridges (fig. 19 *d*). Its external sculpture is very similar to what we find in Wahlenberg's type.

We are not acquainted with the interior, which may perhaps present some corresponding differences. It was found by Mrs. E. Gray, of Glasgow, in the Caradoc Limestone of Craig-head Quarry, near Girvan, in Ayrshire. Dr. Gustav Lindström informs me that a similar shell occurs in the Lower Silurian rocks of Sweden. I have seen six or seven specimens of this shell, and they all agree in shape and character.

LEPTÆNA SEGMENTUM, *Angelin*. Pl. XLVIII, figs. 28—30.

LEPTÆNA SEGMENTUM, *Angelin*, MS. Musæum Palæontologicum Suecicum, 1838.
— — *Lindström*. Gotland's Brachiopoder, p. 374, 1860; and Revised List, 1867.

Spec. Char. Shell small, semicircular, wider than long, broadest at the hinge-line; cardinal extremities prolonged into mucronate wings; sides and front rounded. Ventral valve moderately convex; beak very small, scarcely projecting; area moderately wide; fissure triangular, narrow, lanceolate, and entirely arched over by a small pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; area narrow. Surface of both valves bearing seven or eight principal, fine, thread-like radii, with interspaces between each pair, very wide and longitudinally striated; a short rib here and there occupying the centre of the interspace in the vicinity of the margin. In the interior of the ventral valve the muscular scars are very small, and scarcely defined; a wide granulated border surrounds the interior of the valve. In the interior of the dorsal valve the cardinal process is minute, and situated between two small diverging brachial laminæ; the muscular scars form two large oval depressions with raised margin, widely separated anteriorly.

Length 3, width 5, depth ½ line.

Obs. This small shell has been for many years mistaken for the young of *Leptæna transversalis*. In 1838 it received from Prof. Angelin, who regarded it as distinct, the specific designation of *segmentum*. In England, however, the name was not known prior to Dr. Lindström's description of the species in 1860. No figure was appended; but the shell was subsequently found in England by Dr. Lindström, and identified with the Swedish type. *L. segmentum* differs from *L. transversalis* in many important particulars. It is a much smaller species, considerably less convex, and more spindle-shaped; its beak scarcely projects. The area in both valves is comparatively wider, and the fissure and pseudo-deltidium are much smaller and lanceolate, while the principal thread-like radii, which ornament its valves, are considerably less in number, and have much wider interspaces between them. In the interior of both valves the differences are likewise great, as will be at once perceived by a glance at the figures of the two species given in our plate. The differences between it and *Leptæna quinquecostata* (M'Coy) are less striking; and we are not yet acquainted with the internal characters of the latter shell.

Position and Locality. It occurs plentifully in the Wenlock Shale near Dudley, and at Buildwas, near Wenlock, &c.

Abroad it was found by Dr. Lindström in the Middle Gothland beds at Djupvik (Eksta), and Lilla Carlsö, Gothland.

LEPTÆNA QUINQUECOSTATA, *M'Coy.* (sp.). Pl. XLVIII, figs. 23—27.

ORTHIS QUINQUECOSTATA,		*M'Coy.*	Sil. Foss. Ireland, p. 33, pl. iii, fig. 8, 1846.
LEPTÆNA	—	*Id.*	Brit. Pal. Foss. p. 236, 1852.
—	—	*Schmidt.*	Sil. Form. Ehstland; Archiv, &c., p. 216, 1858.
—	—	*Salter.*	Siluria, 3rd ed., p. 211, fig. 3, 1859.
—	—	*D'Eichwald.*	Leth. Rossica, Pér. Anc., vol. i, p. 872, 1859.
—	—	*Salter.*	Mem. Geol. Survey, vol. iii, p. 266, 1866.

Spec. Char. Semicircular, wider than long, greatest width at the long straight hinge-line; cardinal extremities rounded, sometimes slightly prolonged in the shape of semicylindrical ears. Ventral valve convex, much arched in profile, and especially so at the beak, flattened towards the sides; beak small, incurved; area triangular, moderately wide; fissure narrow, arched over by a convex pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; area about one third of the width of that of the other valve. Surface of both valves ornamented with three, five, or seven principal, equidistant, slender, thread-like rounded radii, which extend from the beak to the margin, leaving very wide interspaces, which are closely and finely striated longitudinally; an occasional shorter rib occupying the centre of the interspace, and extending a short way from the margin in the direction of the beaks. Interior not well known.

Length 3, width 6, depth ½ line.

Obs. This small species appears to bear much resemblance to *Leptæna segmentum,* but is distinguished exteriorly by its smaller number of principal radii, which in most specimens do not exceed five. Its beak is also larger and more projecting than in *L. segmentum.* I have never been so fortunate as to be able to examine the interior of its valves. Prof. M'Coy remarks that the internal cast of the ventral valve presents a very short mesial septum, dividing the small, tumid, reniform pair of muscular impressions, reaching only to one fifth of the length of the shell; that from these, five or six slender, branched impressions of the pallial vessels extend on each side to the margin, a broad border round which is very minutely and closely punctured under the lens, the rest of the cast being seemingly nearly smooth. Prof. M'Coy further observes that it is internally easily distinguished from *L. sericea* by its extremely short muscular impressions, and by this character, as well as by the very few external principal radii, it is easily separable from *Lept. transversalis.* This species will, however, demand further research, and better material should be sought for.

Position and Locality. In 'Siluria' *Leptæna quinquecostata* is said to be limited to the Caradoc or Bala period; but it has been obtained by Prof. Ramsay in the Upper Llandeilo of Garn, and south side of Arenig, and by Mr. Hughes in the Lower Llandovery; and also in the Upper Llandovery by Mr. Salter.

From the Caradoc it has been found west of Bala Lake, in Merionethshire. In the Bala Schists of Cefn Rhyddan, Llandovery, South Wales; in the Bala Schists of Mathyrafal, Meifod, Montgomeryshire; Bala Schists of Goleugoed and Penlan, Llandovery, South Wales; of Pen-y-Craig, Llangynyw, Montgomeryshire, &c.; of Moelydd and Tyisaf Llangedwyn. Mr. Hughes has found it also near Sedberg, in Yorkshire. It is stated at p. 266 of the third vol. of the 'Mem. of the Geol. Survey' to have been obtained at Llandovery in Upper Llandovery rocks.

In Scotland it is stated by M'Coy to be not uncommon in the green trappean sandstone of Glenwhapple, and at Ardwell, near Girvan, in Ayrshire. I have also seen it from the Caradoc Limestone of Craig-head Quarry in the same neighbourhood; also from Colmonel, on the Stinchar.

In Ireland it is stated to occur in the Sandstone of Cooling Cong, County Galway; also in the Limestone of the Chair of Kildare, &c.

Abroad it is mentioned as being found in Russia by Messrs. D'Eichwald and Schmidt.

LEPTÆNA SERICEA, *Sow.* Pl. XLVIII, figs. 10—19.

LEPTÆNA SERICEA, *J. de C. Sow.* Sil. Syst., pl. xix, figs. 1, 2, 1839.
ORTHIS — *D'Eichwald.* Sil. Syst. in Esthl., p. 157, 1840.
— — *Portlock.* Geol. Londonderry, p. 450, pl. xxxii, figs. 23, 24, 1843.
LEPTÆNA — *De Verneuil.* Geol. Russia, vol. ii, p. 227, pl. xv, fig. 1, 1845.
— — *M'Coy.* Sil. Foss. Ireland, p. 27, 1846.
— — *Barrande.* Sil. Brach. Böhmen; Naturw. Abhandl., vol. ii, p. 71, pl. xxi, fig. 18, 1847.
— — *Hall.* Pal. New York, vol. i, pp. 110 and 287, 1847; vol. ii, p. 59.
— — *Phillips* and *Salter.* Mem. Geol. Survey, vol. ii, p. 285, 1848.
— — *M'Coy.* Brit. Pal. Foss., p. 237, 1852.
— — *Salter.* Siluria, 3rd ed., p. 210, fig. 6, and pl. v. fig. 14, 1859.
— — *D'Eichwald.* Lethæa Rossica, vol. i, p. 870, 1859.
— — *Salter.* Mem. Geol. Survey, vol. iii, p. 266, 1866.

Spec. Char. Transversely semicircular, longer than wide; hinge-line nearly as wide as, or slightly exceeding, the width of the shell. Cardinal extremities angular, but sometimes forming small semicylindrical ears; sides rounded; front almost straight. Ventral valve convex, most so at and near the beak, which is incurved and of very small projection; area moderately wide; fissure narrow, arched over by a pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; hinge-area narrow. Surface of valves ornamented with numerous fine, equal, hair-like, rounded radii; with interspaces between each pair, four times as great as the width of each of the principal riblets; the interspace is itself longitudinally furrowed by five to seven very fine striæ, which are again separated by very narrow sulci, containing rows of minute punctures. In the interior of the ventral valve the elongated, deviating, muscular depressions are posteriorly divided in the middle by a median ridge; anteriorly by a deep indentation. In the interior of the dorsal valve the muscular scars form two large, wide, flattened, parallel, slightly raised depressions, separated into two pairs by a deep median interspace, along the centre of which is a small ridge.

Length 5, width 9, depth 1 line.

Obs. This species seems to differ from *L. transversalis* chiefly by its smaller beak, more transverse form, coarser striæ, and much finer punctures; but especially by the expanded flattened shape (instead of convexity) of its muscular impressions. This difference becomes at once apparent on a comparison of the interior of the dorsal valve of both species drawn in our plate (figs. 7 and 16). The interspace between the principal radii is also comparatively smaller in this species than in *Lept. transversalis;* and the longitudinal striæ are likewise fewer in number.

Position and Locality. In 'Siluria' *L. sericea* is stated to occur in the Llandeilo, Caradoc or Bala, Llandovery, and perhaps the Wenlock formation. In the Caradoc it is especially abundant; and half of a quarto page of M'Coy's work on 'British Palæozoic Fossils' is devoted to their enumeration. We will mention a smaller number of the principal localities.

In the *Llandeilo Flags* at Llan Mill.

In the *Caradoc* at Pwll-y-wrach-isaf; Hope Bowdler; Acton Scott; Y-Gelli Grin; Bala; Carnedd Dafydd; Bettws-y-Coed; Dolwyddelan; Bodean; Pwllhei; Llyn Idwal, Caernarvonshire. South of Cerrig-y-Druidion; south of Llangollen; Cricor Mawr; east of Llanelidan; south of Pont-y-Glyn Diffwys, Glyn Ceiriog, Denbighshire. Llanwddyn; Meifod; Llanfyllin; north of Llangedwin; Alt-yr-Anker, Montgomeryshire. East, west, and south-east of Bala Lake, &c., Merionethshire, &c. Common also in Bala beds at Coedog, Corwen; Das Eithen ridge; Hirnant; Haverfordwest; and elsewhere in Wales; at Whittingslow, Horderley, and Moclydd near Oswestry, in Shropshire; and at Keisley and Pusgill, near Dufton, Westmoreland.

In the *Lower Llandovery* at Miomffri; half a mile south-east of Cwmrhyddan, Cefnrhyddan, Llandovery, Mathyrafal, &c.

In *Upper Llandovery* at Pentan, Coldbrook, Craig-yr-Coyddon, Llandovery, &c.

I am not acquainted with any Wenlock localities.

In Scotland it occurs in the Caradoc Limestone of Craig-head, near Girvan, in Ayrshire, and in several other localities in the same district.

In Ireland it abounds in many places, such as Grangegeeth, County Meath; Ballygeale, Waterford; at Portraine, at Kelly Pomeroy, Desertcreat, &c.

Abroad it has been found in Russia, Esthonia, Bohemia, Norway, Spain, the Island of Anticosti, Canada West, the United States, &c.

Var. *a*—RHOMBICA, *M'Coy*. Pl. XLVIII, figs. 20—22.

LEPTÆNA SERICEA, var. RHOMBICA, *M'Coy*. Brit. Pal. Fossils, p. 239, 1852.

"In this variety the shell is more gibbous in the middle than in the true types, and less transverse; the proportional length varying from $\frac{65}{100}$ to $\frac{70}{100}$, as compared with the width; and the strong ridges fewer and often nearly a line apart, sometimes elevated on obtuse folds near the margin; in those respects approaching the *L. transversalis*, from which, however, it differs in having the intervening striæ of the same size and strength as the ordinary types; wanting the remarkable large punctures on the interior, &c.; the muscular impressions also agree rather with *L. sericea* than with the *L. transversalis*."—M'Coy.

Obs. I have reproduced Prof. M'Coy's reasons for making this a variety of *L. sericea*. I know nothing of its interior; and the chief difference I can perceive rests on the greater size of the shell, some examples having attained—

Length 11, width 17 lines,

much larger proportions than given to *L. sericea*.

This form will require further study, especially as to its interior.

Position and Locality. This variety occurs in the Caradoc-Bala at Moclydd, near Oswestry; Pwll-y-wrach-isaf, Llanfyllin; Alt-yr-Anker, Meifod; Mathyrafal, south of Meifod; Pen-y-Craig, Llangynyw, Montgomeryshire. Belli Grin, Bala, Merionethshire. Glyn Ceiriog, Denbighshire, &c.

In Scotland it has been found at Craig-head Quarry, near Girvan, in Ayrshire.

LEPTÆNA SCISSA, *Salter*. Pl. XLVII, figs. 21—25.

LEPTÆNA SCISSA, *Salter*, MS. Catal. Coll. Foss. Mus. Pract. Geol., p. 36, 1865.
— — *Id.* Mem. Geol. Survey, vol. iii, p. 267, 1866.

Spec. Char. Shell small, semicircular, widest at the hinge-line, with small semicylindrical ears. Ventral valve gibbous, much arched in profile, flattened at the ears; area narrow; fissure covered by a pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; area narrow. External surface ornamented with four or five slender, thread-like, rounded radii, with broad interspaces finely and longitudinally striated. In the interior of the ventral valve a prominent tooth on each side of the fissure is supported by dental plates, which enclose a moderate-sized saucer-shaped muscular depression, with raised edge; longitudinally divided by a prominent median ridge, and deeply indented in front. In the interior of the dorsal valve the muscular depressions are large, elongated, and divided into four parallel lobes, margined by a raised rim.

Length 2, width 4, depth $\frac{1}{2}$ line.

Obs. This small species was named, but not described or figured, by Mr. Salter. I have described and drawn the shell from the typical specimens in the Museum of Practical Geology. It occurs chiefly in the condition of internal casts; and the enlarged figures, 22 *a* and 23 *a,* show well its characters; as also do the enlarged figures of the shell itself, 24 *a* and 25 *a,* taken in gutta-percha from internal casts. From figs. 22 and 24 it will be seen that the muscular depressions are wider in some examples than in others. There are also four longitudinal indented lines or vascular impressions seen in the cast of the ventral valve, which give it a very peculiar appearance (fig. 23 *a*).

I cannot say whether this species is distinct from *Leptæna quinquecostata,* as I am not acquainted with the internal characters of the last-named species; but it was stated to be so by Mr. Salter.

Position and Locality. In 'Siluria' this species is restricted to the Llandovery period; but specimens in the Museum of Practical Geology are labelled from the *Caradoc* of Sholes Hook, Haverfordwest; Bettws-y-Coed, Caernarvonshire; east and west of Bala Lake, Merionethshire, &c.

In the *Lower Llandovery* at the Gas Works, Haverfordwest; west of Pantygasey, Llandovery, &c.

In the *Upper Llandovery* at Builth; Cefn-Craig-Gwyddon; Mathyrafal; Pentan; Norbury; Bishop's Castle, &c.

I am not acquainted with any Scottish examples.

In Ireland it is found in the *Caradoc* at Desertcreat, &c.

LEPTÆNA TENUICINCTA, *M'Coy.* (sp.). Pl. XLVII, figs. 7—18.

PRODUCTA TENUICINCTA, *M'Coy.* Sil. Foss. Ireland, p. 25, pl. iii, fig. 4, 1846.
LEPTÆNA ÆNIGMA, *De Verneuil.* Bull. Soc. Géol. France, sér. 2, vol. v, p. 340, pl. iv, fig. 6, 1848.
— TENUICINCTA, *M'Coy.* Brit. Pal. Foss., p. 239, pl. i H, fig. 40, 1852.
— — *Salter.* Siluria, 3rd ed., p. 210, fig. 4, 1859.
— — *Id.* Mem. Geol. Survey, vol. iii, p. 267, 1866.

Spec. Char. Variable in shape; rotundato-quadrate or semicircular; either shorter or longer than wide; sides sometimes almost subparallel; front rounded. Hinge-line nearly or quite as wide as the shell; cardinal extremities obtusely angular, or presenting short semicylindrical or convoluted ears. Ventral valve either evenly convex and flattened at the wings (fig. 7), or longitudinally flattened and slightly depressed along the middle (fig. 12). Area triangular, rarely exceeding one line in height; fissure triangular, covered by a pseudo-deltidium; beak small, incurved. Dorsal valve concave, following the curves of the opposite valve; hinge-area almost linear. Surface of both valves crossed by numerous, close, fine, thread-like, concentric lines or wrinkles. In the interior of the dorsal valve, on either side of the fissure, is placed a small prominent hinge-tooth. The muscular scars form two, long, narrow, deviating depressions, with raised margin (convex in the cast at fig. 18), and separated by a wide interspace. These scars extend almost to the frontal margin; and are in all probability due to the divaricator muscle; while posteriorly and at a short distance only from the beak are two smaller cavities (convexities in the cast), which may be referable to the adductor muscle. In the interior of the dorsal valve are two widely deviating, narrow, brachial (?) laminæ, on the outer side of which are situated the hinge-sockets and hinge-area. The adductor muscular depressions are in the shape of two elongated, subparallel, oval scars, which extend to near the frontal margin, and are separated from each other by an interspace about equal in width to one of the scars; while a narrow prominent ridge runs along the middle of the valve. The muscular depressions are also posteriorly divided by a transverse ridge; and a prominent raised border surrounds the whole muscular space (figs. 16, 17). The internal surface of the ventral valve (not occupied by the muscular depressions) is also very rugose (fig. 18). Two specimens measured—

Length 9, width 10, depth 1 line.
„ 10, „ 6, „ 1 „

Obs. In 1846 Prof. M'Coy described and figured an incomplete ventral valve (a cast) of this shell under the designation of *Producta tenuicincta,* mistaking the rugosities for "a few scattered, lengthened spine-bases." I saw the original specimen in the collection of Sir R. Griffith, and was able to ascertain that it belonged to a *Leptæna;* and for this the original designation of *tenuicincta* will require to be retained. Prof. M'Coy (in 1846) did not omit to observe and figure the fine close concentric striæ with which the surfaces of the valves (when perfect) are ornamented. I am consequently at a loss to understand why, while describing his *Leptæna tenuicincta,* at page 239 of the work on 'British Palæozoic Fossils,' he observes, "This beautiful species seems almost identical in size, shape, and marking, with the *Producta tenuicincta* (M'Coy) and *Leptæna ænigma* (Vern.), but has a very wide, distinctly marked, cardinal area"—which, I would add, cannot be seen in the original so-termed *Producta,* this part of the specimen being concealed by the matrix.

The shell is very variable in shape, as may be seen from the many examples figured in our plate, which have been carefully selected with that view. The interior is also very peculiar, but is rarely found, except in the condition of internal casts. In some rocks, such as the olive-coloured Caradoc Schists of Cynwyd, near Corwen, in Merionethshire, Mr. Parrott found casts of this species strangely distorted by cleavage; some examples having been so much lengthened as to present seventeen lines in length by only six in breadth; whilst in all probability the shell itself was originally not more than eight or nine lines in length at the utmost.

In external shape, as well as in the internal characters of the dorsal valve, *L. tenuicincta* bears a great resemblance to *Leptæna oblonga* of Russia (*Plectambonites ovata* and *oblonga*, Pander, 1830); but this last is stated by M. de Verneuil to be very finely and longitudinally striated, and not concentrically, as in the shell under description; but the Gothland *Lept. ænigma* (De Verneuil) so closely resembles *Lept. tenuicincta* that we have considered it synonymous.

Position and Locality. L. tenuicincta is stated in 'Siluria' to range through the Llandeilo and Caradoc series. From the Upper Llandeilo Prof. Ramsay and Salter obtained it at Fron-oleu, three miles east of Llangeful, in North Wales; and in the Caradoc south of Cerrig-y-Druidion, in Denbighshire; Llanfyllin and Meifod, Montgomeryshire; west and north of Bala Lake (especially Rhiwlas), in Merionethshire. Prof. M'Coy quotes it from olive Bala Schists at Cefn Grugos, west of Llanfyllin, Montgomeryshire. I have seen it also from Lledfron and Rhosfawr, near Llanfyllin; Sholes Hook, Haverfordwest; and Keisley, in Westmoreland.

In Scotland it occurs at Penwhapple-glen, Knockgerran, and several other localities near Girvan, in Ayrshire.

In Ireland at the Chair of Kildare. At Tyrone very fine internal casts of the dorsal valve were found by Mr. Wyatt-Edgell, and of these figures will be found in our plate.

LEPTÆNA (?) LÆVIGATA, *Sow.* Pl. XLIX, figs. 1—12.

LEPTÆNA LÆVIGATA, *J. de C. Sow.* Sil. Syst., pl. xiii, fig. 3, 1839.
— — *Dav.* London Geol. Journ., vol. i, p. 59, pl. xii, fig. 30, 1847.
— LEPISMA, var. MINOR, *Phillips* and *Salter.* Mem. Geol. Surv., vol. ii, p. 284, pl. xxvi, figs. 3, 4, 1848.
— LÆVIGATA, *M'Coy.* Brit. Pal. Foss., p. 235, 1852.
— — *Salter.* Siluria, 3rd ed., pl. xx, fig. 15, 1859.

Spec. Char. Shell small, semicircular, widest at the hinge-line, cardinal extremities prolonged into acute-angled mucronate wings. Ventral valve very gently convex or flattened posteriorly, most convex at the beak and near the margin. Area narrow; fissure arched over with a pseudo-deltidium; beak scarcely projecting, with sometimes a minute circular foramen close to its extremity. Dorsal valve slightly concave, following the curves of the opposite valve; hinge-area linear. Surface almost smooth, shining, obscurely marked with a few radiating striæ and concentric lines of growth. Interior details imperfectly known. In the interior of the dorsal valve the deviating brachial (?) laminæ are small; the muscular scars are divided along the middle by a narrow rounded ridge, which extends to about half the length of the valve.

Length 4, width 7, depth ½ a line; but the shell is usually found with smaller dimensions.

Obs. In 1839 Mr. J. de C. Sowerby described, under the designation of *Leptæna lævigata* (' Sil. Syst.,' pl. xiii, fig. 3), one valve of a small *Leptæna* " with projecting angular ears at the extremities of the hinge-line; surface shining, obscurely radiated with minute concentric waves and a few radiating lines: Wenlock Shale, Burrington, near Ludlow." Again, at p. 618, pl. viii, of the same work, he describes, under the name of *Leptæna lepisma,* Dalm. (?), another small, semicircular, smooth species, with hinge-line equal to or rather less than the width of the shell. In 1848 Messrs. Phillips and Salter seem to have erroneously described and figured the first-named species under the designation of *L. lepisma;* and this mistake is noticed by Prof. M'Coy in the following manner:—" The figures given in the ' Memoirs of the Geol. Survey,' as above quoted, under the name of *Leptæna lepisma* (Dal.), var. *minor,* with reference to pl. viii, fig. 7, of the ' Sil. Syst.,' certainly belongs to this species (*Leptæna lævigata*), in which the faint broad striæ are rarely to be found; and Mr. Salter mentions that he doubts the distinction himself of the *L. lævigata.* Further, I might mention that there seems to be no such species as *L. lepisma* described in any work of Dalman; and the specimen so-called by Sowerby I find agrees with Dudley specimens, which I have certainly determined to be the young of *L. transversalis,* on comparison with a number of Gothland species." Now, I agree with the first portion of M'Coy's observations, but quite dissent from the supposition that the so-termed *Leptæna lepisma* of the ' Silurian System' is a young example of *L. transversalis;* it does not even belong to the same genus, being, as will be seen further on, an almost entirely smooth species of *Chonetes.* In some examples of *Leptæna lævigata* the small circular foramen at the extremity of the beak is distinctly seen (fig. 4); but I am not sure that it is a *Leptæna,* and no good interiors have been hitherto discovered. The *Leptæna lævissima,* M'Coy (' Sil. Foss. Ireland,' p. 27, pl. iii, fig. 7), appears to me to be the same as the shell under description.

Position and Locality. Leptæna lævigata has been found in the Wenlock Shales of Burrington, Salop; in the Lower Ludlow of Clungunford, Shropshire; at Ledbury, &c. It is said also to occur at Builth. Several other localities are quoted by M'Coy, but, as there has been much confusion between the two forms above recorded, I mention those only of which I feel certain.

In Ireland it has been met with at Doonquin and Ferriter's Cove, Dingle, County Kerry.

LEPTÆNA (vel CHONETES ?) TENUISSIME-STRIATA, *M'Coy* (sp.). Pl. XLIX, figs. 20—22.

ORTHIS TENUISSIME-STRIATA, *M'Coy*. Sil. Foss. Ireland, pl. iii, fig. 20, 1846.
LEPTÆNA — (?) *Id.* Brit. Pal. Foss., p. 239, pl. i H, fig. 44, 1852.
— — *D'Eichwald.* Lethæa Rossica, vol. i, p. 871, 1859.

Spec. Char. "Semicircular; twice as wide as long; both valves flat; hinge as long as the shell is wide; cardinal angles slightly pointed; cardinal area narrow, with nearly parallel sides; striation of the surface scarcely visible to the naked eye, composed of extremely fine, equal, radiating striæ, slightly branching" (M'Coy).

Length 6, width 12 lines.

Obs. I know very little about this obscure so-called species, and consequently reproduce Prof. M'Coy's original description, as I am not certain that his second description and figures (p. 239, 'British Pal. Fossils') apply to the same species; and evidently he is not himself certain as to what his shell really is. In the last-named work the author observes that in form it strikingly resembles the *Leptæna* (*Chonetes*) *lata* of the Ludlow rocks; but is destitute of spines on the hinge-line, and is easily distinguished by the much greater fineness of the striæ, or the greater number in a given space; and that when the larger striæ can be distinctly seen, which is not often the case, the resemblance is very strong to *Leptæna sericea*, from which it differs in the flatter entering (dorsal) valve, in the finer and more equal striæ, without the larger striæ, and in the distinct, radiating, coarsely punctured lines of the interior, and the small size of the bilobed muscular impressions of the receiving (ventral) valve, in the form of which, however, there is some resemblance. I obtained from Sir R. Griffith the loan of Prof. M'Coy's original example (fig. 22). It looks like a *Chonetes*, and may possibly belong to that genus; but it is a crushed flattened impression, and I would by no means venture to express any decided opinion as to its specific value. I have reproduced Prof. M'Coy's description and figures, in the hope that better examples may be sought for in the original locality. Mr. Salter unites this species with *Orthis protensa* ('Mem. Geol. Surv.,' vol. ii, p. 289); but Prof. M'Coy objects to the identification on the grounds that the latter has vastly coarser and fasciculated striæ.

Position and Locality. Abundant in the Caradoc (?), slates of Slieve Roe, Rathdrum, County Wicklow, Ireland. In his work on 'British Pal. Foss.' Prof. M'Coy states that this shell occurs in several Welsh localities (Caradoc), such as Moel, Saesiog, Llanrwst, Denbighshire; the Bala Limestone of Llandeilo, Caermarthenshire, &c.; but, as stated above, I fear Prof. M'Coy has confounded two different species under his designation of *L. tenuissime-striata.*

Genus—CHONETES, *Fischer.*

(See 'General Introduction,' p. 113.)

No true species of *Productus* seems to have been hitherto discovered in the Silurian rocks, although several ill-understood and obscure specimens have been erroneously referred to it. The genus *Chonetes,* however, which forms part of the Family *Productidæ,* has been long known to occur in our Silurian strata. Although exteriorly *Chonetes* often assumes the shapes of *Leptæna,* it may be distinguished from it by its series of sloping tubular spines on the cardinal edge of the ventral valve, as well as by the shape of its muscular and reniform impressions. Only a very few species of the genus have been found in Silurian strata; it is much more abundant in those of the Devonian and Carboniferous periods.

CHONETES STRIATELLA, *Dalman* (sp.). Pl. XLIX, figs. 23—26.

Pectunculus planus flabelliformis, *Bruckmann.* Siles. Subterr., p. 338, pl. vii, fig. 6, 1720.
Pectunculite, *Walch.* Das Steinreich, p. 151, pl. xiv, No. 3, fig. infer., 1769.
Calcareus testaceus, *Brugman.* Lithologia Groningana, p. 13. pl. i, fig. 1, 1781.
ORTHIS STRIATELLA, *Dalman.* Kongl. Akad. Handl., p. 111, pl. i, fig. 5 *a, b, c, d,* 1827.
LEPTÆNA LATA, *Von Buch.* Abhandl. Akad. Wissens. Berlin, pp. 53 and 70, pl. iii, figs. 1, 3, 5—9, 14, 15, 1828.
ORTHIS STRIATELLA, *Klöden.* Verstein. Mark-Brandenburg, p. 179, 1834.
LEPTÆNA — *Id.* *Ibid.*, p. 181.
ORTHIS — *Hisinger.* Lethæa Suec., p. 70, pl. xx, fig. 7, 1837.
LEPTÆNA LATA, *J. de C. Sow.* Sil Syst., p. 160, pl. v, fig. 13 (non ibid., pl. iii, figs. 10 *b* and 12 *c*), 1839.
PRODUCTUS SARCINULATUS (partim), *Von Buch.* Abhandl. Akad. Wissens. Berlin, p. 25, (non ib., *T. sarcinulatus,* Schloth.), 1841.
LEPTÆNA SARCINULATA (partim), *D'Archiac* et *De Verneuil.* Geol. Trans. London, ser. 2, vol. vi, part ii, p. 397, 1841.
STROPHOMENA SERICEA (?), *Emmons.* Nat. Hist. New York; Geology, part ii, p. 394, pl. 105, fig. 1, 1842.

Leptæna vicina ?, *De Casteln.* Syst. Silur. de l'Amérique, Lept., p. 39, pl. xiv, fig. 9, 1843.

Chonetes sarcinulata (partim), *De Vern.* Geol. Russia, vol. ii, p. 242 (except fig.; *non* de Kon., *nec* de Keys.), 1845.

— — *Geinitz.* Grundriss Verstein., p. 517, pl. xxii, fig. 11, 1846.

Leptæna lata, *M'Coy.* Sil. Foss. Ireland, p. 27, 1846.

Chonetes striatella, *De Koninck.* Monogr. Genre Chonetes, p. 200, pl. xx, fig, 5, 1847.

— — *Dav.* Bull. Soc. Géol. France, ser. 2, vol. v, p. 315, pl. iii, fig. 2, 1848.

Leptæna (Chonetes) sarcinulata, *Phillips* and *Salter* (non *Schlotheim*). Mem. Geol. Surv., vol. ii, p. 285, 1848.

— — lata, *M'Coy.* Brit. Pal. Foss., p. 249, 1852.

Chonetes striatella, *D'Eichwald.* Lethæa Rossica, vol. i, p. 878, 1859.

— — *Lindström.* Gotland's Brachiop., p. 374, 1866.

— — *Dav.* Pal. Mem. Geol. Soc. Glasgow, vol. i, p. 20, pl. iii, fig. 14, 1868.

Spec. Char. Transversely semicircular, widest at the hinge-line, with acutely angular extremities; sides rounded; front slightly convex. Ventral valve moderately convex, flattened at the ears; beak small, not projecting; area narrow; fissure small, arched over with a pseudo-deltidium. Dorsal valve concave, following the curves of the opposite valve; hinge-area narrow. Surface of both valves covered with numerous thread-like radii, which increase in number at variable distances from the beaks, both by bifurcation and by the interpolation of shorter ribs, so that from eighty to nearly one hundred may be counted round the edge of the shell of some individuals. There exists also along the cardinal edge of the ventral valve about eight slanting tubular spines, four on each side, which become longer and larger as they approach its extremities. In the interior of the dorsal valve a narrow ridge extends from under the cardinal process to about two thirds of the length of the shell. Muscular impressions feebly marked; the inner surface covered with numerous granulations, which become larger towards the margin of the shell.

Length 7, width 12, depth 1 line.

Obs. This species has been carefully studied by Prof. L. de Koninck, who gives an elaborate description in his 'Monograph of the Genus *Chonetes*.' He unhesitatingly refers Sowerby's or Von Buch's *Leptæna lata* to Dalman's *Orthis striatella,* and observes that the greater number of Palæontologists were led into error by a false appearance of similitude in the figures with which Dalman and Schlotheim represented their *Terebratulites sarcinulatus* and *Orthis striatella;* and that after a long and attentive examination he was able to convince himself that Schlotheim's *T. sarcinulatus* ('Petrefakten-Kunde,' p. 29, fig. 3, 1820) is an exclusively Devonian species, differing from *Ch. striatella* in its smaller number of ribs. The shell alluded to by M'Coy as *Leptæna semiradiata,* Sow., at p. 27 of the 'Silurian Fossils of Ireland,' belongs likewise to *Ch. striatella.*

Good interiors of this species are much required, and may turn up with further search.

Position and Locality. *Chonetes striatella* is stated in 'Siluria' to occur in the Llandovery (?), Wenlock, and Ludlow formations. I know it from the last two only. In the *Woolhope Beds* it occurs east of Merchlin, Conway. In the *Wenlock Beds* at Hay-head, near Walsall; Burton and Brocton, near Wenlock, &c. In the *Lower Ludlow* at Vinnal Hill; Cefn Ila. In the *Aymestry Limestone* at Llangibby; Shucknall Hill, &c. In the *Upper Ludlow* it is especially abundant, in a great number of localities, such as Horeb Castle and Ludlow, Pont-ar-y-Llechan, Llangadoc; north-east of Pillard's Barn, Woolhope; Barrel Hill, Woodbury Hill; Overley, Brock Hill, &c., in the Malvern district; Ankerdine Hill in the Abberley district; in several places in the Usk district, as well as in that of Builth. North end of Potter's Fell and Underbarrow, Kendal, Westmoreland.

In Scotland it occurs in the Pentland Hills; in Ireland at Ferriter's Cove, Dingle, &c.

Abroad it is not rare in the Island of Gothland; it is found at Klinka, in Scania; at Malmokalven and Steensfiord, in Norway; also in Esthonia and some other Russian localities; in North America, &c.

CHONETES LEPISMA, *Sow.* (not *Dalman*) (sp.). Pl. XLIX, figs. 13, 14.

LEPTÆNA LEPISMA, *J. de C. Sow.* (not *Dalman*). Sil. Syst., p. 618, pl. viii, fig. 7, 1839.
CHONETES LÆVIGATA, *Etheridge.* Catal. Foss. Mus. Pract. Geol., p. 46, 1865.

Spec. Char. Shell small, semicircular, wider than long. Hinge-line slightly shorter than the width of the shell; cardinal extremities obtusely rounded; ventral valve evenly convex; sides and front rounded; beak small, not projecting; area narrow; fissure small. Dorsal valve concave, following the curves of the opposite valve; hinge-area linear. Surface smooth, glistening, and marked by a few fine concentric lines of growth. Along the cardinal edge of the ventral valve rise six slanting tubular spines, three on each side, which become longer as they approach its extremities. Interior not known.

Length 4, width 5, depth $\frac{1}{2}$ a line.

Obs. While describing *Leptæna lævigata,* I pointed out the differences and respective claims of the two species. In Sowerby's original specimen (fig. 14) the cardinal spines are not preserved; but whole blocks of a light-yellow limestone at Malvern are covered with specimens of this small shell, many of which have still their cardinal spines (fig. 13); and of these examples may be seen in the Museum of Practical Geology. *Leptæna margaritacea* of Angelin, from Gothland, is in all probability the same as the shell under notice. During a visit to London, Dr. Lindström recognised in the Museum of Practical Geology British specimens agreeing with Angelin's shell, labelled "*Chonetes lævigata* or *lepisma*, Sow."

I regret that no interiors should have yet turned up; but the row of spines on the cardinal edge is sufficient to denote that the place of this shell is with *Chonetes*. Both Sowerby's and Angelin's specimens are also remarkable on account of their glistening or nacreous surface. *Chonetes lepisma*, Sow., sp., bears some resemblance to the Carboniferous *Chonetes polita*, M'Coy (see my 'Carb. Mon.,' p. 190, pl. xlvii, figs. 8, 11); but in the latter the beak is more projecting, the hinge-line longer, and the ventral valve more convex or keeled along the middle.

Position and Locality. This species occurs in the *Lower Ludlow* rock at Garden House Quarry, Aymestry, from which locality Murchison's original example (in the Museum of the Geological Society) was obtained. It is found also in the *Aymestry Limestone* at Malvern.

Abroad it has been collected by Prof. Angelin and Dr. Lindström in the Island of Gothland.

CHONETES (?) MINIMA, *Sow.* (sp.) Pl. XLIX, figs. 15—19.

LEPTÆNA MINIMA, *J. de C. Sow.* Sil. Syst. pl. xiii, figs. 4, 4 *a*, 1839.
— — *Dav.* London Geol. Journ., vol. i, p. 59, pl. xii, fig. 29, 1847.
— GRAYII, *Id.* Bul. Soc. Géol. France, ser. 2, vol. vi, p. 271, fig. 1, 1849.
— ? MINIMA, *M'Coy.* Brit. Pal. Foss., p. 235, 1852.
— — *Salter.* 'Siluria,' 2nd ed., pl. xx, fig. 16, 1859.
— GRAYII, *Etheridge.* Catal. Coll. Foss. Mus. Pract. Geol., p. 41, 1865.

Spec. Char. Shell minute, semicircular, wider than long, hinge-line nearly or quite as long as the width of the shell; cardinal extremities acutely or obtusely angular. Ventral valve moderately convex, flattened at the ears; area triangular, moderately wide; fissure small, arched over by a pseudo-deltidium; beak not projecting. Dorsal valve slightly concave, flattened near its cardinal extremities; hinge-area very narrow. Surface of both valves marked with from ten to twenty principal prominent radii, with a wide interspace and a median shorter and smaller riblet between each pair. The radii are rather irregular, some being larger and closer than others. Interior not well known; in the dorsal valve the muscular impressions are scarcely visible on either side of a slightly projecting mesial ridge. The inner surface is also marked by numerous rather large and projecting tubercles.

Length of a large specimen 2, width $2\frac{1}{2}$, depth $\frac{1}{5}$th line; the shell is usually smaller.

Obs. This small species was in 1839 so briefly described by Mr. J. de C. Sowerby, from an incomplete ventral valve, that I did not recognise by it the perfect examples obtained in 1847 by Mr. Gray near Dudley. I was therefore unfortunately induced to redescribe (with full illustrations) the species under the designation of *Leptæna Grayii;* and indeed I am not yet perfectly convinced that the last is not a well-marked variety of *Ch. minima,* in which the ribs are less numerous and the shell much smaller. For instance, in the typical example of *Ch. minima* (Ludlow) there are from twenty-five to twenty-six principal ribs, whilst in the var. *Grayii* (Wenlock) there are, upon an average, not more than from twelve to sixteen. *Ch. minima,* is also a larger shell, and is much more concavo-convex.

Position and Locality. This small shell is stated to occur in the Upper Llandovery (at Llangadock) and in the Wenlock and Ludlow formations.

In the *Wenlock Shales* it is not very rare at Burrington, near Dudley; at Bryn-mawr, Mynydd Tryfan; Capel-y-rhiw, &c.

In the Woodwardian Museum, Cambridge, are specimens from Llanfair, Welshpool, and Tynewydd Myddfoi; also from calcareous flags, bed of the Dee, Llansilio, south of Llangollen.

In the *Lower Ludlow* at Elton Lane and Vinnal Hill, Ludlow, &c.

I do not know of any foreign locality. The shell so named, from Bohemia, by M. Barrande, does not belong to Sowerby's species.

APPENDIX.[1]

Genus—Lingulella, *Salter*.

At page 55 of my 'Silurian Monograph' will be found a full description of this genus, so far as we are acquainted with its internal characters.

Lingulella ferruginea, *Salter*. Pl. XLIX, figs. 32—35.

Lingulella unguiculus, *Salter*. Report Brit. Assoc., 1865, p. 285, 1865.
— ferruginea et var. ovalis, *Salter*. Quart. Journ. Geol. Soc., vol. xxiii, p. 340, figs. 1—3, 1867.
— — — *Dav.* Geol. Mag., vol. v, p. 306, pl. xv, figs. 1—8, 1868.

Spec. Char. Shell small, ovate, oblong; widest about the middle; broadly rounded in front; sides nearly parallel for some distance; and the beak obtusely pointed. Valves very slightly convex, and marked with concentric lines of growth.

Length 3, width 2 lines.

Obs. This small species has been correctly described and illustrated by Mr. Salter; and is, as far as we are aware, the earliest Brachiopod hitherto discovered; for specimens (fig. 35) were found by Mr. Hicks at the middle and the very base of the purple and red rocks of Sedgwick's "Harlech group," which directly underlies the "Mænevian group," or Lowest Lingula-flags. The position is about 1200 feet lower in the series than the specimen described by Mr. Salter and Mr. Hicks in the 'Quart. Journ. Geological Society' (vol. xxiii). The shell does not appear to be scarce, but the beds are much cleaved, and their colour is not in any way favorable to the exhibition of the characters of so thin a shell.

After an attentive comparison of the single example of the variety *ovalis* with a number of specimens of *L. ferruginea* from the "Mænevian group," I was quite at a loss

[1] The larger portion of the contents of this Appendix was published in my paper "On the Earliest Forms of Brachiopoda."—'Geol. Mag.,' vol. v, pp. 303, &c., 1868.

to make out any distinctive features; and I found that Mr. Salter himself did not fail to observe that his variety is not to be distinguished from the other "except by the shape of the front edge, which is rounded off, and not squared at all." This last character, however, cannot be considered of any importance, for I have before me specimens of *L. ferruginea* of a similar size, which have the front quite as much rounded off as in the single example of the var. *ovalis*.

There can also be no doubt as to the shell termed *L. unguiculus* (in 1865) being the same species as *L. ferruginea* described in 1867. *L. ferruginea*, it is true, like most of its congeners, varies slightly in its shape in different examples; some having their front a little more rounded than others, and the posterior portion converging rather more in some individuals than in others.

Position and Locality. After a very close study of a number of specimens submitted to my examination by Messrs. Hicks and Belt, it appeared to me that the *Lingulella* under notice made its first appearance in the lowest beds of the Harlech period, and continued to live during the whole of the "Mænevian" or "Lower Llandeilo," and was very probably, if not certainly, still existing during the period of the deposition of the Middle and Upper Lingula-flags; for several examples much resembling Salter's species were met with by Mr. Belt in his "Dolgelly" and other divisions. This, however, must still remain an undecided question, for several specimens of *Lingulella lepis* can hardly be distinguished from *L. ferruginea;* and in this predicament we find the small specimen found by Mr. Hicks at Rhyw-felyn, near Mawddach, North Wales. *L. ferruginea* occurs in the "Mænevian" rocks of St. David's, South Wales; as well as at Camlan, Tafern Helig, Waterfall Valley, near Maentwrog, and several other places in North Wales; also in the Harlech Grits of Solva and St. David's.

Genus—Lingula.

(See 'General Introduction,' p. 134.)

Lingula petalon, *Hicks.* Pl. XLIX, fig. 30.

Lingula petalon (*Hicks*, MS.), *Dav.* Geol. Mag., vol. v, p. 308, pl. xv, fig. 16, 1868.

Spec. Char. Shell small; broadest about the middle, and then becoming rapidly and obtusely rounded. Valves much flattened, and marked by concentric lines of growth.

Length 5, width $4\frac{1}{2}$ lines.

Obs. Well authenticated species of *Lingula* do not appear to have been discovered lower down than the "Middle Lingula-flags," where the genus is represented by *L. squamosa,* a not well-determined species, it is true; while *L. pygmæa,* another uncertain species, has been found in the "Upper Lingula-flags." In the Arenig or Skiddaw Group we have *L. petalon;* but it is chiefly in the "Llandeilo flags" that the genus begins to be represented by such shells as *L. attenuata, L. brevis, L. granulata, L. Ramsayi,* and one or two others. In external shape *Lingula petalon* much resembles some small examples of *L. cuneata* and *L. attenuata;* but it is always smaller and shorter than either of those species.

Position and Locality. *Lingula petalon* was found for the first time, in 1864, by Mr. Hicks, in the Upper and Lower Arenig or Skiddaw Group, at Whitesand Bay, near St. David's, South Wales; and subsequently in the same formation at Ramsay Island and Tremanhire.

Genus—OBOLELLA, *Billings.*

In 1861 Mr. Billings proposed the genus *Obolella,* with the following diagnosis:—"Shell ovate, circular or subquadrate, convex or plano-convex. Ventral valve with a false area, which is sometimes minute, and usually grooved for the passage of the peduncle. Dorsal valve either with or without an area. Muscular impressions, in the ventral valve, four; one pair in front of the beak, near the middle, or in the upper half of the shell; the other pair situated one on each side near the cardinal edge. Shell calcareous; surface concentrically striated, sometimes with thin, expanded, lamellose ridges. In general form these shells resemble *Obolus,* but the arrangement of the muscular impressions is different. In *Obolus* the two central scars have their smaller extremities directed downwards, and converging towards each other; but in this genus the arrangement is exactly the reverse." Such is Mr. Billings' diagnosis, but I fear it will require some little modification in its details if it is to comprise *O. chromatica* (the type), *O.* (?) *polita, O. desiderata, O. sagittalis, O. maculata, O.* (?) *Salteri,* and several other species. Unfortunately the American material in my possession is not sufficiently complete to enable me to determine the point in question; the internal cast of one of the valves of *O. desiderata* being the only interior I have been able to examine. The interior of *O. polita* will be found figured in 'The Sixteenth Annual Report of the Regents of the University of the State of New York, for 1863,' and some complete illustrations of both valves of *O. sagittalis* are here given. Drawings of these last having been sent to Mr. Billings, he wrote back—"Your figures show the great muscular scars of *Obolella,* but their proportions are quite different from those of *O. chromatica, O. desiderata,* and *O. polita.* In Hall's figures of *O. polita* the muscular scars agree with those of my species, as nearly as two forms of the same genus usually do; but the two anterior scars are vastly larger in proportion to the size of the shell than they are in *O. sagittalis.*" I cannot, however, find any hinge-area in the last-named shell, nor groove for the passage of a pedicle; this being visible only, so far as I can make out, in *O.* (?) *polita.*

Obolella sagittalis, *Salter.* Pl. L, figs. 1—14.

Obolella sagittalis, *Salter*, MS. Report Brit. Assoc. for 1865, p. 285, 1866.
Discina labiosa, *Id.* Ibid.
Obolella sagittalis, *Dav.* Geol. Mag., vol. v, p. 309, pl. xv, figs. 17—24, 1868.

Spec. Char. Shell small, rarely exceeding two and a half lines in length and in breadth; almost circular, rather broader anteriorly; front broadly rounded; beak in the dorsal valve somewhat obtusely pointed; posterior margin in the ventral valve nearly straight, or slightly indented in the middle. Valves convex, and more or less deeply marked by concentric lines of growth. In the interior of the dorsal valve two rather large, irregularly circular, projecting scars, see fig. 5 *a* (*a*), are situated close to the posterior margin, and are separated by a moderately elevated tongue-shaped ridge (*c*), which extends to about two thirds of the length of the valve, and on either side, at about half the length of the valve, are two smaller, oval, divaricating, slightly prominent scars (*b*). (In the cast these projections form corresponding depressions; but they vary considerably in their minor details, according to age and other conditions.) In the interior of the ventral valve (fig. 10 *a*), two oval and oblique scars (*a*), smaller than the corresponding ones in the opposite valve, and more widely separated, lie also close to the posterior margin. A little lower down, two rather larger, but very slightly marked scars (*b*) may be noticed; and between these four muscular impressions is a projecting Λ-shaped ridge, with its most elevated portion (*o*) in the middle and between the first-named scars. This leaves in the cast a deepish angular depression, which assumes, at first sight, some resemblance to an apicial foramen.

Obs. This well-marked species was named by Mr. Salter in 1865, but was not figured or described. It is tolerably abundant in the condition of internal casts, which are sometimes very sharply marked, so that I trust I have been able to define its internal characters in a sufficiently satisfactory manner. I was, moreover, able to demonstrate that the so-called *Discina labiosa* (figs. 2, 13, 14) had been established on the internal cast of the ventral valve of the species under description. This I ascertained beyond doubt—first, from finding the casts of both valves of *O. sagittalis* abundantly spread over the same slabs; secondly, from the casts agreeing exactly in their respective dimensions; and thirdly, from having, with the aid of gutta percha, taken moulds from these casts attributed to *D. labiosa*, it became evident that the hollow, supposed to be due to a foramen, was nothing more than the prominence in the interior of the shell, described as existing between the four muscular scars. Now, if we compare the interior of the dorsal valve with the corresponding one in *Crania,* we shall find in both the same large scars (*a*), which in that genus have been attributed to the divaricator muscle (Hancock), whilst those marked *b* have been produced by the occlusor or adductor muscle; and if the animal possessed anterior occlusors, they would, as in *Lingula,* occupy the sides of the projecting tongue-shaped ridge at the place marked *c*. Here, therefore, as in *Crania,* the divaricator scars are larger than the occlusor or adductor scars. In *Obolus* the scars *b* are larger than those marked *a;* and, in addition to these, on either of the lateral portions of the interior of the valve, are two other scars, not visible here. There is also a total absence of hinge-area, or groove for the passage of a peduncle, so constant in *Obolus.* Nor do we find any trace of that flattened internal margin which surrounds the valves in *Crania.* If we again compare the interior of the ventral valve with that of *Crania,* we shall in both cases refer the scars *a* to the divaricator, while the feebly marked ones (*b*) would be attributable to the occlusor.

Position and Locality. From the researches of Messrs. Hicks, Salter, and Belt, this remarkable and characteristic species appears to be moderately plentiful throughout nearly the whole of the "Mænevian Group," but it is still uncertain whether a minute, obscurely marked specimen found by Mr. Hicks in the upper portion of the Harlech Group, which underlies the "Mænevian," may not belong to the species under description. A still more minute shell, found tolerably abundantly by Mr. Belt in the Lower Tremadoc beds of Craig-y-dinas, in North Wales, if not totally distinct from the present species, at any rate constitutes a well-marked variety, or even species; and this we will provisionally retain under the distinctive denomination of *O. Belti.* *O. sagittalis* was obtained by Mr. Hicks for the first time at Porth-y-rhaw, and subsequently at Pen-y-pleidiau, and several other places near St. David's, South Wales. Also by Mr. Homfray in beds of the Mænevian formations at the Rheider Waterfall Valley and other places in North Wales. Mr. Belt obtained it also at Gwynfynydd, and in several other localities in the neighbourhood of Dolgelly, North Wales. A species, nearly approaching in its characters to *O. sagittalis,* was found by Mr. Baily at Bellewstown Hill, County Meath, Ireland; also at Balbriggan, County Dublin; but the specimens were two obscure for correct identification.

Obolella Belti, *Dav.* Pl. L, figs. 15—17.

Obolella Belti, *Dav.* Geol. Mag., vol. v, p. 310, pl. xv, figs. 25—27, 1868.

Spec. Char. Shell small, less than a line in length, by about one line in breadth; transversely oval; beak acuminated; front broadly rounded. Valves moderately convex, and marked by concentric lines of growth. The internal characters agree pretty closely with those described in *O. sagittalis.*

Position and Locality. The Lower Tremadoc beds, Craig-y-dinas, North Wales.

OBOLELLA MACULATA, *Hicks.* Pl. L, figs. 18—21.

OBOLELLA MACULATA, *Hicks,* MS. Report Brit. Assoc. for 1865, p. 285, 1866.
— — *Dav.* Geol. Mag., vol. v, p. 311, pl. xvi, figs. 1—3, 1868.

Spec. Char. Shell small, transversely oval; valves moderately convex; four lines in length, by five in breadth. Beak very obtusely acuminated; front broadly rounded; greatest breadth at about the middle of the shell; surface smooth, marked only by fine concentric lines of growth. Interior incompletely known.

Obs. It has unfortunately not been possible to offer a description of the internal characters of this interesting fossil. I have, however, attempted to draw what little was clearly observable in its interior. *O. maculata* differs considerably from *O. sagittalis* on account of its much larger dimensions and very transverse shape. The shell appears also to have been much thinner than that of the species last mentioned, and is often found very much flattened in the rock in which it is imbedded.

Position and Locality. Obolella maculata was found by Mr. Hicks chiefly in the middle portion of the 'Mænevian Group' at Porth-y-rhaw, St. David's. Mr. Belt obtained it from the "Lower Mænevian," at Camlan; also in the lower portion of the group at Gwynfynydd, North Wales.

Genus—OBOLUS, *D'Eichwald.*

(See 'General Introduction,' p. 135; and *suprà*, p. 61.)

OBOLUS (?) PLUMBEUS, *Salter* (sp.). Pl. L, figs. 23, 24.

OBOLELLA (?) PLUMBEA, *Salter. Vide suprà*, p. 61.

While describing the exterior of *Obolus* (?) *plumbeus* at p. 61, I felt uncertain as to the propriety of placing that species in *Obolella.* Since then, through the kindness of Mr. Morton, of Liverpool, I have been able to examine the interior of one of its valves (fig. 23); and this leads me to infer that the shell under notice is really more nearly related to *Obolus* than to *Obolella.*

Obolus plumbeus, var. plicata, *Hicks*. Pl. L, fig. 22.

After a lengthened study and comparison of a smaller form, sent to me by Mr. Hicks, with the designation of *Obolella plicata*, which occurs sparingly in the "Lower Arenig or Skiddaw Group" at Tremanhire and Ramsay Hand, near St. David's, in South Wales, I could not divest myself of the idea that this last was nothing more than a small variety of the typical form which occurs in the "Upper Arenig" or "Lower Llandeilo" rocks of North Wales. In external shape this variety "*plicata*," is somewhat transversely oval, obtusely acuminated posteriorly, broadly rounded anteriorly; the largest example I have been able to examine did not exceed four lines in length, by five in breadth. The valves are slightly convex, and marked by numerous fine, thread-like, radiating, bifurcating striæ. No sufficiently perfect interior having been discovered, I cannot attempt to describe its internal characters. I must also here observe that Mr. Hicks admits the possibility of his *Obolella plicata* being a small variety of *Obolus* (?) *plumbeus*.

Genus—Kutorgina, *Billings*, 1861.

The characters of this genus (?) have not yet been fully discovered or described; but the exterior of the shell presents some remarkable peculiarities.

Kutorgina cingulata, *Billings*. Pl. L, fig. 25.

Kutorgina cingulata, *Billings*.	Geol. Surv. Canada, Pal. Foss., vol. i, pp. 8, 9, 10, 1865.
Obolella (?) Phillipsii (*Holl*), *Dav.*	*Suprà*, p. 62, pl. iv, figs. 17—19, 1866.
Kutorgina cingulata (*Billings*), *Dav.*	Geol. Mag., vol. v, p. 312, pl. xvi, fig. 10, 1868.

When preparing the first portion of this 'Silurian Monograph,' I felt very uncertain as to the genus and species to which the so-termed *Obolella Phillipsii* should be referred. Since then, thanks to the kindness of Mr. Billings, I have been able to compare his Canadian type of *Kutorgina cingulata* with a similar-sized example of *Obolella Phillipsii* kindly presented to me by the Rev. W. S. Symonds. I was able to show these specimens to Dr. Holl, and he at once agreed with me that his *Ob. Phillipsii* and the American shell belonged to the same species. Neither, however, were at all referable to the genus *Obolella;* their long, straight, hinge-line precluding such a possibility. The term *Obolella*

Phillipsii must consequently be regarded as a synonym, Billings' name claiming priority of publication. Dr. Holl informs me that the Potsdam Sandstone and Shale, in which *K. cingulata* occurs, occupy, he thinks, as nearly as possible the position of our "Lingula beds," and all along the Apalachian chain, rest, like our Holybush Sandstone, unconformably on old metamorphic rocks, resembling precisely, and occupying the same position as, those of the Malverns. Dr. Holl suggests the upper portion of the Middle Lingula-flags as the stage at which *Kutorgina cingulata* occurs.

Genus—Acrotreta, *Kutorga*, 1848.

(See 'General Introduction,' p. 133.)

Acrotreta (?) Nicholsoni, *Dav.* Pl. XLIX, figs. 36—40.

Acrotreta (?) Nicholsoni, *Dav.* Geol. Mag., vol. v, p. 313, pl. xvi, figs. 14—16, 1868.

Spec. Char.—Shell small, about two lines in length, by about the same in breadth . almost circular ; rather wider and broadly rounded anteriorly, nearly straight posteriorly ; dorsal valve very slightly convex ; ventral valve conical ; apex subcentral and truncated by a minute circular foramen, situated at a little more than one third of the length of the valve. From the centre of the posterior margin a narrow groove or channel extends to the base of the foramen, while on either side a small, flattened, triangular space or false area (?) is limited by an indented line. Surface of both valves marked with numerous concentric lines of growth.

Obs. This is another of those minute and curious forms that have been discovered subsequent to the publication of the first portion of this 'Silurian Monograph.' Several examples of this interesting little species were sent to me in February, 1867, by Dr. H. A. Nicholson, their discoverer, with the designation of "*Siphonotreta micula*," but I soon perceived that they could not be identified with that genus or species; and, although I am by no means confident as to the propriety of placing this form in *Acrotreta*, this latter is the genus to which our Scottish shell under notice seems to bear the closest resemblance. One valve is nearly flat; the other conical, with a minute perforation at its apex, a longitudinal groove, and a "false area"—all being features (external) peculiar to the Russian genus. However, as we know nothing of the interior of *Acrotreta*, and very little of the Scottish shell, the true generic position of this species must be viewed as provisional.

Position and Locality. Acrotreta Nicholsoni occurs in black shales of the Upper Llandeilo (?) beds in Dobb's Linn, near Moffat, in Dumfriesshire; whilst *Siphonotreta micula* is found at Hart Fell, or Glenkiln Burn, near Moffat, in distinctly different rocks. *Siphonotreta micula* is, strictly speaking, a "Llandeilo flag" species; but Mr. Hicks believes he has found it, or another (undeterminable) allied form, in the upper portion of the "Arenig Group" at Whitesand Bay, St. David's, South Wales.

Genus—Discina, *Lamarck*, 1819.

(See 'General Introduction,' p. 126; and *suprà*, p. 63.)

Discina (Trematis) corona, *Salter*, MS. Pl. XLIX, figs. 43, 44.

Of this species there are two incomplete examples in the Cambridge Woodwardian Museum. The shell is not, however, sufficiently perfect to be described satisfactorily. It is nearly circular in outline. The upper or free valve is moderately convex or conical, with the apex at about one third the length of the shell from the margin. The outer surface is covered with close-set rows of small cells or sunken dots, about twelve rows near the margin occupying a breadth of two lines. The rows of dots radiate from the apex.

Length about 20 lines, by rather less in breadth.

Position and Locality. This shell occurs in Bala Shales at Dufton Pusgill, in Westmoreland. A search for better examples of this interesting species should be made.

Discina pileolus, *Hicks*. Pl. XLIX, figs. 41, 42.

Discina pileolus, *Hicks*, MS. Report Brit. Assoc. for 1865, p. 285, 1866.
— — *Dav.* Geol. Mag., vol. v, p. 312, pl. xvi, figs. 11—12, 1868.

Spec. Char. Shell very small, circular or slightly longitudinal oval, rather broader anteriorly; about two and a half lines in length and a little less in breadth. Dorsal valve conical; ventral valve slightly convex, depressed near the margin; vertex in both valves at a short distance from the centre, as also the foramen (?) in the ventral valve. Surface marked with concentric lines, which are more strongly marked in the ventral valve. Interior not known.

Obs. Mr. Salter was the first to detect the presence of this genus in the "Mænevian Group," and the species under notice subsequently received the designation of "*pileolus*," from Mr. Hicks. We have already stated that the so-termed *Discina labiosa* (Salter) was founded on the internal cast of the ventral valve of *Obolella sagittalis*.

Position and Locality. Discina pileolus was found by Mr. Hicks in the Middle beds (Sandstone) of the "Mænevian Group" at Porth-y-rhaw, Ninewells, and Solva Harbour, St. David's, where it is scarce and usually very imperfectly preserved. A minute *Discina* was found by Mr. Hicks in one of the yellowish-grey beds of the "Harlech Group," on the road leading from Solva to Whitechurch, St. David's; and, if it should turn out to be the same as the shell under description, which it resembles, it will be the oldest known form of the genus and one of the earliest Brachiopoda on record. *Discina pileolus* has also been found by Mr. Belt in the Mænevian stage at Camlan, in North Wales.

CONCLUSION.

I HAVE now described and illustrated all the British Silurian species of Brachiopoda of which I could procure examples; and, although the material kindly furnished to me from many public, as well as private, sources has been very great, it has unfortunately in many cases been insufficient to enable me to do as much justice to every part of the subject as could have been desired. No Palæontologist will, however, feel surprised at such a statement; nor could any one expect that the first attempt at a Monograph of so extensive a group of fossils as the one entrusted to my elaboration could be entirely successful, or that I could fully describe and illustrate a number of forms hitherto known by a few imperfect specimens or casts only, and these, in some cases, of only one of the valves. In order to be able to appreciate the real specific value of any form, a matter difficult under any circumstances, it is necessary to be provided with a sufficient number of specimens showing the modifications assumed by the exterior of both valves, as well as that presented at various stages of the animal's growth. The interior of both valves of the shell itself, or its representatives on sharply marked internal casts, is also absolutely necessary; and for a large proportion of our species such material has not yet been forthcoming. Hence with reference to these last we cannot correctly appreciate their specific claims. I have, nevertheless, been compelled, for reference-sake, to allow them to retain provisionally a distinctive designation. It is highly probable, I may say, if not quite certain, that, when better known, the two hundred and eight so-termed species of SILURIAN BRACHIOPODA described in this Monograph will require to be reduced in number; and I would earnestly entreat Geologists and collectors of fossils, who may be advantageously situated, to search for more satisfactory material relating to the imperfectly known species and varieties, of which they will find incomplete descriptions and illustrations in this Monograph.

I should desire them to look upon this, as well as upon the whole series of my Monographs, as a bold outline sketch, and not as a finished picture, and as still demanding much labour and research, from many experienced hands, before it can be regarded by the Scientific Public as in any way approaching to a complete work. That such may be accomplished with time, patience, and labour cannot be at all doubted. The material required exists, but is still hidden in the rock, and may be disclosed by the careful and discriminating use of the geological hammer. This should stimulate many a young Geologist to search for the missing links; and their efforts will surely result in some useful discovery, as well as in credit to themselves. The great object of the Palæontographical Society is to work out, in the most complete possible manner, every British fossil species; and the full elaboration of a single form is of more real value to Science than the imperfect knowledge of ten times that number of half-known and ill-described species. We cannot, however, pick and choose when we have to work out a series of fossils; we are obliged to do our best with the incomplete as well as with the perfect material at our command; and under these circumstances the student sees clearly where his work can be most advantageously directed.

In the accompanying Table, drawn up upon the same plan as that in 'Siluria,' I have carefully noted all the Silurian species and their several varieties, of which more or less complete descriptions and figures are given in this Monograph. There is likewise noted their duration in time, as far as such is known; but this part of the work must be considered imperfect and essentially provisional; the state of our knowledge on such matters not being sufficiently advanced to entitle us to assume any other conclusion.

The Table has been divided into eight columns only; as these represent the great divisions of the Silurian System in Great Britain. It would have been possible, no doubt, to have subdivided each of these columns into two, three, or more parts, to which local designations have been given by different Geologists; but, although we could in many cases have referred our species to one or more of these subdivisions, we are evidently not yet in such an advanced state as to be able to do so correctly for the entire group, and we should have felt at a loss in which of the minor subdivisions such and such a species should be placed. It is therefore, I think, preferable for the present not to attempt too much in a general Table, and to refer the student to the description of each species for any further detail that can be offered; and, indeed, in this (as already intimated) we have followed what has been done by Murchison and Salter for Siluria; and several other Geologists have adopted a similar process. In the last-named work the Table of Distribution is divided into seven columns; but we have made slight alterations in ours, namely, by adding a "Cambrian" column for the "Harlech Group," or "Upper Longmynd beds" of Murchison, which underlie the lowest division of the "Lingula-flags," and in which Mr. Hicks has recently discovered two species of Brachiopoda, these being the earliest forms of the group hitherto discovered in the British Isles. I have likewise devoted two columns to the "Llandovery period," as it has been proposed to limit the *Upper Silurian* at the base of the "Upper Llandovery" or "May Hill Sandstone," and to end the *Lower Silurian* with the "Lower Llandovery," commencing with the lowest division of the "Lingula-flags" (see pp. 30, 31). At the same time I entirely agree with what is stated in 'Siluria' by Sir Roderick Murchison and Mr. Salter, namely, that these two Llandovery divisions form but one natural-history division; and I would go still further, by asserting that, as far as the Brachiopoda are concerned, I can see but a single great natural-history division from the Longmynd or Harlech group to the uppermost bed of the Ludlow formation; and that the sequence of forms seems to me to be gradual, natural, and presenting no other difference than what would be expected to have taken place during so immensely extended a period as that which elapsed during the deposition of the Silurian strata.

Systems, indeed, are arbitrary combinations which may be, and undoubtedly are, necessary in the present state of our knowledge, but it is evident likewise that, as our geological and palæontological acquirements become more extended and more perfected, all arbitrary and provisional lines of demarcation will become gradually lessened in importance, just as many of those supposed distinctions between closely allied species very often vanish, and have to be relinquished, when we are able to inspect a large series of specimens.

The 210 "Silurian" forms enumerated in our Table are provisionally arranged into twenty-eight genera; but doubt or uncertainty may still be entertained whether some few of these are good, or whether, if good genera, the species we refer to them are really correctly placed, the material in our possession at present obliging us to assume more than we absolutely know. That, as well as many other difficulties, will consequently have to be cleared away with time and study before we can expect to arrive at an accurate knowledge of either the British or the foreign species; and all that can be expected from us at present is to do the best we can with the material at our command.

It will be seen from the Table that it was during the Caradoc and Wenlock periods that the Silurian Brachiopoda in Great Britain were specifically most abundant, and the condition of the sea most suited to their development. The number of species was also great during the Llandovery time; but it must always be borne in mind that these estimates are strictly provisional, and represent no more than the state of our present imperfect knowledge.

NOTE.

It is now time that this work, commenced in 1850, should come to a conclusion, and I may confidently assert that each Monograph was as complete as I could make it at the period of its publication. Science, however, is continually progressing; consequently fresh discoveries will demand the periodical publication of Supplements. It will, in the first instance, be preferable to revise the whole subject in a new work; and into this all fresh discoveries can be recorded, but without again describing or figuring what has been already sufficiently illustrated. If life and health be granted me for some few years to come, I may myself attempt this new labour. It is only, however, for the Introduction and the Cretaceous and Jurassic Monographs that supplementary matter has been principally accumulating; very little new, since the commencement of my researches, having been discovered among the Palæozoic forms, which compose fully two thirds of the entire work.

In conclusion, I once again tender my warmest thanks to the many friends and fellow-workers who have so materially assisted me in my labours during the last twenty years.

FINIS.

TABULAR VIEW OF BRITISH SILURIAN BRACHIOPODA.

Genus, Species, and Author.	Reference to page, plate, and figures, in this Monograph.	Ludlow.	Wenlock.	Upper Llandovery.	Lower Llandovery.	Caradoc or Bala.	Llandeilo.	Lingula-flags.	Cambrian.
LINGULA Lewisii, *Sow.*	p. 35, pl. iii, figs. 1—6	×	×						
— granulata, *Phillips*	p. 36, pl. ii, figs. 15—18	...	...	...	...	×	×		
— tenuigranulata, *M'Coy*	p. 37, pl. ii, figs. 9—14	...	...	...	...	×			
— ovata, *M'Coy*	p. 38, pl. ii, figs. 19—23	...	...	...	...	×			
— parallela, *Phillips*	p. 39, pl. ii, figs. 24—27	...	...	×					
— Rouaulti, *Salter*	p. 40, pl. i, figs. 14—20	...	...	...	...	...	× ?		
— crumena, *Phillips*	p. 40, pl. ii, figs. 1—6	...	...	×					
— squamosa, *Holl*	p. 41, pl. ii, fig. 7	...	...	...	...	...	...	×	
— Hawkei, *Rouault*	p. 41, pl. i, figs. 21—26	...	...	...	...	...	× ?		
— Lesueuri, *Rouault*	p. 42, pl. i, figs. 1—11	...	...	...	...	...	× ?		
— Bechei, *Salter*	p. 44, pl. i, figs. 12, 13	...	...	×					
— attenuata, *Sow.*	p. 44, pl. iii, figs. 18—27	...	...	...	...	?	×		
— striata, *Sow.*	p. 45, pl. iii, figs. 45—48	×	×						
— Symondsii, *Salter*	p. 45, pl. iii, figs. 7—17	×	×	×					
— cornea, *Sow.*	p. 46, pl. ii, figs. 28—35	×							
— minima, *J. de C. Sow.*	p. 48, pl. ii, figs. 36—44	×							
— Ramsayi, *Salter*	p. 49, pl. iii, figs. 49—52	...	...	...	...	...	×		
— lata, *Sow.*	p. 49, pl. iii, figs. 40—44	×							
— brevis, *Portlock*	p. 50, pl. iii, figs. 34—39	...	...	...	...	×			
— longissima, *Pander*	p. 51, pl. iii, figs, 28—30	...	...	...	...	×			
— obtusa, *Hall*	p. 52, pl. iii, fig. 31	...	...	...	...	...	×		
— curta, *Conrad*	p. 52, pl. iii, fig. 33	...	...	...	...	...	×		
— pygmæa, *Salter*	p. 53, pl. ii, fig. 8	...	...	...	...	...	...	×	
— Salteri, *Dav.*	p. 53, pl. i, figs. 27—29	...	...	...	...	...	× ?		
— petalon, *Hicks*	p. 337, pl. xlix, fig. 30	...	...	...	...	...	×		
LINGULELLA lepis, *Salter*	p. 54, pl. iii, figs. 54—58	...	...	...	...	...	?	×	
— ferruginea, *Salter*	p. 336, pl. xlix, figs. 32—35	...	...	...	...	...	...	×	×
— Davisii, *M'Coy*	p. 56, pl. iv, figs. 1—16	...	...	...	...	...	...	×	
OBOLUS Davidsoni, *Salter*	p. 58, pl. iv, figs. 30—39	...	×						
— — var. transversus, *Salter*	p. 59, pl. v, figs. 1—6	...	×						
— — var. Woodwardii, *Salter*	p. 60, pl. v, figs. 7, 8	...	×						
OBOLELLA (?) plumbea, *Salter*	p. 61 and p. 341, pl. iv, figs. 20—27; and pl. l, figs. 23, 24	...	...	...	...	...	×		
— var. plicata, *Hicks*	p. 342, pl. l, fig. 22	...	...	...	...	...	×		
— sagittalis, *Salter*	p. 339, pl. l, figs. 1—14	...	...	...	...	...	...	×	?
— var. Belti, *Dav.*	p. 340, pl. l, figs. 15—17	...	...	...	...	...	...	×	
— maculata, *Hicks*	p. 341, pl. l, figs. 18—21	...	...	...	...	...	...	×	
— (?) Salteri, *Holl*	p. 61, pl. iv, figs. 28, 29	...	...	...	...	...	×		
KUTORGINA cingulata, *Billings* (= Obolella Phillipsii, *Holl*, p. 62 of this Monograph)	p. 62 and p. 342, pl. iv, figs. 17—19; and pl. l, fig. 25	...	...	...	...	...	...	×	
ACROTRETA (?) Nicholsoni, *Dav.*	p. 343, pl. xlix, figs. 36—40	...	...	...	...	...	×		
DISCINA rugata, *Sow.*	p. 63, pl. v, figs. 9—18	×	×	×					
— perrugata, *M'Coy*	p. 65, pl. v, figs. 19—24	...	...	...	...	×			
— Morrisii, *Dav.*	p. 65, pl. vii, figs. 10—12	×	×						

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DISCINA oblongata, *Portlock*	p. 66, pl. vii, figs. 1—9	...	...	...	...	×			
— Vicaryi, *Dav.* (probably Devonian)	p. 67, pl. vii, fig. 13								
— striata, *Sow.*	p. 67, pl. vi, figs. 1—4	×							
— pileolus, *Hicks*	p. 344, pl. xlix, figs. 41, 42	...	...	...	...	...	...	×	×
— Verneuilii, *Dav.*	p. 68, pl. vi, fig. 5	...	×						
— crassa, *Hall*	p. 69, pl. vi, figs. 6, 7	...	...	...	...	×	×		
— (Trematis) punctata, *Sow.*	p. 69, pl. vi, fig. 9	...	...	...	...	×			
— — Siluriana, *Dav.*	p. 71, pl. vi, fig. 8	...	...	...	...	×			
— — corona, *Salter*	p. 344, pl. xlix, figs. 43, 44	...	...	...	...	×			
ORBICULOIDEA Forbesii, *Dav.*	p. 73, pl. vii, figs. 14—18	...	×						
— Beckettiana, *Dav.*	p. 75, pl. vii, fig. 19	...	×						
SIPHONOTRETA Anglica, *Morris*	p. 75, pl. viii, fig. 1	...	×						
— micula, *M'Coy*	p. 76, pl. viii, figs. 2—6	...	...	...	...	...	×		
CRANIA divaricata, *M'Coy*	p. 78, pl. viii, figs. 7—12	...	...	...	...	×			
— implicata, *Sow.*	p. 80, pl. viii, figs. 13—18	×	×	×					
— Siluriana, *Dav.*	p. 82, pl. viii, figs. 19, 20	...	×						
— (?) Grayi, *Dav.*	p. 82, pl. viii, figs. 22—24	...	×						
SPIRIFERA plicatella, *Linn.*	p. 84, pl. ix, figs. 9—12	×	×						
— — var. radiata, *Sow.*	p. 87, pl. ix, figs. 1—6	×	×	...	?				
— — var. globosa, *Salter*	p. 89, pl. ix, figs. 7, 8	...	×						
— bijugosa, *M'Coy*	p. 89, pl. x, figs. 1—3	...	×						
— sulcata, *Hisinger*	p. 91, pl. x, figs. 4—6	...	×						
— elevata, *Dalm.*	p. 95, pl. x, figs. 1—11	×	×	×					
— crispa, *His*	p. 97, pl. x, figs. 13—15	×	×	×					
— (Cyrtia) exporrecta, *Wahl.*	p. 99, pl. ix, figs. 13—24	×	×	×	× ?				
— (Cyrtia?) nasuta, *Lindström*	p. 201, pl. xxv, figs. 1, 2	...	×						
NUCLEOSPIRA pisum, *Sow.*	p. 106, pl. x, figs. 16—20	...	×						
MERISTELLA tumida, *Dal.*	p. 109, pl. xi, figs. 1—13	×	×						
— angustifrons, *M'Coy*	p. 111, pl. x, figs. 21—27	...	...	...	×				
— didyma, *Dal.*	p. 112, pl. xii, figs. 1—10	×	×	×					
— nitida, *Hall*	p. 114, pl. x, figs. 28—32	...	×						
— Circe, *Barrande*	p. 116, pl. x, figs. 33—35	...	×						
— (?) Maclareni, *Haswell*	p. 116, pl. xii, fig. 20	...	×						
— (?) crassa, *J. de C. Sow.*	p. 117, pl. xiii, figs. 1—3	...	...	×	×				
— (?) furcata, *Sow.*	p. 119, pl. xiii, figs. 7—9	...	...	×					
— (?) subundata, *M'Coy*	p. 120, pl. xiii, fig. 4	...	...	...	×				
MERISTA (?) cymbula, *Dav.*	p. 204, pl. xxii, figs. 28, 29	...	...	...	...	×			
ATHYRIS obovata, *Sow.*	p. 121, pl. xii, fig. 19; and pl. xiii, fig. 5	×							
— compressa, *Sow.*	p. 122, pl. xii, figs. 16—18	...	×						
— (?)depressa, *Sow.*	p. 123, pl. xii, figs. 11—15; and pl. xiii, fig. 6.	...	×						
RETZIA Salteri, *Dav.*	p. 125, pl. xii, figs. 21, 22	...	×						
— var. Baylei, *Dav.*	p. 125, pl. xii, figs. 23—25, and 27	...	×						
— var. (?) Bouchardii, *Dav.*	p. 127, pl. xii, figs. 26, 28, & 30	...	×						
— Barrandii, *Dav.*	p. 128, pl. xiii, figs. 10—13	...	×						

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ATRYPA reticularis, *Linné*	p. 129, pl. xiv, figs. 1—22	×	×	×	×				
— marginalis, *Dal*	p. 133, pl. xv, figs. 1, 2	...	×	×	×	×			
— imbricata, *Sow.*	p. 135, pl. xv, figs. 3—8	...	×	×	×	×			
— (?) hemisphærica, *Sow.*	p. 136, pl. xiii, figs. 23—30	...	...	×	×				
— (?) Scotica, *M'Coy*	p. 140, pl. xiii, fig. 31	...	...	...	×				
— (?) Grayii, *Dav.*	p. 141, pl. xiii, figs. 14—22	...	×						
— (?) apiculata, *Salter*	p. 202, pl. xxv, fig. 6	...	...	...	...	×			
— (?) incerta, *Dav.*	p. 203, pl. xxiv, fig. 30; and pl. xxv, figs. 7, 8	...	...	×					
PENTAMERUS galeatus, *Dal*	p. 145, pl. xv, figs. 13—23	×	×						
— Knightii, *Sow.*	p. 142, pl. xvi, figs. 1—3; pl. xvii, figs. 1—10; pl. xix, fig. 3	×	×						
— linguifer, *Sow.*	p. 149, pl. xvii, figs. 11—14	...	×	× ?					
— rotundus, *Sow.*	p. 150, pl. xv, figs. 9—12	...	×	?					
— oblongus, *Sow.*	p. 151, pl. xviii, figs. 1—12; pl. xix, figs. 1, 2	...	...	×	×				
— undatus, *Sow.*	p. 155, pl. xix, figs. 4—9	...	?	×	×				
— globosus, *Sow.*	p. 156, pl. xix, figs. 10—12	...	...	×	×				
STRICKLANDINIA lirata, *Sow*	p. 159, pl. xx, figs. 1—13	...	×	×	×				
— lens, *Sow.*	p. 161, pl. xix, figs. 13—23	...	...	×	×				
RHYNCHONELLA cuneata, *Dal.*	p. 164, pl. xxi, figs. 7—11	...	×						
— Stricklandii, *Sow*	p. 166, pl. xxi, figs. 1—6, and 28	...	×						
— Wilsoni, *Sow.*	p. 167, pl. xxiii, figs. 1—9	×	×						
— — var. Davidsoni, *M'Coy*	p. 172, pl. xxiii, figs. 11—14	×	×						
— — var. sphæroidalis, *M'Coy*	p. 173, pl. xxiii, fig. 10	...	×						
— nasuta, *M'Coy*	p. 173, pl. xxiii, fig. 19	...	...	...	...	×			
— borealis, *Schl.*	p. 174, pl. xxi, figs. 14—27	×	×	×	×				
— decemplicata, *Sow.*	p. 177, pl. xxiii, figs. 20—24	...	?	×					
— deflexa, *Sow.*	p. 178, pl. xxii, figs. 24—27	...	×						
— Lewisii, *Dav*	p. 180, pl. xxiii, figs. 25—28	...	×	× ?					
— nucula, *Sow*	p. 181, pl. xxiv, figs. 1—7	×	×	×	× ?				
— Llandoveriana, *Dav*	p. 184, pl. xxiv, figs. 8—13	...	...	×	×				
— Weaveri, *Salter*	p. 185, pl. xxiv, fig. 14	...	...	×					
— tripartita, *Sow*	p. 185, pl. xxiv, figs. 15, 16	...	...	...	×	×			
— Thomsoni, *Dav.*	p. 186, pl. xxiv, fig. 18	...	...	...	...				
— Pentlandica, *Haswell*	p. 187, pl. xxii, figs. 9—19	×							
— Salteri, *Dav*	p. 188, pl. xxiv, figs. 19, 20	...	...	...	...	×	×		
— (?) æmula, *Salter*	p. 188, pl. xxiv, fig. 21	...	...	...	...	×			
— (?) Beltiana, *Dav.*	p. 189, pl. xxiv, fig. 22	...	×						
— (?) Portlockiana, *Dav.*	p. 189, pl. xxiv, figs. 23—25	...	...	...	...	×			
— (?) Edgelliana, *Dav.*	p. 190, pl. xxiv, figs. 27, 28	...	...	...	...	...			
— (?) navicula, *Sow.*	p. 190, pl. xxii, figs. 20—23	×	×						
— (?) nana, *Salter*	p. 192, pl. xxiv, fig. 26	...	...	...	...	×			
EICHWALDIA (?) Capewelli, *Dav.*	p. 193, pl. xxv, figs. 12—15	...	×						
PORAMBONITES intercedens, *Pander*; var. filosa, *M'Coy*	p. 195, pl. xxv, figs. 16, 17—19 (?); pl. xxvi, figs. 1—3 (?)	...	...	...	...	×			

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TRIPLESIA Grayiæ, *Dav.*	p. 198, pl. xxiv, figs. 31, 32; and pl. xxv, figs. 9—11	...	...	...	...	×	×		
(?) Maccoyana, *Dav.*	p. 199, pl. xxiv, fig. 29	...	...	...	...	×			
— (?) monilifera, *M'Coy*	p. 200, pl. xxv, figs. 3—5	...	...	...	...	×			
ORTHIS biloba, *Linné*	p. 206, pl. xxvi, figs. 10—15	×	×	×	×	×			
— Lewisii, *Dav.*	p. 208, pl. xxvi, figs. 4—9	...	×						
— — var. Hughsii, *Dav.*	p. 254, pl. xxxviii, fig. 26	...	...	...	...	×			
— Bouchardii, *Dav.*	p. 209, pl. xxvi, figs. 16—23	...	×	?	?	× ?			
— elegantula, *Dalman*	p. 211, pl. xxvii, figs. 1—9; and woodcuts figs. 1, 2, p. 205	×	×	×	×	×	×		
— crassa, *Lindström*	p. 213, pl. xxvii, figs. 17—19	×	×						
— hybrida, *Sow.*	p. 214, pl. xxvii, figs. 15, 16	×	×	×	×	×			
— lunata, *Sow.*	p. 215, pl. xxviii, figs. 1—5	×							
— Girvaniensis, *Dav.*	p. 216, pl. xxviii, fig. 10	...	...	...	...	×			
— basalis (?), *Dalm.*	p. 217, pl. xxvii, figs. 10, 11	...	×						
— canaliculata, *Lindst.*	p. 218, pl. xxvii, figs. 12, 13	×							
— polygramma, *Sow.*, var. Pentlandica	p. 219, pl. xxix, figs. 1—10	...	×	?	?				
— reversa, *Salter*	p. 220, pl. xxix, figs. 11—13	...	...	...	× ?				
— — var. Mullockiensis, *Dav.*	p. 221, pl. xxix, figs. 14—18	...	?	×	×				
— fallax, *Salter*	p. 223, pl. xxxi, figs. 9—11	...	...	...	× ?	×			
— Bailyana, *Dav.*	p. 223, pl. xxix, figs. 19, 20	...	...	...	...	×			
— redux (?), *Barr.*	p. 224, pl. xxviii, figs. 6—9	...	...	...	...	× ?			
— testudinaria, *Dal.*	p. 226, pl. xxviii, figs. 13—24	...	...	...	×	×	×		
— Edgelliana, *Salter*	p. 228, pl. xxxii, figs. 1—4	...	×						
— Menapiæ, *Hicks*	p. 228, pl. xxxiii, figs. 8—12	...	...	...	...	...	×		
— Carausii, *Salter*	p. 229, pl. xxxiii, figs. 1—7	...	...	...	...	...	×		
— Hicksii, *Salter*	p. 230, pl. xxxiii, figs. 13—16	...	...	...	...	...	...	×	
— lenticularis (?), *Wahl.*	p. 230, pl. xxxiii, figs. 22—28	...	...	...	...	...	...	×	
— alata, *Sow.*	p. 232, pl. xxxiii, figs, 17—21	...	...	...	...	...	×		
— Berthoisi (?), *Rouault*, var. erratica, *Dav.*	p. 233, pl. xxxii, figs. 21—28	...	...	...	...	× ?			
— Valpyana, *Dav.*	p. 235, pl. xxxii, figs. 29—33	...	...	...	...	× ?			
— intercostata, *Portlock*	p. 236, pl. xxxviii, figs. 1—3	...	...	...	...	×			
— vespertilio, *Sow.*	p. 236, pl. xxx, figs. 11—21	...	...	...	×	×			
— rustica, *Sow.*	p. 238, pl. xxxiv, figs. 13—17	...	×						
— calligramma, *Dal.*	p. 240, pl. xxxv, figs. 1—17								
— — var. Davidsoni, *Vern.*	p. 240, pl. xxxv, figs. 18, 19								
— — var. Scotica, *M'Coy*	p. 240, pl. xxxv, figs. 20—22		×	×	×	×	?		
— — var. virgata, *Sow.*	p. 240, pl. xxxv, figs. 23, 24; and pl. xxxvii, fig. 2								
— plicata, *Sow.*	p. 245, pl. xxxv, figs. 25, 26; and pl. xxxvii, fig. 1	...	...	...	...	×			
— Sowerbyana, *Dav.*	p. 247, pl. xxxv, figs. 27—31	...	...	...	×	×			
— flabellulum, *Sow.*	p. 248, pl. xxxiv, figs. 1—12*a*	...	...	...	...	×			
— porcata, *M'Coy*	p. 250, pl. xxxi, figs. 12—20; and pl. xlvi, fig. 4	...	...	...	...	×			
— Actoniæ, *Sow.*	p. 252, pl. xxxvi, figs. 5—17	...	...	×	×	×	×		
— simplex, *M'Coy*	p. 255, pl. xxxii, figs. 10, 11	...	...	...	...	×			
— Salteri, *Dav.*	p. 255, pl. xxxvi, figs. 31—34	...	...	...	...	×			
— crispa, *M'Coy*	p. 256, pl. xxxviii, figs. 5—10	...	...	...	×	×			
— unguis, *Sow.*	p. 257, pl. xxxvii, figs. 16—22	...	...	...	...	×			
— protensa, *Sow.*	p. 257, pl. xxxvi, figs. 24—30	...	...	×	×	?			
— turgida, *M'Coy*	p. 258, pl. xxxii, figs. 12—20	...	...	...	×	×	×		

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ORTHIS sagittifera, *M'Coy*	p. 260, pl. xxxvi, figs. 18—23	...	...	...	×	×			
— (?) Hirmantensis, *M'Coy*	p. 261, pl. xxxii, figs. 5—9	...	...	...	...	×			
— sarmentosa, *M'Coy*	p. 262, pl. xxxvi, figs. 35—38	...	...	...	...	×			
— æquivalvis, *Dav.*	p. 263, pl. xxx, figs. 9, 10	...	×						
— alternata, *Sow.*	p. 264, pl. xxxi, figs. 1—8	...	...	...	...	×			
— var. retrorsistria, *M'Coy*	p. 265, pl. xxxvi, figs. 39—42	...	...	...	...	×			
— confinis, *Salter*	p. 266, pl. xxxvi, figs. 1—4	...	...	?	?	×	× ?		
— patera, *Salter*	p. 267, pl. xxx, figs. 1—8	...	...	...	?	×			
— biforata, *Schloth*	p. 268, pl. xxxviii, figs. 11—25	...	×	×	×	×	× ?		
— (?) insularis, *Eichw.*	p. 273, pl. xxxvii, figs. 8—15	...	...	×	×	×	×		
— (?) spiriferoides, *M'Coy*	p. 275, pl. xxxvii, figs. 3—7	...	...	...	...	×	×		
— tricenaria (?), *Conrad* (?)	p. 276, pl. xxxviii, fig. 28	...	...	...	...	×			
ORTHISINA adscendens, *Pander*	p. 278, pl. xlix, figs. 27—29	...	...	...	×				
STROPHOMENA rhomboidalis, *Wilckens*	p. 281, pl. xxxix, figs. 1—21; pl. xliv, fig. 1	×	×	×	×	×			
— ungula, *M'Coy*	p. 285, pl. xlii, figs. 20, 21	...	...	...	...	×			
— imbrex, *Pand.*, var. semi-globosa, *Dav.*	p. 286, pl. xli, figs. 1—6	...	×	?	?	× ?			
— euglypha, *His.*	p. 288, pl. xl, figs. 1—5	×	×	×					
— Walmstedti, *Lindst.*	p. 290, pl. xl, figs. 6—8	...	×						
— funiculata, *M'Coy*	p. 290, pl. xl, figs. 9—13	...	×	?					
— Dayi, *Dav.*	p. 292, pl. xli, fig. 7	...	×						
— deltoidea, *Conrad*	p. 292, pl. xlii, figs. 1—5; and pl. xxxix, fig. 22	...	...	...	...	×			
— — var. undata, *M'Coy*	p. 295, pl. xxxix, figs. 23, 24	...	...	...	...	×			
— Jukesii, *Dav.*	p. 296, pl. xxxvii, figs. 23—26	...	...	...	...	×			
— arenacea, *Salter*	p. 296, pl. xlii, figs. 6—8	...	...	×					
— simulans, *M'Coy*	p. 297, pl. xlii, figs. 9, 10	...	...	?	...	×			
— (?) retroflexa, *Salter*	p. 298, pl. xlii, figs. 15—17	...	...	...	...	×			
— antiquata, *Sow.*	p. 299, pl. xliv, figs. 2—13, 21, 22	...	×	×	?	?			
— corrugatella, *Dav.*	p. 301, pl. xli, figs. 8—14	...	...	...	...	×	×		
— Holli, *Dav.*	p. 303, pl. xlii, figs. 18—19	...	...	...	... ?	×			
— Siluriana, *Dav.*	p. 303, pl. xlvii, figs 1—4	...	...	...	×	× ?			
— pecten, *Linné*	p. 304, pl. xliii, figs. 1—11	...	×	×	?	?			
— Orbignyi, *Dav*	p. 306, pl. xlii, figs. 12—14	...	×						
— filosa, *Sow.*	p. 307, pl. xliv, figs. 14—20	×	×						
— applanata, *Salter*	p. 308, pl. xliii, figs. 12—14	...	×						
— ornatella, *Salter*	p. 309, pl. xliii, figs. 16—20	×							
— Waltoni, *Dav.*	p. 310, pl. xlii, fig. 11	...	×						
— Hendersoni, *Dav*	p. 311, pl. xliii, fig. 15	...	×						
— grandis, *Sow.*	p. 311, pl. xlvi, figs. 1—3, and 5, 6	...	...	...	...	×			
— expansa, *Sow.*	p. 312, pl. xlv, figs. 1—10	...	...	...	×	×			
— compressa, *Sow.*	p. 315, pl. xlvi, figs. 7—9	...	...	×	?	×			
— — var. Llandeiloensis, *Dav.*	p. 316, pl. xlvi, figs. 11—14	...	...	...	...	...	×		
— Fletcheri, *Dav*	p. 317, pl. xlvii, figs. 5, 6	...	×						
LEPTÆNA transversalis, *Wahl.*	p. 318, pl. xlviii, figs. 1—9	...	×	×	×	×			
— — var. Youngiana, *Dav.*	p. 320, pl. xlvii, figs. 19, 20	...	...	...		×			
— segmentum, *Angelin*	p. 321, pl. xlviii, figs. 28—30	...	×						
— quinquecostata, *M'Coy*	p. 322, pl. xlviii, figs. 23—27	...	...	×	×	×			
— sericea, *Sow.*	p. 323, pl. xlviii, figs. 10—19	...	?	×	×	×	×		
— — var. rhombica, *M'Coy*	p. 325, pl. xlviii, figs. 20—22	...	...	...	...	×			

Genus, Species, and Author.	Reference to page, plate, and figures, in this Monograph.	Ludlow.	Wenlock.	Upper Llandovery.	Lower Llandovery.	Caradoc or Bala.	Llandeilo.	Lingula-flags.	Cambrian.
LEPTÆNA scissa, *Salter*	p. 325, pl. xlvii, figs. 21—25	...	...	×	×	×			
— tenuicincta, *M'Coy*	p. 326, pl. xlvii, figs. 7—18	...	...	...	?	×	×		
— lævigata, *Sow.*	p. 328, pl. xlix, figs. 1—12	×	×						
— (vel Chonetes ?) tenuissime-striata, *M'Coy*	p. 330, pl. xlix, figs. 20—22	...	...	...	...	×			
CHONETES striatella, *Dalm.*	p. 331, pl. xlix, figs. 23—26	×	×	× ?					
— lepisma, *Sow.*	p. 333, pl. xlix, figs. 13, 14	×							
— minima, *Sow.*	p. 334, pl. xlix, figs. 15—19	×	×	×					
		40	89	48	42	84	30	12	2

TOTAL—28 genera and 210 species; but these numbers are provisional, and only represent the present state of our information.

INDEX TO VOLUMES I, II, AND III,

COMPILED BY

THE REV. T. WILTSHIRE, M.A., F.G.S., &c.; HON. SEC. PAL. SOC.

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

CORRIGENDUM.

In Part V, on sheet 34*, there is an error of paging, the numbers 271, 272, 273, and 274, being twice repeated. Therefore at "Appendix to the Carboniferous Brachiopoda" add a * to the numbers on the pages 271, 272, 273, and 274, and change these into 271*, 272*, 273*, and 274.*

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PLATE XXXVIII.

SILURIAN SPECIES.

FIG.

1—4. *Orthis intercostata*, Portlock. Caradoc. 1. After the original figure in the 'Report Geol. Londonderry,' &c., pl. xxxvi, fig. 2. Desertcreat, Tyrone. 3. Another example from the same locality. 3 *a*. Enlarged. Both in the Museum of Practical Geology. 2. From Kelley, Pomeroy. Sir R. Griffith's Collection. 4. From Girvan, Ayrshire. Hunterian Museum, Glasgow.

5—10. „ *crispata*, M'Coy. 5 and 7. Caradoc; Tramore, Waterford. 6 and 8. Knockmahon, Waterford. 10. Interior of dorsal valve. Trongock, Meifod, near Welshpool. 9, 9 *a*. Lower Llandovery. Internal cast of the ventral valve, and external impression of the same valve; from a place a quarter of a mile south-east of Cwmrhydan, Wales.

11. „ *biforata*, Schlotheim. Wenlock Limestone, near Dudley.

12—14. „ „ Caradoc; Craighead Quarry, near Girvan, Ayrshire. 13. Dorsal valve, enlarged. 14. Another specimen from the same locality. Ventral valve, enlarged.

15—17. „ „ var. *fissicostata*, M'Coy. Caradoc. 15, 16. From the Chair of Kildare. Museum of the Geol. Survey of Ireland. 17. From Ketchbridge, near Llanfyllin.

18. „ „ var. (*Spirifer terebratuliformis*, M'Coy, 'Sil. Foss. Ireland,' pl. iii, fig. 26.)

19. „ „ var. *fissicostata*. Caradoc; Cwm Gwenan-Uchaf, Llanfyllin. Mus. Pract. Geol.

20. „ „ Internal cast of ventral valve. Woolhope beds; Bogmine, Shelve. Mus. Pract. Geol.

21. „ „ Interior of the ventral valve, enlarged from the cast fig. 20.

22. „ „ Internal cast (enlarged) of the dorsal valve. Caradoc; Grangegeeth, County Meath. Mus. Geol. Survey.

23. „ „ Interior of the dorsal valve, enlarged. Caradoc; Pentrefflymru.

24. „ „ Internal cast of the dorsal valve. Woolhope beds; Bogmine, Shelve. Mus. Pract. Geol.

25. „ „ = "*Spirifer tridens*," M'Coy, 'Sil. Foss. Ireland,' pl. iii, fig. 27.

26. „ *Lewisii* (?), var. *Hughsii*, Dav. 26 *a*, *b*. Enlarged. Coniston Grit; Helmside, Dent.

27. „ *triangularis*, Sow. 27 *a*. Enlarged, after the original specimen, 'Sil. Syst.,' pl. v, fig. 13. Marrington Dingle, Cherbury (an undetermined cast, see page 277).

28. „ *tricenaria*, Conrad (?). 28 *a*. Enlarged. Piedmont Glen, Ayrshire. Mus. Geol. Survey.

29, 30. „ *productoides*, M'Coy (an obscure species, see page 277). Knockmahon, Tramore, County Waterford. Sir R. Griffith's Collection.

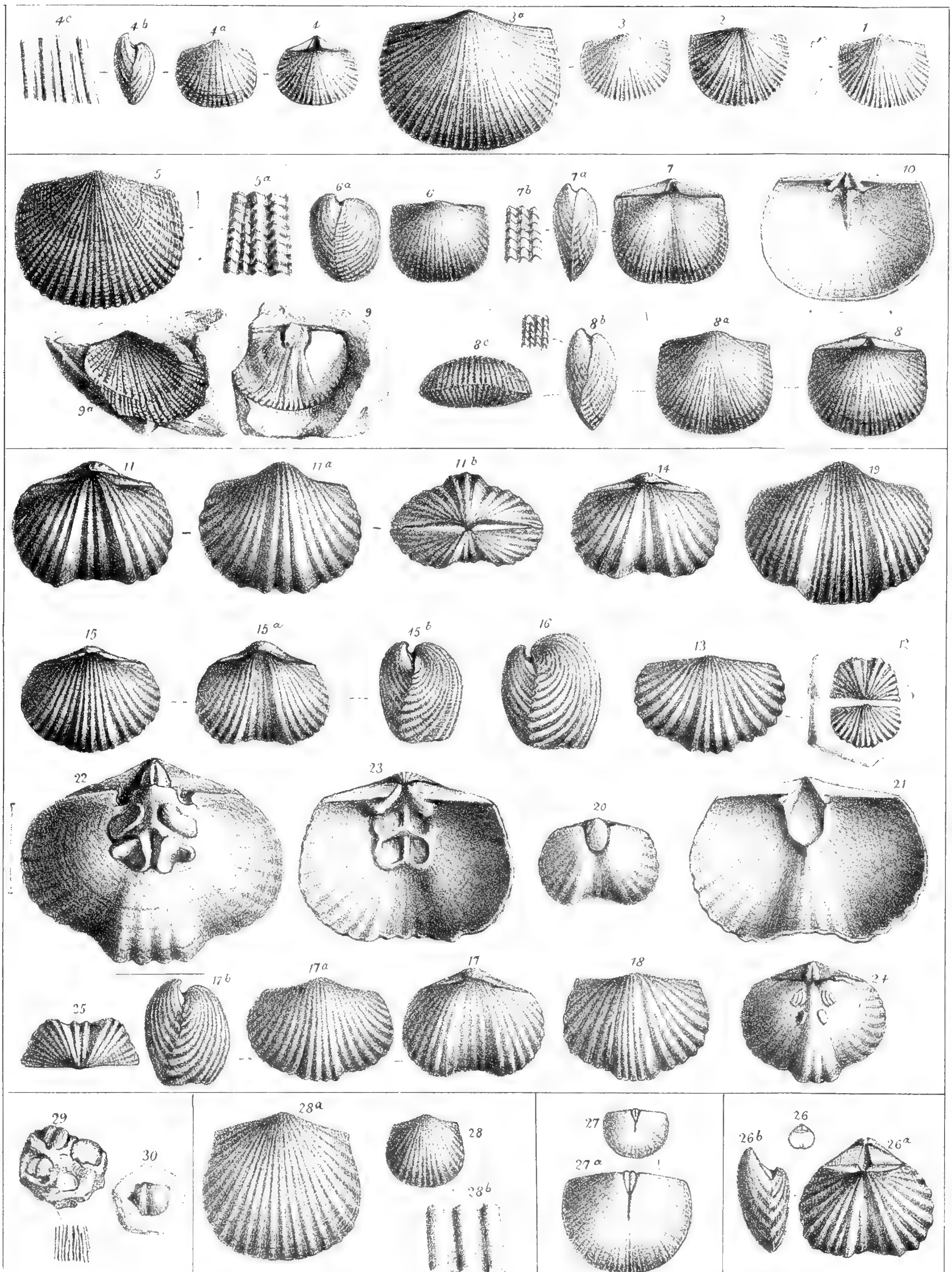

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PLATE XXXIX.

SILURIAN SPECIES.

FIG.

1—21. *Strophomena rhomboidalis*, Wilckens. 1. Exterior of a very large-winged specimen. Wenlock Limestone, Dudley. 2—9. Different forms and ages. From Dudley, Benthal Edge, the Pentland Hills, &c. 8 and 9 show the small circular foramen. 3 *b* is a longitudinal section of both valves. 4. From Dormington Wood, Woolhope. Mus. Pract. Geol. 10. Interior of the dorsal valve. Wenlock Limestone; Abberley. Worcester Museum of Nat. Hist. 11, 12. Another specimen from Dudley. 13. Internal cast of the dorsal valve. 14. Interior of a ventral valve. Dudley. 15. Another winged example. British Museum. 16. A Gothland specimen, showing impressions of oral arms. 17. Internal cast of a ventral valve from Woolhope (?) beds; Bogmine, Shelve. Mus. Pract. Geol. 18. From Ludlow Rock; Freshwater. 19. "*Lept. tenuistriata*," Sow., 'Sil. Syst.,' pl. xxii, fig. 2 *a*. 20. From Llandovery Rock; Penhill, Ayrshire. 21. From Caradoc beds; Bala Lake. Mus. Pract. Geol.

22. ,, *deltoidea*, Conrad (?) = "*Stroph. semiovalis*," M'Coy, 'Sil. Foss. Irel.,' pl. iii, fig. 6; referred to *St. deltoidea* by the same author in 'Brit. Pal. Foss.'

23, 24. ,, ,, var. *undata*, M'Coy, after figures in 'Brit. Pal. Foss.,' pl. i H. Caradoc beds. 23. From Llwyn-y-Ci.

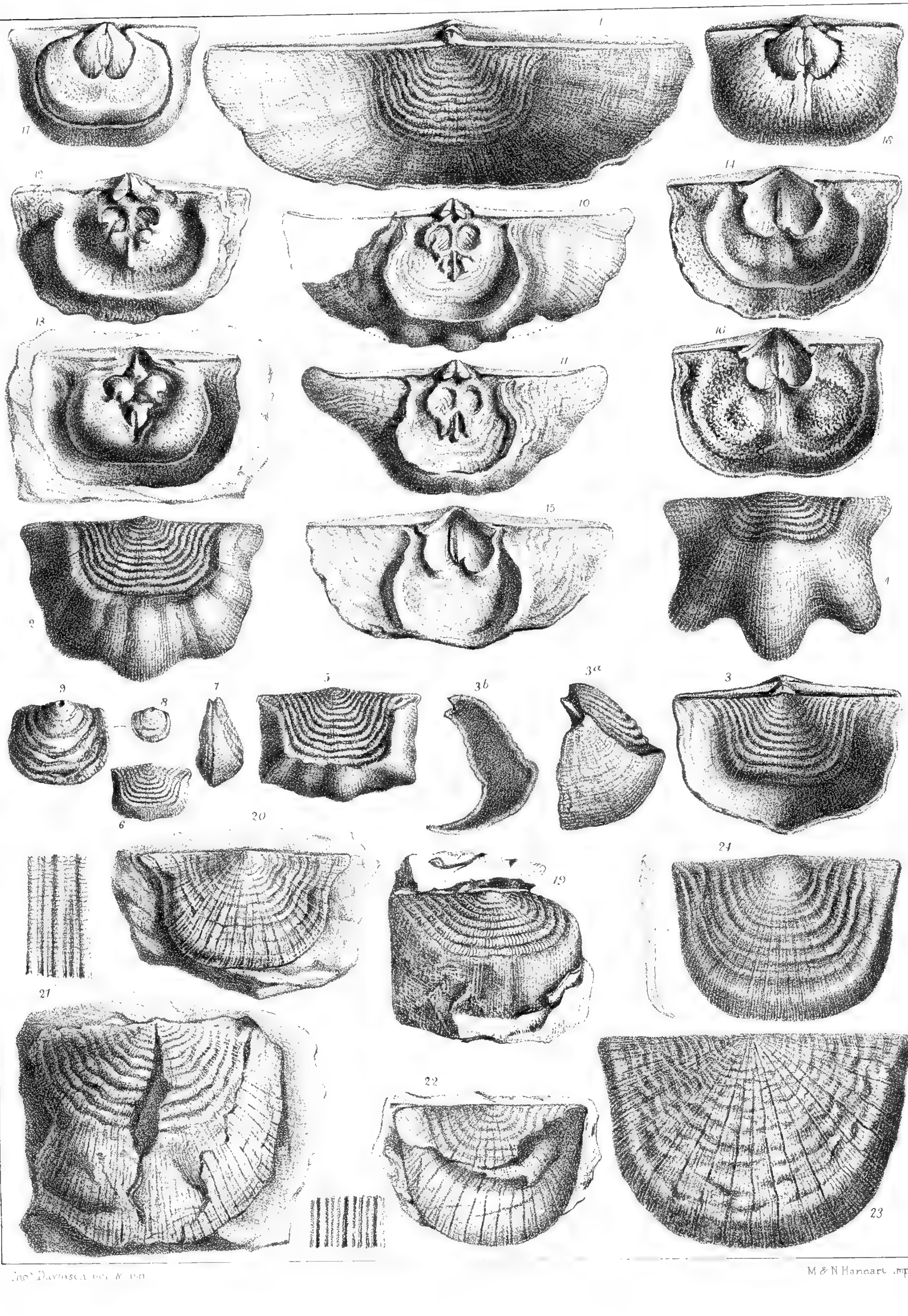

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PLATE XL.

SILURIAN SPECIES.

FIG.

1—5. *Strophomena euglypha*, Sow. 1, 1 *a*, 1 *c*. Exterior of both valves. 1 *b*. Longitudinal section of both valves. 2. Interior of the ventral valve. 3. Interior of the dorsal valve. All from the Wenlock Limestone; Dudley. 4. Exterior, and 5, internal cast, of the dorsal valve. Lower Llandovery; Sevin, Llettyrhyddod, Llandovery.

6—8. ,, *Walmstedti*, Lindström. Wenlock Shale; Pentland Hills. 6. Exterior of the dorsal valve. 6 *a*. Longitudinal section of both valves. 6 *b*. Portion of shell-sculpture, enlarged. In Mr. Henderson's Collection. 7. Internal cast of the ventral valve. 8. Fragment of both valves, to show the area.

9—13. ,, *funiculata*, M'Coy. Wenlock Limestone; Dudley and Lincoln Hill. 9, 9 *a*. Exterior of the valves. 9 *b*. Section. 9 *c*. Shell-sculpture, enlarged. 10. Interior of the dorsal valve. 10 *a*. The same, enlarged. 11. Interior of the ventral valve. 12. Another specimen of the same valve. 13. Interior of ventral valve, enlarged.

SILURIAN

Pl. L

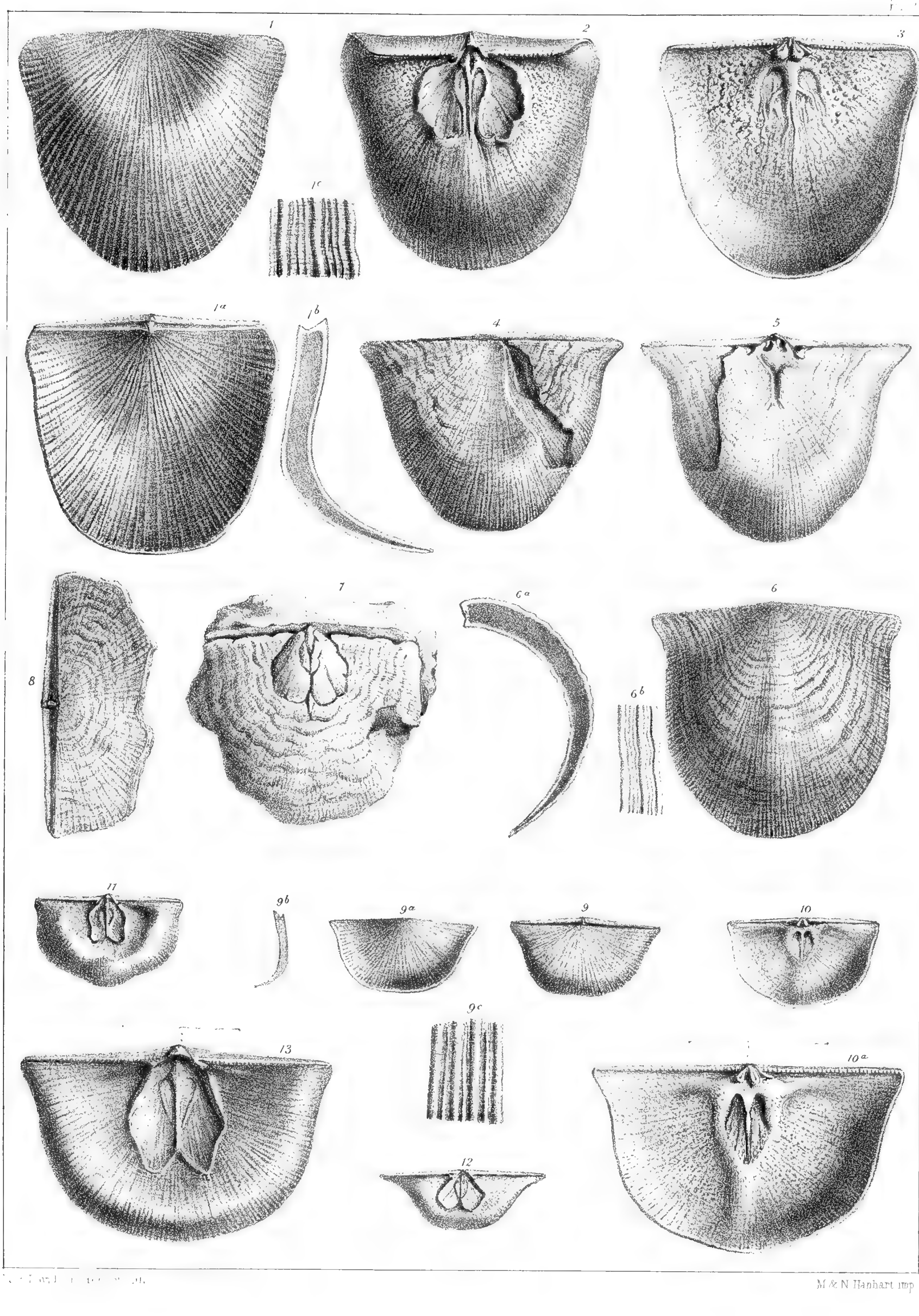

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PLATE XLI.

SILURIAN SPECIES.

FIG.

1—4. *Strophomena imbrex,* Pander (?), var. *semiglobosa,* Dav. 1, 1 *a.* Wenlock Shale, from Rushall Canal, near Walsall. 1 *b.* Longitudinal section of both valves. 1 *c.* Shell-sculpture, enlarged. 2. A more circular example, from the same locality. 3. Interior of dorsal valve. Near Walsall. Mus. Midland Geol. Soc. 4. A large specimen of the same valve.

5, 6. " " ? Caradoc beds; Craighead Quarry, near Girvan, Ayrshire.

7. " *Dayi,* Dav. Wenlock Shale; Buildwas, near Wenlock.

8—14. " *corrugatella,* Dav. 8. Original specimen of Portlock's "*Orthis corrugata.*" Caradoc; Desertcreat, Tyrone. Mus. Pract. Geol. 8 *a.* Section. 8 *b.* Portion of the shell-sculpture, enlarged. 9, 9 *a.* Specimen from the Caradoc beds of the Chair of Kildare, much enlarged. 10. Complete shell, seen from the dorsal valve. Caradoc; Keisley, Westmoreland. 11. Ventral valve. Chair of Kildare. 12. A young shell. Balcletchie, near Penkill, Ayrshire. 13. Outline of the interior of dorsal valve. 14. "*Orthis undulata,*" M'Coy, after original figure, 'Sil. Foss. Irel.,' pl. iii, fig. 22.

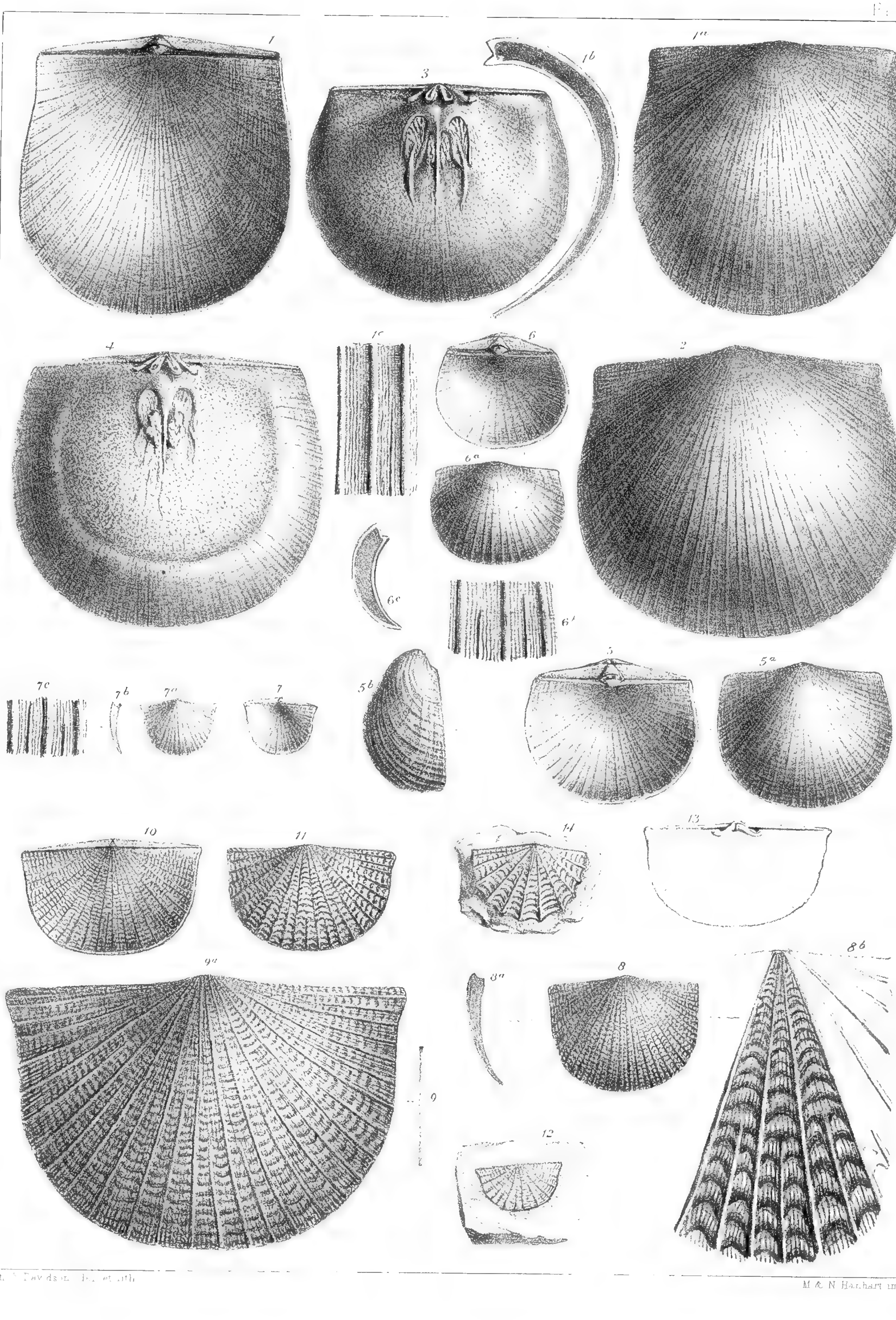

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PLATE XLII.

SILURIAN SPECIES.

FIG.

1—5. *Strophomena deltoidea*, Conrad. 1, 1 *a*. Exteriors of the valves. Caradoc; Grangegeeth. 1 *b*. Section. 1 *c*. Sculpture, enlarged. 2. From the Chair of Kildare. 3. Internal cast of the dorsal valve; nat. size. 3 *a*. Enlarged. 3 *b*. The valve, enlarged; from a gutta-percha mould of the cast. 4. Internal cast of ventral valve. 4 *a*. Shell, enlarged; from a gutta-percha mould of the cast. All from Grangegeeth, County Meath. Mus. Geol. Survey of Ireland. 5. = "*Orthis sublævis*," M'Coy, 'Sil. Foss. Ireland,' pl. iii, fig. 19. Caheranearta, Chair of Kildare, Ireland. Sir R. Griffith's Collection.

6—8. ,, *arenacea*, Salter, MS. 6. Exterior of ventral valve. Upper Llandovery; Norbury. 6 *a*. Section. 6 *b*. Shell-sculpture, enlarged. 7. Internal cast of the ventral valve. Gunwich Mill, near Alfrick. 8. Ditto, from Huntley Hill. All in the Mus. Pract. Geol.

9, 10. ,, *simulans*, M'Coy. 9. Exterior of the dorsal valve. 9 *a*. Section. 9 *b*. Shell-sculpture, enlarged. 9 *c*. Exterior of the ventral valve. 10. Muscular impressions of the ventral valve. After the original figures, 'Brit. Pal. Foss.,' pl. i H, figs. 33—35. Caradoc Schists of Cefn Coed. Woodwardian Museum, Cambridge.

11. ,, *Waltoni*, Dav. Wenlock Shale; Falfield.

12—14. ,, *Orbignyi*, Dav. Wenlock Limestone; Dudley. 12, 14. Mus. Pract. Geol.

15—17. ,, ? *retroflexa*, Salter. Caradoc beds. 15, 16. From Chair of Kildare. Mus. Pract. Geol. 17. From Girvan, Ayrshire.

18, 19. ,, *Hollii*, Dav. Caradoc beds. 18 *a*. Interior of ventral valve, enlarged from the internal cast. 19 *a*. From the Onny section.

20, 21. ,, *ungula*, M'Coy. 20, 20 *a*, 20 *b*. Complete example. Caradoc beds; Pontyglyn Diffws, five miles from Corwen. Mr. Davies' Collection. 20 *c*. Shell-sculpture, enlarged. 21. Internal cast of the ventral valve. Glen Ceiriog.

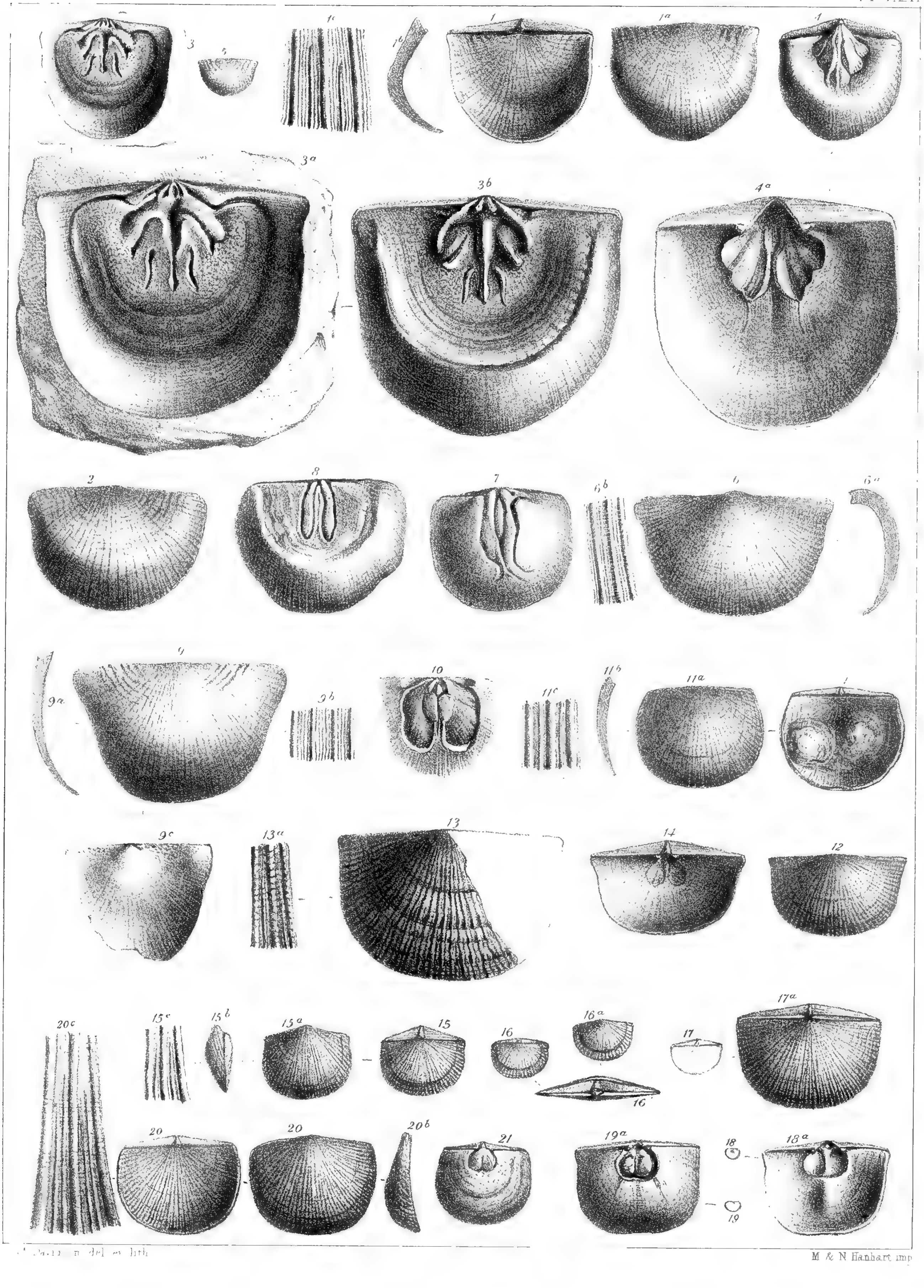

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PLATE XLIII.

SILURIAN SPECIES.

FIG.

1—11. *Strophomena pecten*, Linné. 1. A very large example. Wenlock Shale; near Walsall. 2. The same locality. 3. From the Wenlock Limestone of Dudley. 4, 5, 6. Wenlock Shale; Pentland Hills. 5, 6. Internal casts. 7, 8. Interior of valves. Dudley. 9. Young shells (= "*Orthis minuta*," Haswell). Pentland Hills. 10, 11. Young shell (= "*Orthis semicircularis*," Sow.). Llandovery rocks; Hope Quarry, Minsterley. Mus. Geol. Soc.

12—14. " *applanata*, Salter. Wenlock Shale; Pentland Hills. 12 *a*, *b*. Enlarged.

15. " *Hendersoni*, Dav. Wenlock Shale; Pentland Hills.

16—20. " *ornatella*, Salter. Upper Ludlow; Whitecliff, Ludlow. 16. Internal casts, nat. size. 17 *a*, *b*. Complete shell, enlarged. 18. Interior of dorsal valve. 18 *b*. A part of the cast, greatly enlarged. 19, 20. Interiors of ventral valve. 19 *a*. Internal cast of ventral valve, enlarged.

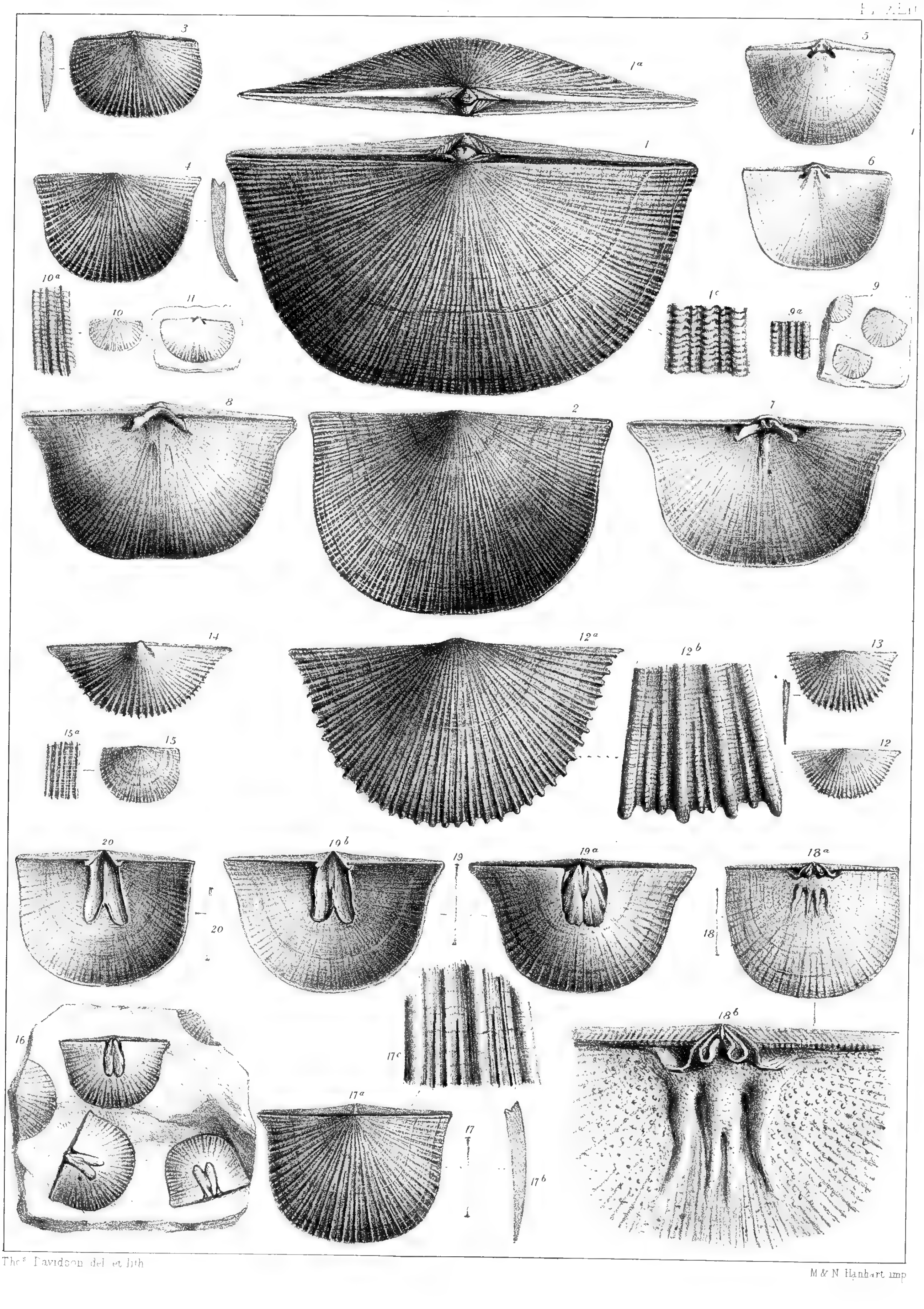

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PLATE XLIV.

SILURIAN SPECIES.

FIG.

1. *Strophomena rhomboidalis,* Wilckens, sp., (? var.) Caradoc; Craighead Quarry, Ayrshire. 1 *a, b, c.* Enlarged.

2—13, 21, 22. ,, *antiquata,* Sow. 2. After the original figure, 'Sil. Syst.,' pl. xiii, fig. 13. Wenlock Shale; Woolhope. Mus. Geol. Soc. 3, 4. From the Wenlock Limestone of Dudley. 5. Llandovery (?); Penkill, Ayrshire. 6. Wenlock Shale; Wenlock Edge. Mus. Pract. Geol. 7. Wenlock Shale; Pentland Hills. 8 *b.* Internal cast of the ventral valve, and 9, of the dorsal valve, both enlarged; from the same locality. 10, 11. Var. *scabrosa,* Dav. Wenlock Limestone; Dudley, and Rock Farm, May Hill. 10. Mus. Geol. Soc. 11. Mus. Pract. Geol. 12. Interior of the ventral valve, and 13, of the dorsal valve. Wenlock Limestone; Benthall Edge. 21 and 22. Internal casts. Lower Llandovery; Gas-works, Haverfordwest. Mus. Prac. Geol.

14—20. ,, *filosa,* Sow. 14. Wenlock Limestone; Dudley. 15. Upper Ludlow; Ludlow, and south-west of Hayle, Woolhope. Mus. Pract. Geol. 16. Wenlock Limestone; Usk. Mus. Pract. Geol. 17. Aymestry Limestone; Leintwardine. Mus. Geol. Soc. 18. Upper Ludlow; Ringwood Chase, Ludlow. Mus. Geol. Soc. 19. Interior of the ventral valve. Dudley. 20. Internal casts of the ventral valve. Wenlock Limestone; Llandovery. Mus. Pract. Geol.

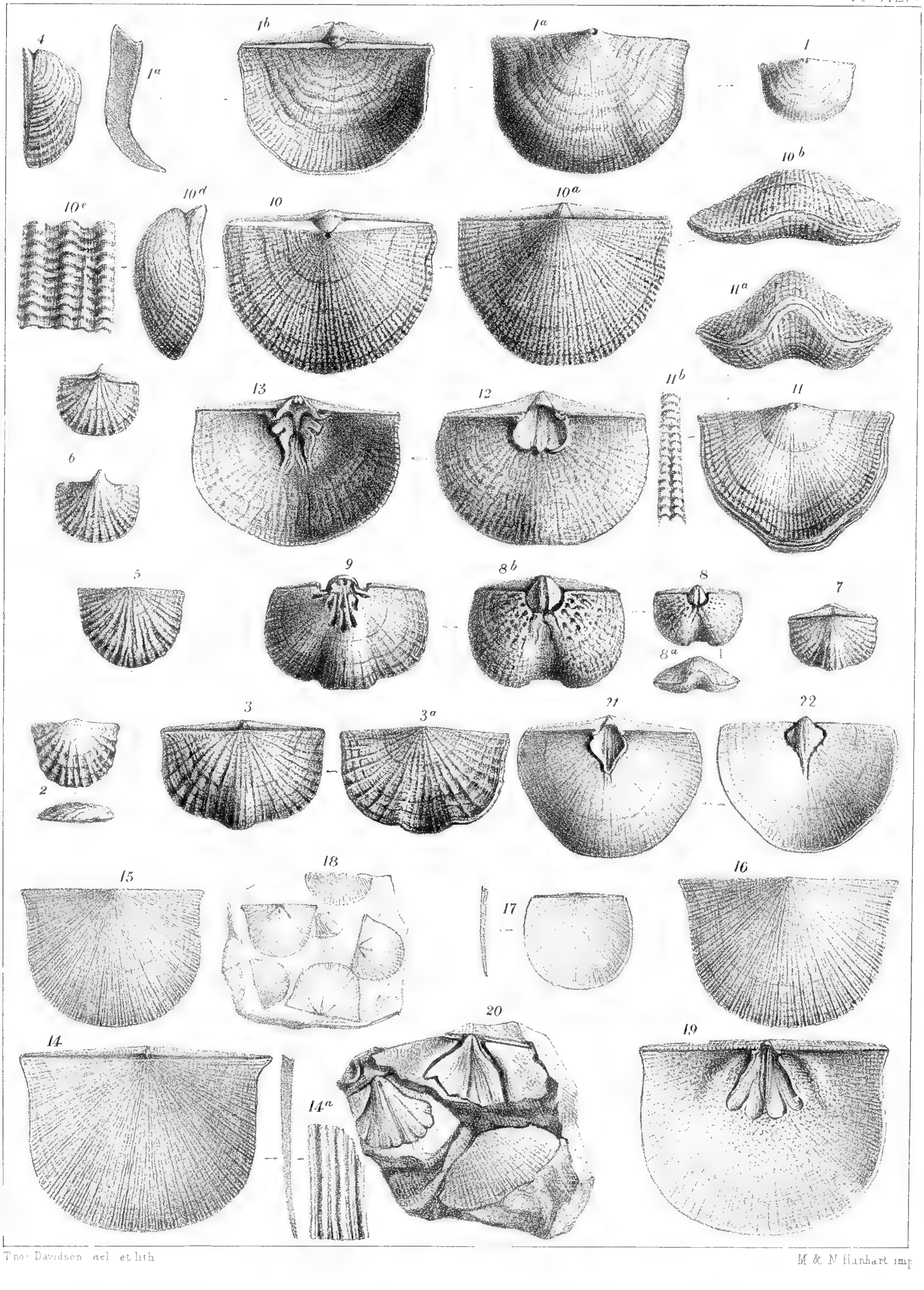

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PLATE XLV.

SILURIAN SPECIES.

FIG.

1. *Strophomena expansa*, Sow. Caradoc; The Maen, near Meifod. Mus. Geol. Soc. 1 *a*. Shell-sculpture, enlarged.

2. " " Lambay Island. Mus. Pract. Geol.

3. " " Longitudinal section of both valves.

4, 5. " " Caradoc; Harnage, south-east of Shrewsbury.

6. " " Interior of the ventral valve, showing the muscular and vascular impressions. Caradoc; Moel-y-Garth. Taken from Murchison's original specimen (an internal cast) in the Mus. Geol. Soc.

7. " " Interior of ventral valve. Soudley, near Church Stretton. Taken from an internal cast. Mus. Pract. Geol.

8. " " A large internal cast of the ventral valve. Caradoc; near Meifod.

9. " " Slab covered with large internal casts, principally of the ventral valve. Bardahessiagh, Tyrone. Mus. Pract. Geol.

10. " " Interior of dorsal valve, taken from gutta-percha model of an internal cast. Caradoc beds; near Llanfyllin.

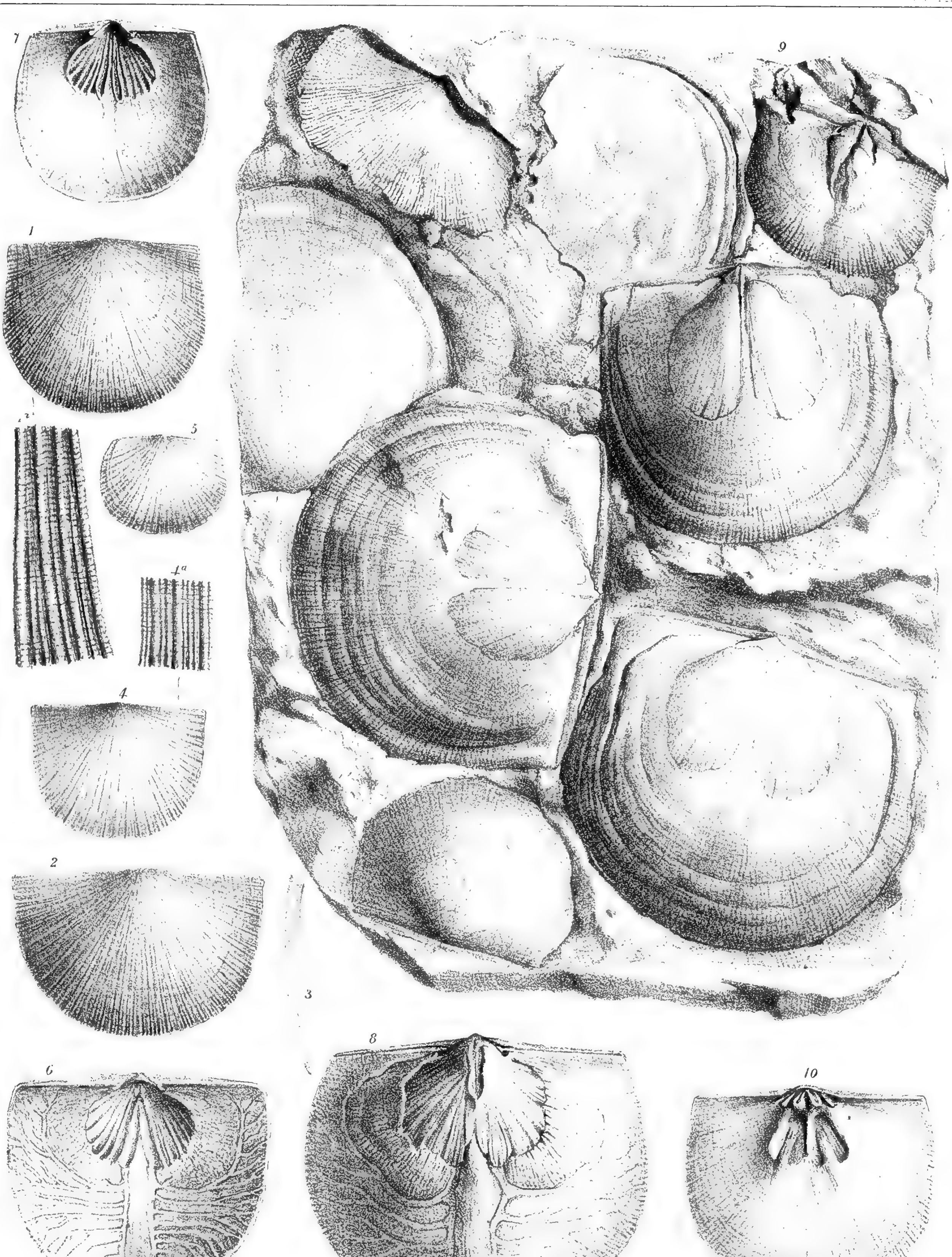

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PLATE XLVI.

SILURIAN SPECIES.

FIG.

1—3, 5, 6. *Strophomena grandis,* Sow. 1. Caradoc; Bardahessiagh, Pomeroy; taken from a gutta-percha mould of an external impression. Sir R. Griffith's Collection. 2. From Acton-Scott. The late Mr. Wyatt-Edgell's Collection. 3, 3 *a.* Interior of the ventral valve. Id. Caradoc; Acton-Scott, Shropshire. Sir R. Murchison's original specimen, in the Mus. Geol. Soc. 3 *a.* The ventral valve, from a gutta-percha mould of the cast fig. 3, slightly restored round the edge. 5. Interior of the ventral valve; Acton-Scott. 6. Internal cast. Mus. Pract. Geol.

4. *Orthis porcata,* M'Coy=" *Orthis grandis,*" Portlock (not of Sowerby). 4. Internal cast of the dorsal valve. 4 *a.* Mould in gutta-percha. 4 *b.* Longitudinal section of both valves. Caradoc; Pomeroy, Tyrone. Sir R. Griffith's Collection.

7—10. *Strophomena compressa,* Sow. 7, 8. Upper Llandovery; Dameroy Bridge, Tortworth. 9. Interior of dorsal valve. Mus. Pract. Geol. 10. Internal cast of ventral valve.

11—14. ,, ,, var. *Llandeiloensis,* Dav. 11, 12. Exterior of the valves. Llandeilo Flags; Llann Mill, Caermarthenshire. 11 *c.* External sculpture, enlarged. 13. Interior of dorsal valve. 14. Interior of ventral valve. Mus. Pract. Geol.

15. ? " *Orthis cancellata,*" Portlock. Geol. Report, pl. xxxii, fig. 19. Tyrone.

16. ? " *Orthis anomala,*" Sow. 'Sil. Syst.,' pl. xxi, fig. 10. Caradoc; Horderley Edge.

17. ? " *Leptæna complanata,*" Sow. 'Sil. Syst.,' pl. xx, fig. 6. Caradoc; Acton-Scott.

I have not been able to identify these three last-named shells, or to determine to what species they belong.

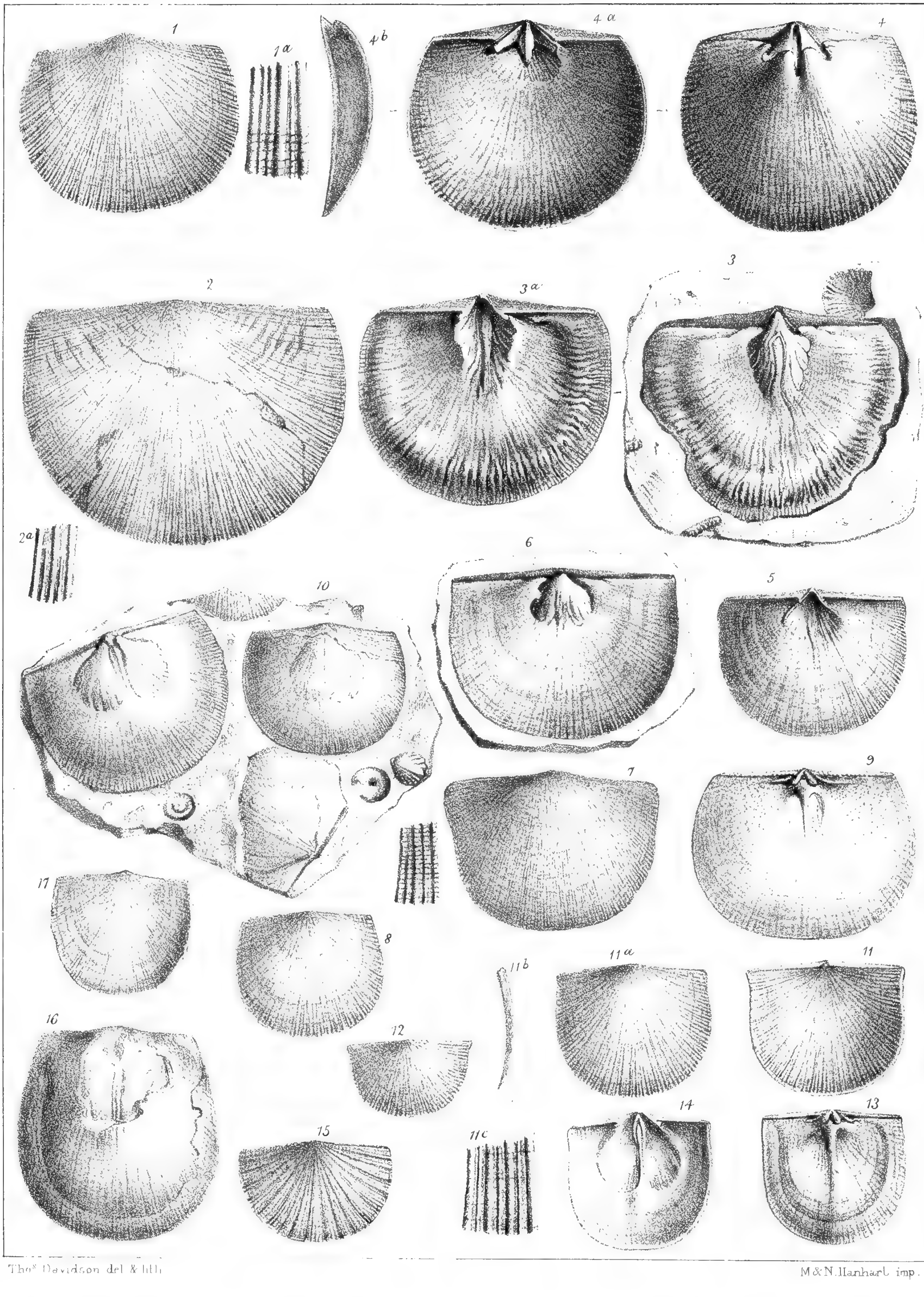

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PLATE XLVII.

SILURIAN SPECIES.

FIG.

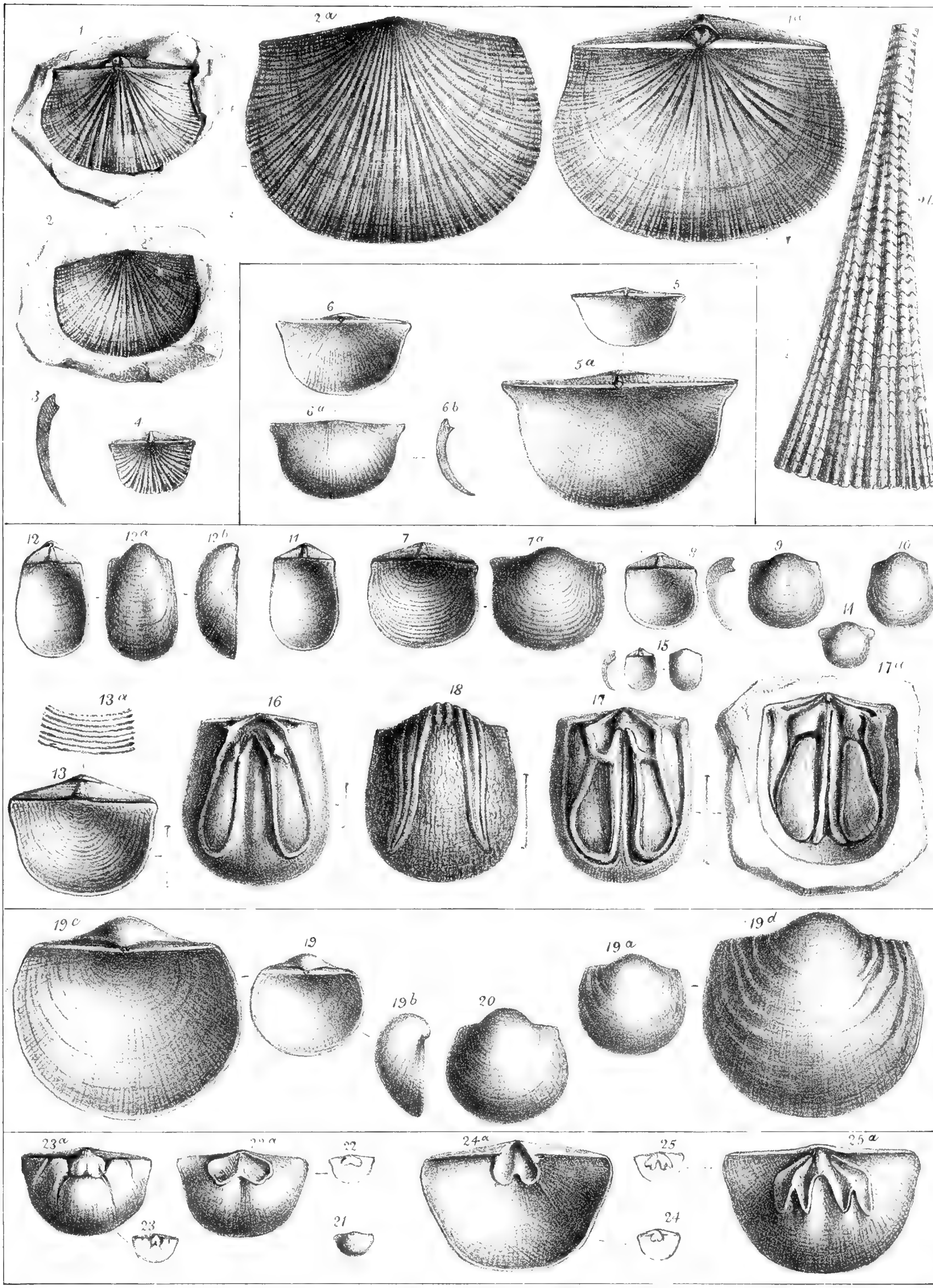
1—4. *Strophomena Siluriana*, Dav. Lower Silurian; Fairy Gill, Cautley, near Sedberg, Yorkshire. 1 *a*, 2 *a*, 2 *b*. Enlarged.

5, 6. ,, *Fletcheri*, Dav. Wenlock Shale; Benthal Edge. 5 *a*. Enlarged.

7—18. *Leptæna tenuicincta*, M'Coy. 8—15. Various modifications in shape and stages of growth. Caradoc; Lledfron, Llanfyllin, Girvan, Tyrone, and the Chair of Kildare. 16, 17. Interior of the dorsal valve, enlarged. 16. From Sholes Hook, Haverfordwest. 17. From Tyrone, Ireland. 17 *a*. Internal cast of the dorsal, and 18, internal cast of the ventral valve, enlarged. Lower Llandovery; Rhosfawr, near Llanfyllin. Several of the specimens are in the Mus. Pract. Geol.

19, 20. ,, *transversalis*, var. *Youngiana*, Dav. Caradoc; Craighead Quarry, Girvan, Ayrshire. 19 *c*, *d*. Enlarged.

21—25. ,, *scissa*, Salter. 21. Upper Llandovery; Norbury, Bishop's Castle. 22. Interior of the dorsal valve, and 23, of the ventral valve. Lower Llandovery; Gas-works, Haverfordwest. 22 *a*, 23 *a*. Enlarged. 24. Interior of the ventral, and 25, of the dorsal valve. Caradoc; Sholes Hook, Haverfordwest. 24 *a*, 25 *a*. Enlarged. Mus. Pract. Geol.



Thos Davidson, del. & lith.

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PLATE XLVIII.

SILURIAN SPECIES.

Fig.		
1—9.	*Leptæna transversalis,*	Dalman. 1, 2. Wenlock Limestone; Dudley. 2 *a*. Shell-sculpture, enlarged. 3. Wenlock Shale; Pentland Hills. 4, 5 *a*. A very transverse variety (*L. Duvalii,* Dav.). Dudley. 6. A fragment, enlarged, to show the area, pseudo-deltidium, &c. 7. Interior of the dorsal valve, enlarged. 8. Interior of the ventral valve, enlarged. 9. Area and pseudo-deltidium in the two valves. 9 *a*. Internal cast of the dorsal, and 9 *b*, of the ventral valve. Pentland Hills.
10—19.	,, *sericea,*	Sow. 10, 11. Sowerby's original figures in 'Sil. Syst.' Caradoc; Whittingstow and Horderley, Shropshire. 12, 12 *a*. Copied from 'Siluria.' 13. Llanfyllin. 14. Llandeilo Flags; Llann Mill, Caermarthenshire. 15. Caradoc; Pentrefflymru, near Llanfyllin. 15 *a*, *b*, *c*. Enlarged. 16. Interior of the dorsal, and 17, of the ventral valve, enlarged. Caradoc beds; Llanfyllin. 18. Internal cast of both valves, enlarged. Desertcreat, Tyrone. Portlock's Coll., Mus. Pract. Geol. 19. Internal cast of the ventral valve, showing vascular impressions. 19 *a*. The same, enlarged. Caradoc; Haverfordwest. Mrs. Branwell's Collection.
20—22.	,, ,,	var. *rhombica,* M'Coy. Caradoc; Moclydd, near Oswestry.
23—27.	,, *quinquecostata,*	M'Coy. 23. After M'Coy's original figure, 'Sil. Foss. Ireland,' pl. iii, fig. 8. Tyisaf, Llangedyn. 24. Rhywlas, Bala. Both in the Mus. Pract. Geol. 24 *a*, 25 *a*. Enlarged. 26, 27. Caradoc; Girvan, Ayrshire. 27 *a*. Enlarged.
28—30.	,, *segmentum,*	Angelin. 28. Wenlock Shale; Walsall. 28 *a*, *b*, *c*, *d*. Enlarged. Dudley. Gray's Coll. in the British Museum. 30. Interior of the ventral valve, enlarged.

SILURIAN.

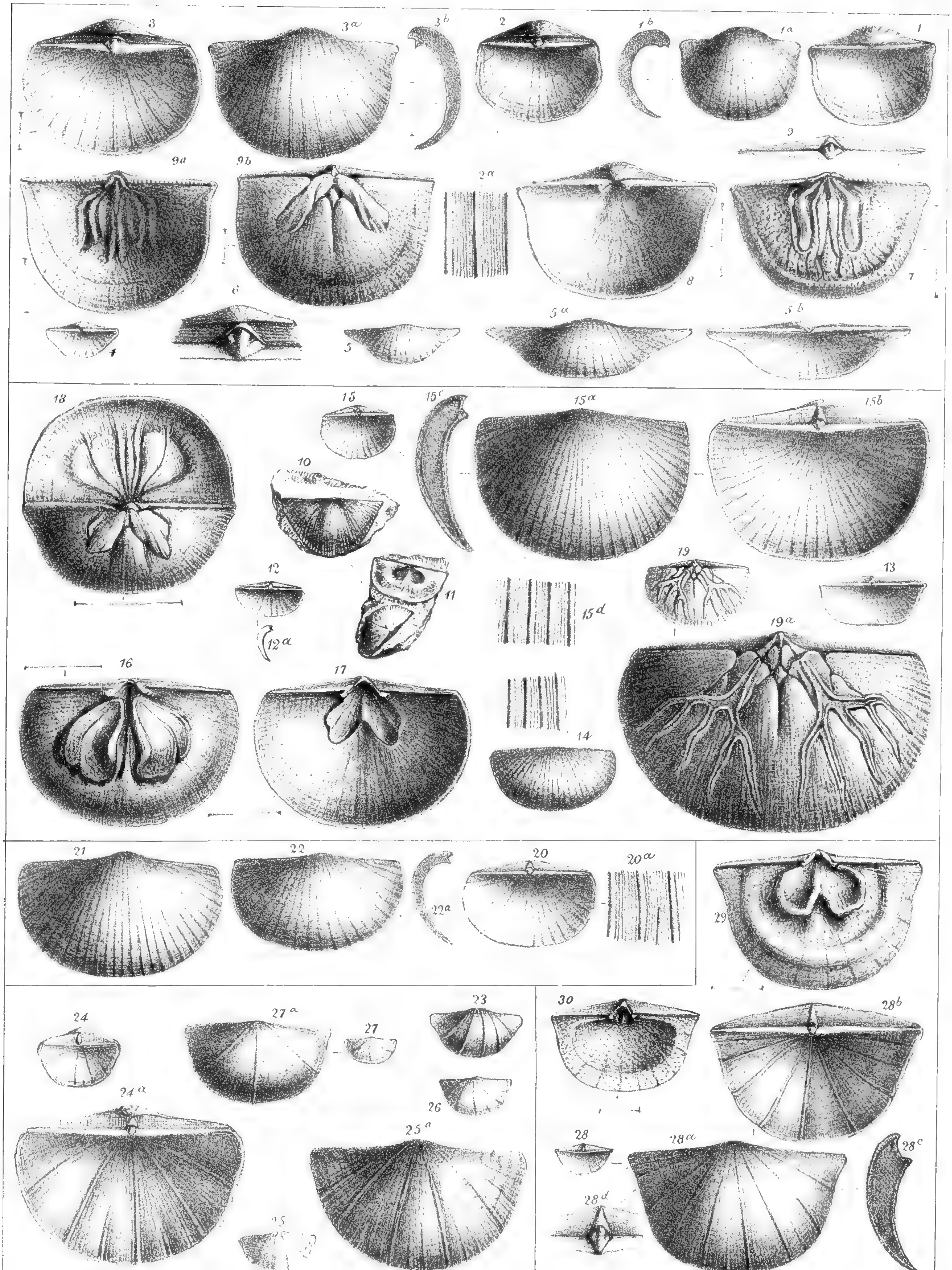

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PLATE XLIX.

SILURIAN SPECIES.

FIG.

1—12. *Leptæna* (?) *lævigata*, Sow. 1, 2. The original specimen. 2 *a*. Enlarged. Wenlock; Burrington, Salop. Mus. Geol. Soc. 3, 4. From near Dudley. Gray's Coll. in the Brit. Mus. 4, 5. Show the small apicial foramen. 6. *L. lævissima*, M'Coy, 'Sil. Foss. Ireland,' pl. iii, figs. 7, 8, 12. *Leptæna lepisma*, var. *minor*, Phillips and Salter (not of Sow.), after figures in the 'Mem. Geol. Survey,' vol. ii, pl. xxvi, figs. 3, 4. Upper Silurian; Builth.

13, 14. *Chonetes lepisma*, Sow. 13. Aymestry Limestone; Malvern. Mus. Pract. Geol. 13 *a*. Enlarged. 14. The original specimen of *Leptæna lepisma*, Sow., 'Sil. Syst.,' pl. viii, fig. 7. 14 *a*. Enlarged. Lower Ludlow; Garden House Quarry, Aymestry. Mus. Geol. Soc.

15—19. ,, ? *minima*, Sow. 15. The original example of "*Leptæna minima*," Sow., 'Sil. Syst.,' pl. xiii, fig. 4. Wenlock Shale; Burrington. Mus. Geol. Soc. 15 *a*. Enlarged. 16, 17. Var. *Grayi*, Dav. 16 *a*, *b*. Enlarged. 17. Interior of dorsal valve. Wenlock Shale; Dudley. 18. Lower Ludlow; Vinnal Hill, Ludlow. Mus. Pract. Geol. 19. Lower Ludlow; Elton Lane, Ludlow. Dr. Holl's Collection.

20—22. *Leptæna* (vel *Chonetes* ?) *tenuissime-striata*, M'Coy. 20. After the original figure in 'Sil. Foss. Irel.' Caradoc (?); Slieve Roe, Rathdrum, County Wicklow. 21. Another crushed example. Same locality. 22. Specimen figured by M'Coy, 'Brit. Pal. Foss.,' pl. i H, fig. 44, from Llandeilo. (This is an undetermined species.)

23—26. *Chonetes striatella*, Dalman, sp. 23. After Sowerby's original example of "*L. lata*," 'Sil. Syst.,' pl. xx, fig. 8. Upper Ludlow; Ludlow. 24. Ludlow. 25. Wenlock Shale; Pentland Hills. 26. Interior of the dorsal valve, enlarged. Dudley.

27—29. *Orthisina adscendens* (?), Pander, sp. 27. Lower Llandovery; Cefncoedog, Corwen. From an impression taken in gutta-percha from a cast in the Woodwardian Museum at Cambridge. 28. Internal cast of a ventral valve. 29. From Cefn Coch. ? Collections of Messrs Parrott and Davies.

30. *Lingula petalon*, Hicks. Arenig Rocks; Whitesand Bay.

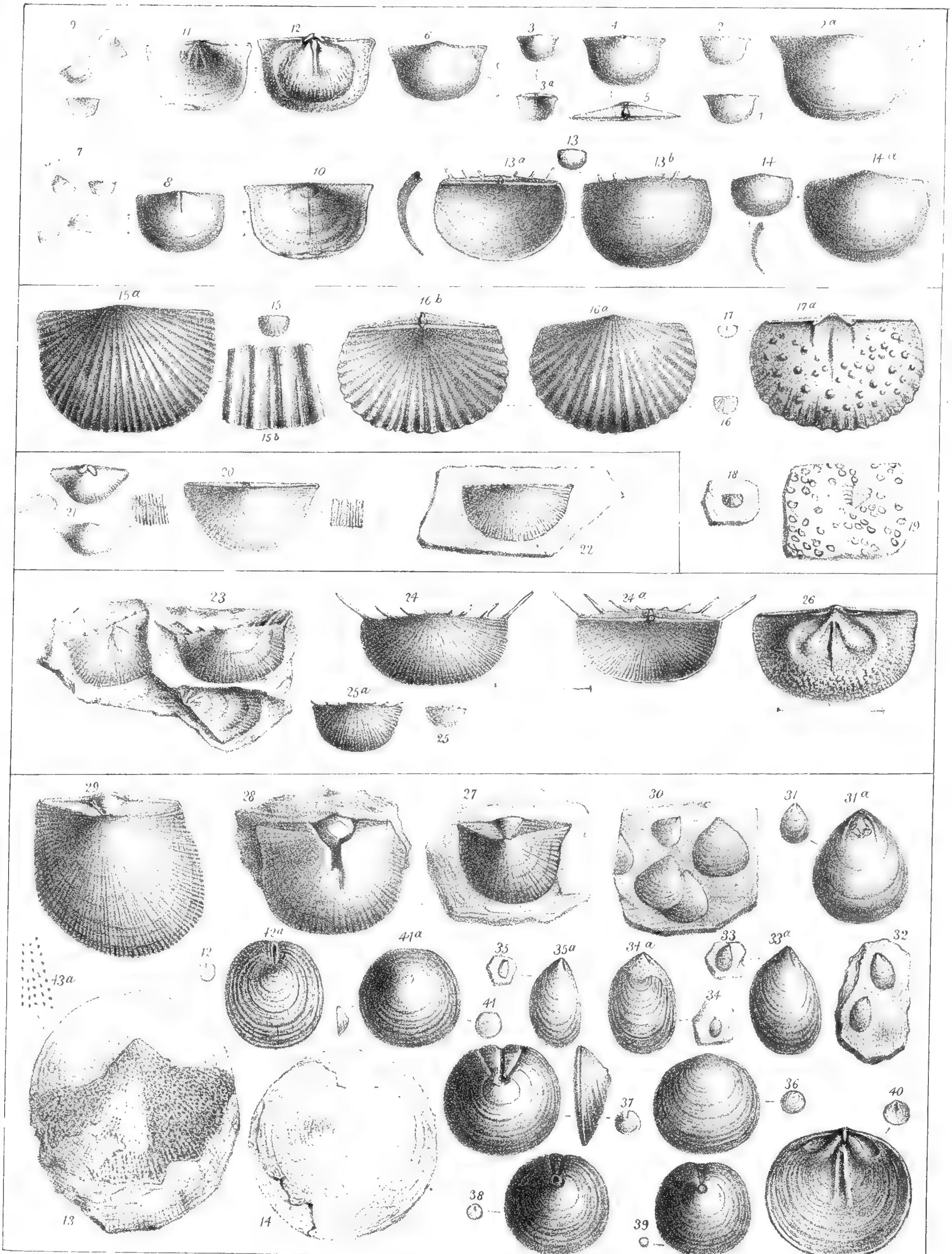
31. *Lingulella lepis*, Salter. Internal cast. Lower Tremadoc; Penmorfa Church, Portmadoc. 31 *a*. Enlarged.

32—35. ,, *ferruginea*, Salter. 32. Nat. size; after Mr. Salter's figures. Mænevian, St. David's. 33. Another example; and 33 *a*, enlarged. 34, 34 *a*. From the purple beds of the Harlech group, St. David's. Copied from the original figure of var. *ovalis*, Salter. 35, 35 *a*. Porthclais Harbour, St. David's; from the lowest beds of the purple Cambrian rocks. The earliest Brachiopod hitherto discovered.

36—40. *Acrotreta* ? *Nicholsoni*, Dav. Upper Llandeilo; Dobb's Linn, Maffat. The smaller figures are of the natural size.

41, 42. *Discina pileolus*, Hicks. Mænevian rocks; Porth-y-rhaw Valley, St. David's. 41 *a*, 42 *a*. Enlarged.

43, 44. ,, (*Trematis*) *corona*, Salter. Caradoc, Bala Shales; Dufton-Pusgill, Westmoreland. Woodwardian Museum, Cambridge.



Thos Davidson, del. et lith.

M & N Hanhart, imp.

PLATE L.

SILURIAN SPECIES.

FIG.

1—14. *Obolella sagittalis*, Salter. Modifications in shape and stages of growth. Menevian rocks of St. David's, and Mawddach Waterfall, Dolgelly. The smaller figures are of natural size. 1. Exterior, 2, 9, 11, 12, 14, interiors and internal casts, of the ventral valve. 3—7. Ditto of the dorsal valve.

15—17. „ „ var. *Belti*, Dav. Lower Tremadoc Slates; Craig-y-dinas, North Wales. 15 *a*, 16 *a*, 17 *a*. Enlarged.

18—21. „ *maculata*, Hicks. Mænevian group, Porth-y-rhaw, St. David's, South Wales, and Gwynfynydd and Camlan, North Wales. The smaller figures are of the natural size.

23, 24. *Obolus ? plumbeus*, Salter, sp. 23. Interior; from the Lower Llandeilo of Shelve. 24. Exterior; from Wellfield, Builth. The smaller figures are of the natural size.

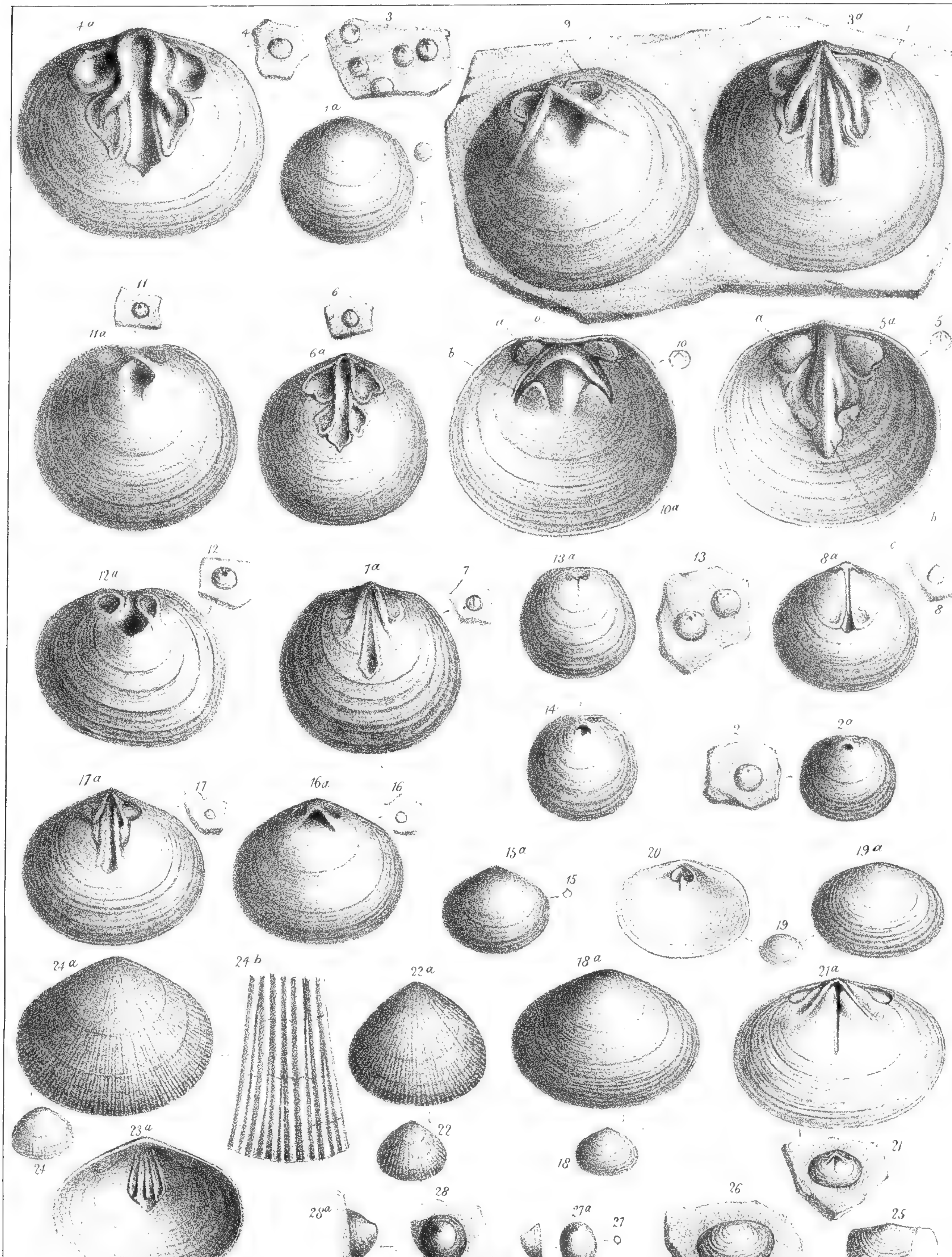
22. „ „ var. *plicata*, Hicks. Lower Arenig Rocks; Tremanhere, St. David's. The smaller figure is of the natural size.

25. *Kortugina cingulata*, Billings (named "*Obolella ? Phillipsii*" at p. 62 and in pl. iv, figs. 17—19, of this Monograph). Malvern.

26. *Discina*, sp. From the Graptolite Shale of Graple Linn, near Moffat, Scotland. Dr. Nicholson's Collection.

27. „ „ From the Bala Limestone of Keisley, Westmoreland. Prof. Harkness's Collection. The small figure is of natural size.

28. „ „ Upper Llandeilo beds of Gilwern, Llandrendod. Dr. C. Ricketts' Collection.



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THE

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INSTITUTED MDCCCXLVII.

VOLUME FOR 1870.

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MDCCCLXXI.

THE EOCENE BIVALVES.

Directions to the Binder.

Vol. I of the "Eocene Bivalves" will be found in the Annual Volumes of the Palæontographical Society issued for the years 1859, 1862, and 1870.

Cancel the title pages to Parts I, II, and III in the Volumes of the Society for the years 1859, 1862, and 1870, and substitute the general title page in the Volume for the year 1870.

Let Plates I—XXV follow the text.

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A MONOGRAPH

OF THE

EOCENE BIVALVES

OF

ENGLAND.

BY

SEARLES V. WOOD, F.G.S.

VOLUME I.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1861—1871.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

THE

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A MONOGRAPH

OF

THE EOCENE MOLLUSCA,

OR,

DESCRIPTIONS OF SHELLS

FROM

THE OLDER TERTIARIES OF ENGLAND.

BY

SEARLES V. WOOD, F.G.S.

PART III.

BIVALVES.

Pages 137—182; Plates XXI—XXV.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1871.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

VERTICORDIA. *S. Wood*, 1844.

Generic Character. Shell subcircular, equivalved, subequilateral, closed, nacreous; ornamented with radiating costæ or striæ; umbo subspiral or incurved; hinge narrow, with an obtuse tooth in the right valve and a depression in the left for its reception; lunule small, deep-seated, heart-shaped; adductor muscles more or less ovate; palleal line simple or without inflexion; connexus cartilaginous, with a very slight extension outside the dorsal margin; an ossicle in the hinge of the living shell.

Much uncertainty has hitherto existed respecting the position of this genus. Mr. A. Adams, when he first described a species which he obtained near the Gotto Islands, Japan, considered it to be allied to the *Bucardiidæ* (*Isocardia*), but subsequently, from further examination, he says (in the 'Annals and Nat. Hist.,' May, 1863, p. 100), "I may take the opportunity of stating that the true position of the genus (*Verticordia*) is in *Anatinidæ* and not with *Isocardia*, with which in a former communication I had associated it. My brother, in examining one of my fresh specimens, has proved the existence of an ossicle in the hinge very similar to that in *Chamostrea* or *Cleidotherus*."

The late Dr. S. P. Woodward and M. Deshayes placed it in the family *Trigoniadæ*. In *Trigonia* the mantle of the only known recent species is said to be open all round; foot large, long, and geniculate. In *Anatinidæ* the genus *Lyonsia* has an ossicle, but *Pandora* has not; both these genera have a nacreous texture. *Anatina*, *Thracia*, and *Cochlodesma* have an ossicle, but are only partially nacreous. The animals of all these have the mantle prolonged into siphons. In *Verticordia* the shell is nacreous and the hinge has an ossicle, but it is one of the *Integropallealia* with a different form of shell, and is more or less costated. I do not think it can belong to the *Anatinidæ*, though I confess not to know its near relations. I would rather place it in a family by itself—"*Verticordidæ*." The genus seems to have some affinity to *Poromya*, perhaps to *Cardilia* and *Mytilimeria*, and in its costated form to that of the *Carditidæ*. I am unable to trace a connection, however remote, that it could have had to any ancestral relation of a Secondary period. The nearest resemblance in outward appearance is a striated *Isocardia* from the Kimmeridge Clay, called *Anisocardia*, which is not unlike *Chama arietina*, Brocchi, a species belonging to this genus, and a shell that is striated, but not costated. The ossicle in the hinge forms the connecting link which this genus is supposed to have with the *Anatinidæ*.[1] Respecting the use of this ossicle Mr. Jeffreys says, in 'Brit. Conch.,' vol. iii, p. 29, "It was conjectured by Clark that it acted like

[1] In the 'Brit. Mollusca,' vol. xi, p. 76, it is said, "Professor Lovén has detected a rudimentary ossicle in *Montacuta bidentata*, which appears to Mr. Alder, who has likewise observed it, a mere calcification of the lower part of the ligament. It is so easily detached that very few cabinet specimens ever exhibit it."

the check-tape of a trunk, to prevent its being opened too widely. This might be so if it were attached to the shell. I should be disposed to attribute to it quite a contrary action, and to believe that its use may be to strengthen the hinge and to prevent its being squeezed too closely and broken, as is frequently the case with certain species of *Anatina* and *Thracia*." The ossicle in *Verticordia* is convex on one side and concave on the other, and the concave side fits over a tubular projection under the dorsal margin of the left valve, in which the cartilaginous connector is inserted. In the right valve the connector is naked or unprotected, extending backwards within the margin a little beyond the ossicle joining the portion of the left valve; this ossicle reduces the large space between the two umbones, and is a partial ossification of the internal connector, appearing to support the cartilage by a closer and more direct action in counteracting the contraction of the adductors instead of a long lateral extension across the deep umbonal region. My Crag species is thick, strong, and convex, and among about a hundred specimens (good and bad) that I have collected from the Coralline Crag I have never seen one fractured in the umbonal region; its large adductors and projecting riblets must enable the animal to firmly close itself within the shell. The absence of the ossicle in *Pandora* may be from the form of the valves, the upper one being somewhat convex *internally*, by which the connector would have a nearer and more direct or vertical action.

In my Monograph of the 'Crag Moll.,' vol. ii, p. 150, the Crag species was thought to be the same as a fossil from Calabria, figured by M. Philippi under the generic name of *Hippagus*, which I adopted. Dr. Lea, who proposed the name of *Hippagus*, has lately sent to Mr. Jeffreys a specimen of the American fossil so called. This appears to belong to the family *Mytilidæ*, and in no way related to *Verticordia*. I have therefore resumed the generic name proposed for this Crag shell when first figured in 'Min. Conch.,' t. 639, in 1844, viz. *Verticordia*, and I purpose here to introduce some Eocene shells in it. This name *Verticordia*, I should add, was employed by Dr. J. E. Gray in his 'Brit. Mus. Catalogue' for 1840, and he tells me (in letter) that he merely adopted it as my manuscript name; both he and myself then imagining the genus to belong to the *Lucinidæ*.

M. Fischer, in the 'Journ. de Conch.,' vol. x, p. 378, has enumerated five recent species and four fossil, but this number will have to be considerably reduced. One fossil that may be referred to this genus has been long known, and was described as *Chama argentea* in 1797, according to Pecchioli, and in 1852 this shell was proposed as the type of a genus by Meneghini, under the name of *Pecchiolia*.

The four Eocene species I propose here to introduce are very rare and have the two valves united, or at least are the casts of those shells when so existing, and the interiors are not visible, though I have no doubt of their belonging to this genus, and possessing the same kind of hinge as my little Crag shell. M. Deshayes has figured and described one species from the Paris Basin. In the sandy formation of the Coralline Crag the valves, as might be supposed, are separated and displaced, with the ossicle, of course, removed. In the clayey beds of the Eocene deposits the two valves are in contact, but the margins all round are so closely united that I am unable to see anything like an osselet.

1. Verticordia formosa, *S. Wood.* Tab. XXI, fig. 6 *a, b.*

Spec. Char. V. Testâ minimâ, suborbiculari, vel sphæroideâ, tumidâ, inflatâ, tenui, inæquilaterali, costatâ; costis paucis, distantibus, intermediis, striatis; umbonibus prominentibus; lunulâ parvâ, profundâ; apice acutâ, valdè incurvatâ; marginibus crenulatis.

Shell small, very tumid, thin, inequilateral, with a few large radiating riblets, and wide interspaces covered with striæ; beaks small, incurved, rather prominent; lunule small, deep; margins crenulated.

Diameter, $\frac{1}{4}$ of an inch.

Locality. London Clay, Whetstone (*Wetherell*).

A single specimen, unfortunately not in good condition, is in the cabinet of Mr. Wetherell, and as this came from a well-digging it may be some time ere another presents itself. I am glad to have the opportunity of bringing it into notice, which the owner has kindly permitted me to do. Although not perfect, there is a small portion of the exterior of the shell remaining, and from this I imagine it did not possess more than half the number of riblets that there are upon *sulcata,* perhaps not more than a dozen; these are not large nor very much elevated; they stand far apart, with a broad intervening space, and in this there are about three or four intermediate smaller rays or coarse striæ. It has some slight resemblance to *Trigonulina ornata* (D'Orbigny).

2. Verticordia obliquata, *Edwards,* MS. Tab. XXI, fig. 8, *a, b.*

Spec. Char. V. Testâ minimâ suborbiculari, tumidâ, inflatâ, tenui, fragili; valdè inæquilaterali; costatâ vel striolatâ, costulis circa 26, *convexiusculis; umbonibus prominulis, incurvatis, acutis; lunulâ parvâ, profundâ; marginibus crenulatis.*

Shell minute, orbicular, tumid, and inflated, thin and fragile; very inequilateral; riblets about 26, rounded; beaks incurved, sharp; umbonal region prominent; lunule small, deep; margins crenulated.

Diameter, $\frac{3}{8}$ths of an inch.

Locality. Bracklesham (*Edwards*).

A single specimen of this species is all that I have seen. It appears to be distinct from the London Clay shell, differing, as it does, in some particulars; it is rather less in size, but this might be from difference in age. The ribs are not so numerous, and they have a greater curve, especially in the pedal region. The ribs are rounded, and about as broad as the spaces between them, and the exterior appears to have been slightly pustular, both over the ribs as well as between them. The valves are united, and the specimen is not in good condition. (The engraved figure is slightly enlarged.)

3. Verticordia sulcata, *J. Sowerby.* Tab. XXI, fig. 9, *a, b.*

Isocardia sulcata, *J. Sow.* Min. Conch., tab. 295, fig. 4, 1821.
— — *Morris.* Catal. Brit. Foss., p. 204, 1854.

Spec. Char. V. Testá minimá, orbiculari vel sphæroideá, tumidá, inflatá, tenui, valdè inæquilaterali, radiato-costulatá, costulis convexiusculis; umbonibus magnis obliquis incurvatis; lunulá parvá, profundá, ovatá; marginibus crenulatis.

Shell small, orbicular, or rather spheroidal, tumid, and inflated, thin, very inequilateral, with radiating and somewhat curving ribs; beaks large, obliquely incurved; lunule small, deep, and ovate; margins crenulated.

Diameter, $\frac{7}{16}$ths of an inch.

Localities. London Clay. Potter's Bar and Sheppey (*Edwards*), Whetstone and Chalk Farm (*Wetherell*).

A few specimens only of this species have as yet been found, although they are distributed through several localities. These unfortunately have the two valves united, so that the interior has not yet been seen.

The shell is very tumid, and with the valves united is nearly spherical; the riblets or costulæ appear to have been nearly convex; but there is so little of the true shell or exterior remaining, that I am unable positively to say what was the correct shape of these ribs; the spaces between them appear to have been about the same breadth; the umbo tumid and prominent, with the beaks much inflexed and very excentric, curving over a deep lunular depression. Pyritous casts are also found at Sheppey.

4. Verticordia propinqua, *S. Wood.* Tab. XXI, fig. 7.

The specimen from which my figure is taken is merely a cast; it comes from the cabinet of Mr. Edwards, and, from its possessing a larger number of ribs or riblets and being more oblique in outline than any of the other species, I have presumed it to be distinct. It is from a cutting in the London Clay at Highgate. The name is, however, provisional, and it is figured for the purpose of calling attention to its existence.

The nacreous composition of these shells seems to have been unfavorable to their preservation.

CARDITA. *Bruguière*, 1789.

Generic Character. Shell thick, strong, equivalved, closed, oblong, or suborbicular; ornamented externally with radiating ribs or costæ, more or less elevated; hinge with two teeth in the right valve, interlocking, one short and straight, the other oblique and elongated, with one small lateral tooth; impression of pedal muscle close to the oral adductor; mantle-mark without a sinus; connexus ligamental.

Animal with the edges of the mantle disunited except at the siphonal extremity, where they are connected to form two short siphons; branchial margin cirrated; foot elongated.

The genus, as here employed, is intended to comprise all those transverse or elongated forms that were for some time considered to be entitled to generic isolation under the name *Venericardia*, as well as those which are circular or lenticular, possessing the same kind of hinge. The line of separation between the transverse and the orbicular is so indistinct that it is not possible to define it. Nearly all conchologists are now agreed to employ but one generic name, and the above is the older of the two.

The exterior of the shell has generally radiating and elevated costæ, but there are some small species with the characteristic form of dentition in which this character is lost, the surface not only becoming smooth, but a few have ridges produced by elevated lines of growth in a transverse or concentric, and occasionally in an oblique direction.

These latter species closely approach the genus *Astarte*, differing only in having an elongated and oblique tooth in the hinge of each valve. The margins of these small species are denticulated; but, unlike those of *Astarte*, they appear to be thus ornamented at all ages. Those species whose shells are furnished with coarse, elevated, and radiating ridges have them produced beyond the margin, where they interlock the one with the other; but the small smooth species have the crenulations imposed upon the inner margin of the shell. These are quite independent of any external rays, and the animal which forms them has probably fimbriated edges to the margins of the mantle. The thick and ponderous species not only firmly interlock by the projecting ridges at the margin, but the animals are furnished with powerful adductors, deeply implanted in the interior of the shell, implying thereby considerable force for closing the valves. It is said that the animal spins a byssus with its foot. All the species I have seen are capable of firmly closing the ventral margin of the valves, and appear to be free species.

In the recent state the shells are covered with an epidermis. The genus has a wide geographical extension, but it has more of a tropical or subtropical character than otherwise; one species is living on the coast of Ochotsk, while some inhabit the seas of the torrid zone. Its vertical range is also great, extending to 150 fathoms. The animals prefer a sandy bottom. In a fossil state it is found as low as the Trias. The species present very considerable variation in regard to magnitude. *C. planicosta* measures 5 inches in diameter, while *C. atomus* is, according to M. Deshayes, only 1 millimètre in diameter; but they all possess considerable solidity.

1. CARDITA ACUTICOSTATA? *Lamarck.* Tab. XXII, fig. 5, *a, b.*

VENERICARDIA ACUTICOSTATA (?), *Lamarck.* An. du Mus., t. vii, p. 57, No. 4, 1807.
— — *Desh.* Coq. foss. des Env. de Par., t. i, p. 153, pl. 25, figs. 7, 8, 1825.
CARDITA — *Nyst.* Coq. foss. de Belg., p. 208, pl. 16, fig. 6? 1843.
— — *J. Sow.* In Dixon's Geol. of Sussex, p. 92, 1850.
— — *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 760, 1858.
CARDIUM SERRIGERUM, *Lamarck.* An. sans Vert., t. vi, p. 19, No. 8, fide Desh., 1819.

Spec. Char. "*C. Testâ subrotundâ, tumidâ, cordiformi, subobliquâ, crebricostatâ, costis angustis, angulatis, squamoso-serratis, anticis duplicatis.*" (*Deshayes.*)

Shell suborbicular, tumid, heart-shaped, slightly oblique, costated; ribs narrow, angulated with squamose tubercles.

Diameter, $\frac{5}{8}$ths of an inch.

Locality. Bracklesham (*Edwards*).
France: Chaumont, Grignon, Parnes, Courtagnon (*Deshayes*).
Belgium: Aeltre, près de Bruges (*Nyst*).
Asia Minor, sec. Deshayes: Egypt, fide Bellardi.

M. Deshayes, as above referred to, speaks of this species as a British fossil, but as differing from the French shell in the number of costæ. He observes, "Dans l'espèce d'Angleterre ces côtes sont au nombre de vingt seulement; on en compte trente, quelquefois trente deux dans l'*acuticostata.*" Our shell has 24 to 26 costæ, and appears to correspond better with the Belgian fossil of that name, which is said to have 26. The costæ upon our specimens are more or less imbricated all over, but especially so on those in the pedal region. The ribs have a central keel, and there is a faint ray on each side, dividing the rib, as it were, into four parts, two on each side of the central keel. This appears to differ from *C. carinata* of 'Min. Conch.' in being less elongated, and in the ribs being more regularly nodulous.

Fig. 11, Tab. XXII, represents a specimen from Bramshaw; it has on the tablet the MS. name of *C. asperrima.* It is intermediate between *acuticostata* and *carinata,* but is not, I think, sufficiently distinct to form a species of itself, but an abnormal form, and for the present it is placed as a var.—*C. acuticostata,* var. *asperrima.*

2. Cardita alticostata, *S. Wood.* Tab. XXI, fig. 3.

Spec. Char. *C. Testâ minimâ, orbiculari, turgidâ, subinæquilaterali, radiatim costatâ, costis circa* 13 *elevatis acutis compressis utrinque nodulosis; umbonibus minutis, obliquis, depressis, subincurvatis; lunulâ minutâ.*

Shell small, orbicular, and nearly spherical, nearly equilateral, costated with about 13 elevated ribs; beaks small, oblique, depressed, slightly incurved; lunule small.

Diameter, $\frac{1}{4}$th of an inch.

Locality. London Clay, Highgate (*Edwards*).

One pretty little specimen is in Mr. Edwards's cabinet, and this appears to me to be entitled to a specific position; its principal distinction is an elevated and compressed rib, the lower part of which is angular; on the top of this angle is an elevated ridge, not very sharp; on each side of these ridges are some large and distinct nodules, but the centre is smooth.

3. Cardita Brongniartii, *Mantell.* Tab. XXII, fig. 9.

Cardita Brongniartii, *Mant.* Geol. of the South East of Engl., p. 368, 1833.
— — *J. Sow.* In Dixon's Geol. of Suss., pp. 116, 225, t. xiv, fig. 33, 1850.

Spec. Char. *C. Testâ transversâ, irregulariter ovatâ, vel obliquè subtriangulatâ, valdè inæquilaterali, crassâ, tumidiusculâ; siphoni-regione subangulatâ; radiatim costatâ, costis* 30—32 *depressis, rugosis; umbonibus subprominentibus lunulâ minimâ profundâ; cardine crassiusculo.*

Shell transverse, irregularly ovate or obliquely subtriangular; very inequilateral, thick, slightly tumid, siphonal region roundedly triangular; costated, ribs about 30, rough and depressed; umbones not prominent; lunule heart-shaped, small and deep; hinge moderately thick.

Length, 2 inches; *height,* $1\frac{1}{2}$ inch.

Localities. London Clay, Bognor. Var., fig. 12, *a, b,* Tab. XXII, Clarendon.

This species is, I believe, peculiar to England, and it has been long known from the locality of Bognor. Mr. Edwards's cabinet contains also a large suite of specimens from Clarendon. This latter shell is here placed as a variety; it differs somewhat in form, being less elongated, and has considerable resemblance to *planicosta,* but it is never so large as that species, nor the ribs so flat. Called by Mr. Edwards *Clarendonensis.*

4. Cardita carinata, *J. Sowerby*. Tab. XXII, fig. 15, *a*, *b*.

Venericardia carinata, *J. Sow.* Min. Conch., t. 259, fig. 2, 1820.

Spec. Char. *C. Testâ elongato-transversâ vel ovato-oblongâ, compressiusculâ, tenui, valdè inæquilaterali, radiatim costatâ, costis* 20—22, *angulatis, carinatis, et nodulosis; margine ventrali convexiusculis; umbonibus minimis, obliquis, depressis; lunulâ minutissimâ, profundâ, lævigatâ; cardine angusto, dentibus elongatis.*

Shell elongately transverse or ovately oblong, slightly compressed, thin, very inequilateral; radiatingly costated with 20 to 22 angular, carinated, and nodulous ribs; ventral margin slightly curved; beaks small, depressed, lunule deep and smooth; hinge narrow, teeth elongated.

Length, $1\frac{1}{4}$ inch; *height,* $\frac{7}{8}$ths of an inch.

Locality. Bracklesham Bay.

This is an elegant species, and by no means rare at the above locality, to which it appears to be restricted. The shells are thinner and more fragile than those of the generality of species in this genus. The ribs upon this species are triangular and obsoletely tricarinate, that is to say, there are two faint rays, one on each side of the regular keel, which is in perfect specimens ornamented with nodules; the bases of the ribs meet, and there is no flat part in the interspaces. The siphonal region is rather compressed, or not so tumid as the pedal side. The interior is thickened in aged specimens, and the muscle-marks then deeply impressed.

5. Cardita crebrisulcata, *Edwards*, MS. Tab. XXII, figs. 4 and 8.

Spec. Char. *C. Testâ suborbiculari, inæquilaterali, turgidâ, crassâ, subsphæricâ, radiatim costatâ, costis* 20—24, *angustis, squamosis, squamulis imbricatis; umbonibus parum obliquis, cordatis; lunulâ lævigatâ, concaviusculâ; cardine angusto, dente unico in valvâ dextrâ elongato; dentibus duobus in alterâ valvâ.*

Shell suborbicular, inequilateral, tumid, thick, nearly spherical; costated ribs 20—24, narrow, and ornamented with numerous fine imbrications; umbones slightly oblique, heart-shaped; lunule short, smooth, slightly depressed; hinge narrow; one elongated tooth in right valve, with a narrow depression in the left.

Diameter, $\frac{5}{8}$ths of an inch.

Localities. Bramshaw and Huntingbridge (*Edwards*).

This much resembles *sulcata*, but it has a larger number of ribs, and these are more prominent, nodulous and imbricated; the interspaces are narrow and deep.

There are also some other specimens, to which is attached the name of *subprofunda*

(Tab. XXII, fig. 2, from Brook), which appear to me to be a variety of this species. These are not quite so much inflated; they resemble much the figure and description of *C. Aizyensis*, Desh., differing slightly in the ornamentation. Our shells are not quite orbicular, but have a greater diameter from the umbo to the ventral margin than in the opposite direction.

6. Cardita Davidsoni, *Deshayes*. Tab. XXII, fig. 17, *a*, *b*.

Cardita Davidsoni, *Desh.* An. sans Vert. du Bas. de Par., t. i, p. 764, pl. 60, figs. 10—12, 1860.

Spec. Char. *C. Testá orbiculato-subtrigonulá, depressiusculá, crassá, inæquilaterali, radiatim costatá, costis* 17—19 *angustis, distantibus, obsoletè tricarinatis; crenato-squamosis, interstitiis latis, irregulariter striatis; umbonibus acutis; lunulá minimá, lævigatá; cardine crassiusculo.*

Shell roundedly trigonular, somewhat depressed, thick, inequilateral; costated ribs 17—19, distant, narrow, and obsoletely triangular; outer keel covered with rather distant squamose tubercles; interstices broad, and covered with concentric striæ or irregular lines of growth; beaks sharp, lunule small and smooth.

Diameter, $\frac{5}{8}$ths of an inch.

Locality. Barton.

France: Ver. Ermonville (*Desh.*).

This species is by no means rare in England at the above locality; it much resembles *C. sulcata*, but it is not so tumid, the costæ are fewer, more distant, the tubercles on the ribs are not so numerous, the ribs are more angulated and not so rounded, and there is generally a distinct line on each side of the keel. The elongated tooth is nearly parallel with the ligamental fulcrum extending laterally beyond it. The valves are not so frequently found united as are those of *sulcata*.

7. Cardita deltoidea, *J. Sowerby*. Tab. XXII, fig. 7, *a*, *b*.

Venericardia deltoidea, *J. Sow.* Min. Conch., tab. 259, fig. 1, 1821.
— latisulcata, *Nyst*. Coq. foss. de Belg., p. 209, pl. xv, fig. 5, *a*, *b*, 1843, fide Von Könen.

Spec. Char. *C. Testá obliquá, subtrigoná vel deltoideá, crassá, convexiusculá, inæquilaterali, radiatim costatá, costis* 15—18 *acutis, elevatis, distantibus; lunulá magná, lævigatá, depressá; umbonibus elevatis, incurvis, obliquis; cardine crassissimo.*

Shell oblique, subtrigonular or deltoidal, thick and strong, slightly convex, inequilateral; costated with 15 to 18 sharp, elevated, and somewhat distant ribs; lunule large, smooth, depressed; beaks prominent, slightly incurved; hinge very thick.

Diameter, $1\frac{1}{8}$th of an inch.

Locality. Lyndhurst (*J. Sowerby*); Brockenhurst (*Edwards*).
Belgium: Hoesselt, Vliermaet, and Lethen (*Nyst*).

This is a handsome shell, and it is more readily distinguished than the generality of species in this genus; its deltoid form and great elevation of umbo are its most prominent features. The costæ are distant, especially towards the pedal region, triangular in shape, with broad interspaces; the top of the rib is small, not sharp, rather flattened, but narrow; the hinge is broad in consequence of its elevated umbo, teeth large, and the muscle-marks deeply impressed. It is, I am told, abundant at Brockenhurst, where the valves are frequently found united. In Morris's 'Cat. Brit. Foss.' it is quoted from Barton, but I have not seen it from that locality.

8. CARDITA ELEGANS, *Lamarck*. Tab. XXII, fig. 16, *a, b*.

VENERICARDIA ELEGANS,		*Lam.*	An. du Mus., t. vii, p. 59, No. 10, and t. ix, pl. 32, fig. 3, *a, b*. 1807.
—	—	*Desh.*	Hist. des An. des Env. de Par., t. i, p. 157, pl. 26, figs. 14—16. 1824.
CARDITA	—	*Nyst.*	Coq. foss. de Belg., p. 215, pl. 17, fig. 2, 1843.
—	—	*J. Sow.*	In Dixon's Geol. of Suss., p. 169, pl. 3, fig. 15. 1850.
—	—	*Desh.*	An. sans Vert. du Bass. de Par., t. i, p. 772, 1859.

Spec. Char. C. "*Testâ subrotundâ, depressiusculâ, tenuè costatâ; costis numerosis, compressis, eleganter squamosis; lunulâ ovato-lanceolatâ.*" (*Deshayes.*)

Shell somewhat rounded and slightly depressed, with numerous ribs, thin, compressed, and elegantly ornamented; lunule ovately elongated.

Diameter, $\frac{3}{8}$ths of an inch.

Localities. Bracklesham, Stubbington (*Edwards*).
France: Grignon, La Montagne de Laon, Soissonais (*Deshayes*).
Belgium: Forêt, Laeken (*Nyst*).

This species is by no means rare in England, and I believe it is also abundant in France; it much resembles the young state of *C. imbricata*, but our present shell never attains to the magnitude of that species; it differs in being rather more tumid, and there is also a slight difference in the costæ, which in this species are less numerous, varying from 17 to 20; there is likewise a greater interspace between the ribs, and the ribs themselves are more nodulous than they are in *imbricata*.

There is a variety from Bramshaw, in which the ribs are sharper and higher (var. *subelegans*).

9. CARDITA IMBRICATA, *Lamarck.* Tab. XXI, fig. 10.

VENUS IMBRICATA, *Chen.* Conch. Cab., t. vi, t. 30, figs. 314, 315, 1782.
— Ency. Meth., pl. 274, fig. 4, *a, b.*
— IMBRICATA, *Gmel.* Syst. Nat., p. 3277, No. 34, 1815.
— — *Lamarck.* An. du Mus., t. ix, pl. 32, fig. 1.
VENERICARDIA — *Bronn.* Syst. der Urw., p. 51, pl. 4, fig. 7, 1824.
— — *Desh.* Coq. foss. des Env. de Par., t. i, p. 152, pl. 24, figs. 4, 5, 1824.
CARDITA — *Nyst.* Coq. foss. de Belg., p. 209, No. 167, 1843.
— — *Desh.* An. sans Vert. du Bas. de Par., t. i, p. 759, 1860.

Spec. Char. *C. Testâ crassâ, suborbiculatâ, cordiformi, subobliquâ, inæquilaterali; radiatim costatâ costis numerosis, convexis, separatis, imbricato-squamosis; umbonibus subelevatis obliquis, cordatis; lununâ minimâ profundissimâ.*

Shell thick and strong, suborbicular, oblique, inequilateral, costated; ribs numerous, convex, distinctly separated, covered with imbricated nodules; beaks small, slightly incurved, and heart-shaped; lunule minute and deep.

Diameter, $1\frac{1}{2}$ inch.

Locality. Bracklesham Bay.
France: Montmirail, Grignon, Courtagnon, &c. (*Desh.*).
Belgium: Forêt, Laeken, Gand (*Nyst*).
Asia Minor: Zafranboli (*Desh.*).

This is rare in England, and I have seen only one specimen. It is very abundant at Grignon. In these the large oblique tooth of the left valve extends as far as the ligamental fulcrum, and in perfect specimens this tooth is vertically striated.

M. Nyst has considered this species in his description as probably identical with *Venericardia rotunda,* Lea, to which certainly it bears resemblance; but from the description by Lea the ribs of his shell appear to be more thickly imbricated, and his figure does not represent it as so oblique.

The variety called *spissa* by D'Orbigny I do not know.

10. CARDITA MITIS? *Lamarck.* Tab. XXII, fig. 3, *a, b.*

VENERICARDIA MITIS? *Lamarck.* An. sans Vert., t. v, p. 611, No. 6, 1805.
— —? *Desh.* Coq. foss. des Env. de Par., t. i, p. 155, pl. 25, figs. 9, 10, 1824.
CARDITA — *J. Sow.* In Dixon's Geol. of Suss., p. 92, 1850.

Spec. Char. *C. Testâ rotundato-subobliquâ, crassiusculâ, tumidâ, cordiformi, inæquilaterali, costatâ, costis* 23—26, *in medio lævigatis, convexis, utroque leviter granosis.*

Shell orbicular, slightly oblique, not very thick; tumid, heart-shaped, inequilateral; costated, ribs 23—26, convex and smooth on the centre of the shell, slightly granular on each side, particularly those in the pedal region.

Diameter $\frac{1}{2}$ an inch.

Localities. Bracklesham, Selsey, Brook (*Edwards*).

In Mr. Dixon's work, and also in Mr. Morris's 'Catalogue of Brit. Fossils,' is the name of *C. mitis.* The specimen from which our figure is taken has likewise the same name in MS., and I have therefore here retained it, although it does not fully accord with the description of the French species of that name. M. Deshayes considered his shell entitled to be separated from *C. planicosta* (the young of which it much resembles), principally on account of the difference in number of costæ, which in *mitis* are said to be as many as thirty-nine, while in *planicosta* there are not more than thirty, and this latter number is the full extent of what our shell possesses. Still, I think our British fossil is not the young of *planicosta,* as it differs in outward form in being more orbicular, more tumid, and less oblique, and the ribs in *planicosta* are flatter even in the young shell than they are in our present species. In this shell the costæ in the pedal region are covered with obtuse tubercles or nodules, and the ribs are not wider than the interspaces.

11. Cardita obovata, *Edwards,* MS. Tab. XXII, fig. 13.

Spec. Char. C. Testâ transversâ, elongatâ, oblongâ vel subquadrangulari; valdè inæquilaterali, radiatim costatâ, costis numerosis depressis, subplanatis; umbonibus obliquis, depressis; lunulâ parvâ, cordiformi; cardine crassiusculo.

Shell transverse, elongate, oblong or irregularly quadrangular, very inequilateral; costated ribs numerous, somewhat depressed; lunule small concave, heart-shaped; hinge moderately thick.

Length, $\frac{7}{8}$ths of an inch; *height,* $\frac{3}{4}$ths of an inch.

Locality. Bracklesham.

Two specimens are in Mr. Edwards's cabinet, to which he has given the above name, and I have provisionally adopted the separation he has made. The form of the shell is different from that of any other except *carinata,* to which it may, perhaps, be referred as a variety; but our present species has a greater number of ribs (thirty), whereas in *carinata* there are only twenty-two. In this the costæ are not so angular, and they are more nodulous.

12. Cardita oblonga, *J. Sowerby*. Tab. XXII, fig. 14, *a*, *b*.

Venericardia oblonga, *J. Sow.* Min. Conch., t. 289, fig. 2, 1821.

Spec. Char. *C. Testâ transversâ, oblongâ, crassiusculâ, subquadrangulari, valdè inæquilaterali; radiatim costatâ, costis* 13—15, *elevatis, tuberculosis; umbonibus depressis; lunulâ parvâ, cordiformi; cardine crassiusculo.*

Shell transverse, oblong, subquadrangular, thick, strong, very inequilateral; costated with 13—15 tuberculated ribs; beaks depressed; lunule small, heart-shaped, depressed; hinge moderate.

Length, $\frac{11}{16}$ths of an inch; *height*, $\frac{1}{2}$ an inch.

Localities. Barton, Hordle, Highcliff, Bracklesham (*Edwards*).

This is a pretty species, and abundant at Barton. The umbo sometimes extends beyond the pedilateral margin, and the hinge is quite at the extremity of the shell; the ventral margin in some specimens has a slight curve inwardly, with the impression of adductors large and distinct; the ribs are covered with nodules, and they are about as wide as the depressed spaces between them.

Mr. J. Sowerby, in 'Min. Conch.,' says that it occurs in France, but I have not been able to ascertain its locality.

In two or three of these oblong species there is a small distinct denticle on the pedal side of the hinge in the left valve, with a depression for its reception in the right; this is immediately above the impression of the pedal muscle. Fig. 18, Tab. XXII, represents what I at first thought might be specifically distinct, the umbo projecting beyond the margin, with more depressed and rounded ribs, which are less tuberculated; but I believe it to be only a variety (*C. oblonga*, var. *transversa*). It is from the Fluvio-marine at Hordle.

Fig. 10, Tab. XXII, represents another form, probably, of this species; it had in MS. the name *C. serratina*. It is not so tumid as the normal form, it is less transverse, and the costæ are more regularly nodulous. I think it is only a variety It was found at Mead End, Headon Hill, and Barton.

Fig. 11, Tab. XXI, represents a small specimen in Mr. Edwards's cabinet, which at one time I thought might be a distinct species; but having only one specimen, and that, perhaps, distorted, I have considered it as a variety (*C. oblonga*, var. *trapezoidalis*). It is from High Cliff, Barton.

13. Cardita paucicostata, *Sandberger*. Tab. XXII, fig. 6, *a*, *b*, *c*.

Cardita paucicostata, *Sandb.* Conch. d. Mainz. Beckens, p. 337, t. 24, f. 6, 1863.

Spec. Char. *C. Testâ rotundato-trigonulâ, crassâ, convexiusculâ, costatâ, costis paucis, elevatis, nodosis, distantibus; subinæquilaterali; lunulâ brevi, concavâ; umbonibus obliquis* *cordatis; cardine crassiusculo, in valvulá dextrá dente elongato, in valvulá sinistrá dentibus duobus obliquis.*

Shell roundly trigonal, thick, and slightly convex; costated, ribs few, elevated, and distant; shell slightly equilateral; lunule concave; beaks prominent and oblique; hinge thick, one tooth in the right valve elongate and oblique, with two in the left valve interlocking.

Diameter, $\frac{1}{4}$ of an inch.

Locality. Headon Hill, Roydon (*Edwards*).

This shell does not appear to be rare. I have referred it to Sandberger's species, depending upon his description and figure. Its principal distinction is a paucity of ribs, not amounting to more than fourteen or fifteen; these are narrow and distant on the pedal side, with large and flat interspaces between them. The ribs are covered with regularly placed nodules, not imbricated. It is named in Mr. Edwards's cabinet *Cardita nodicostata*, and considered by him as distinct, in consequence of the ribs being more nodulous or ornamented.

14. Cardita planicosta, *Lamarck*. Tab. XXI, fig. 5, *a—d*.

Knorr. Petrif., part 2, tab. 23, fig. 5. 1755.
Seba. Thesaurus, vol. iv, pl. 106, fig. 36, 1765.
Venericardia planicosta, *Lamarck.* An. du Mus., t. vii, p. 55; and t. ix, pl. 31, fig. 10, 1807.
— — *J. Sowerby.* Min. Conch., t. l, 1814.
— — *Desh.* Coq. foss. des Env. de Par., t. i, p. 149, pl. 42, figs. 1—3. 1824.
— — *Bronn.* Lethæa Geogn., t. xi, p. 946, pl. 38, fig. 7, 1836.
Cardita — *Nyst.* Coq. foss. de Belg., p. 205, pl. 17, fig. 1, 1843.
— — *Conrad.* Foss. Shells of the Tert. Form. of N. Amer., p. 20, t. v, fig. 2, 1832.
— — *J. Sow.* In Dixon's Geol. of Suss., pp. 92, 169, pl. 2, figs. 14, 18, 1850.
var. minor, Venericardia suessoniensis, *D'Archiac.* Desc. Geol. du Dep. de l'Aisne, p. 272, fide Desh.

Spec. Char. *C. Testá magná, ovato-obliquatá, cordatá, crassissimá, radiatim costatá, costis planulatis; apice acutá incurvatá, aliquando gratulatá; lunulá profundissimá, latá, cordatá; margine crenato; dentibus cardinalibus binis, tenuissimè striatis.*

Shell large, obliquely ovate, heart-shaped, very thick; costated, ribs broad and flat; umbonal region prominent, sometimes granulated; lunule deeply impressed, heart-shaped; margin dentated; cardinal teeth two, finely striated transversely.

Diameter, $4\frac{1}{4}$ inches.

Localities. Britain: Bracklesham, Bramshaw, Brook, Stubbington, Selsey, Alum Bay (*Edwards*). Bagshot and Hawley (*fide R. Jones*).

France: Sables inférieurs, Calcaire grossier, Sables moyens (*Deshayes*), Faluns de Touraine? (*Desh.*).

Belgium: Gand, Lovain, &c. (*Nyst*).

North America: Claiborne, Alabama (*Conrad*).

This species is abundant in individuals, and may be obtained, of all ages and all sizes, on the beach at Bracklesham. M. Deshayes speaks of it as also abundant in France, where it is disseminated through a series of deposits. I have never seen it from Barton. It is a very handsome shell, and its great solidity has been favourable to its preservation.

The interior of the shell in aged specimens is often much thickened, by which means the impressions of the adductors are deeply seated. This animal has also left two small distinct, and deep impressions by the pedal muscles, the one above the oral, the other over the anal adductor, indicating, probably, the possession of a large and falcated foot. The hinge is variable; in some specimens it is very thick, with an elevated umbo, in others it is correspondingly depressed, with a narrow hinge-line, and the contour of the shell is very variable, some specimens being considerably higher than they are long, while others have the length greater than the height.

In the young state the ribs are generally more or less rounded, but they become flat with the increase of age, and in old specimens the ribs are almost obliterated at the outer edge; they vary in number from twenty-seven to thirty.

This is one of those species possessing a wide geographical range. Sir Charles Lyell gives it as a species from Coggins Point, on the James River, below Richmond, in America ('Proc. Geol. Soc.,' vol. iv, p. 564, 1845), and says it cannot be distinguished from one of the common varieties of the European shell. Mr. Conrad speaks of his shell as having twenty-two ribs.

15. Cardita simplex, *Edwards*, MS. Tab. XXI, fig. 4.

Spec. Char. *C. Testâ crassâ, suborbiculatâ, convexâ, inæquilaterali, radiatim costatâ, costis circa* 15, *angustis, distantibus, simplicibus, interstitiis latis, lævigatis; umbonibus prominulis; lunulâ minimâ elongatâ; cardine crassiusculo.*

Shell thick, suborbicular, convex, inequilateral, with about 15 radiating ribs, subangular, thin, and distant, spaces between them broad and smooth; beaks slightly elevated, lunule small and elongated, hinge moderately thick.

Diameter, $\frac{1}{2}$ an inch.

Locality. Roydon (*Edwards*).

This does not appear to be abundant. Its principal distinction is in the character of the ribs, which in this species are free from imbrications, nodules, or rugosities of any kind, rather a rare circumstance with species in this genus.

Fig. 12 of the same plate represents a specimen from High Cliff, Barton, which, I think, may be considered a variety of this species; it has fewer ribs and wider spaces, but it is equally unarmed.

16. Cardita sulcata, *Solander.* Tab. XXII, fig. 1, *a, b.*

Chama sulcata, *Sol.* (in Brander). Foss. Hanton., pl. 7, fig. 100, 1776.
Venericardia cor-avium, *Lamarck.* An. du Mus., t. vii, p. 58, No. 7, 1806.
— — *Desh.* Coq. foss. des Env. de Par., t. i, p. 156, pl. 24, figs. 6—8, 1824.
— globosa, *J. Sow.* Min. Conch., t. 289, fig. 1, 1821.
Cardita cor-avium, *d'Orb.* Prod. de Paleont., t. 11, p. 423, No. 1613, 1850.
— sulcata, *Id.* ,, ,, ,,
— — *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 768, 1858.

Spec. Char. C. Testâ rotundato-globosâ, cordiformi, turgidâ, inæquilaterali, radiatim costatâ, costis 16—20, *elevatis, rugosis, convexis, imbricato-squamosis vel nodulosis; lunulâ latâ, profundâ; umbonibus incurvis.*

Shell roundly globose, heart-shaped, tumid, inequilateral; costated, ribs 16—20, elevated, convex, and rugose, covered with coarse imbrications or nodules; lunule broad and deep; beaks incurved.

Diameter, $\frac{3}{4}$ of an inch, nearly.

Locality. Barton.

France: Ezanville, &c., Sables moyens (*Deshayes*).

Prof. Morris and M. Deshayes have both, and I think very justly, restored to this species the name originally given to it by Solander. Probably Lamarck was not aware that his species had been found in England, or had been figured and described in an English work.

This is most abundant as individuals, at Barton, where it may be considered as one of the characteristic species of that deposit. The reason why this appears not to have been referred to *cor-avium* by Mr. Sowerby was a difference in the hinge between the French and English shells; but this is a variation that may be observed among a large suite of specimens of the British fossil, which will be found to exhibit the broad hinge as well as the narrow one, and I believe with the above-mentioned authors that they constitute but one species. There is a variety at the same locality which differs in having the ribs more distinctly covered with nodules, whereas in the typical form the ribs are more rugose and without distinct tubercles. Var. β of J. Sowerby makes an approach towards *C. Davidsoni,* in which the ribs are sharper.

17. Cardita corpusculum, *S. Wood.* Tab. XXI, fig. 1, *a, b.*

Diameter, $\frac{1}{2}$ a line.

Locality. Barton (*Edwards*).

A few specimens in Mr. Edwards's cabinet, of a very minute size, appear to belong to this genus, and I have given to them the above name provisionally. They are of a somewhat aberrant character, the cardinal denticle of the right valve being short and triangular, like that of *Astarte,* instead of being elongate. They have also a very distinct and distant lateral tooth on the pedal side, prominent in the left valve, and interlocking in a corresponding depression in the right. From this peculiarity of hinge I have imagined this to be a distinct species, and not the young state of a larger kind; it resembles in size a small species of the Paris basin, figured and described by Prof. Deshayes under the name of *C. atomus,* but it has more numerous and more distinct ribs, and our shell is more orbicular. Four specimens are in Mr. Edwards's cabinet, and two of these possess a circular opening or zoophagous perforation. This is, I believe, *Goodallia granulosa,* Tennant, 'Strat. List Brit. Foss.,' p. 30, 1847.

ASTARTE. *J. Sowerby,* 1816.

Generic Character. Shell sub-triangular, sub-orbicular, or oblong, generally compressed; thick, strong, smooth or concentrically ridged, equivalved, closed; hinge with two diverging cardinal teeth in the left valve, with a triangular space between them for the reception of a prominent tooth of the same form in the right, with generally a lateral tooth or raised margin, and a corresponding depression for its reception in the opposite valve; adductor muscles deeply impressed, with a small pedal one within or above the oral adductor; palleal line without a sinus; connexus ligamental.

Animal with the edges of the mantle disunited; siphonal openings simple, not extending beyond the shell; foot rather small; tongue-shaped.

This genus comprises an interesting group of animals, and is largely developed in the Upper Tertiaries in Europe, as also in America. It is found in this country in Secondary Formations, where species are by no means scarce; and it has been said to indicate by its presence in any fossilliferous deposit the conditions of very diminished temperature; but it occurs in association with Tetrabranchiate Cephalopoda, the supposed inhabitants of warm or tropical regions, and at such an horizon of the London Clay (Highgate and Sheppey) as proves its very close synchronism with, and contiguity to, the gigantic *Ophidia, Chelonia, Crocodilia,* and rich Flora of Sheppey.

A great many species in this genus (*Astarte*) have the interior margins of the shell ornamented with crenulations, while in others these margins are plain. The same distinction may be seen in the genus *Nucula*, where some species have a crenulated margin, while others are smooth. There is, however, this difference between the two genera—viz., that in *Nucula* the young shell, as well as the old, is furnished with this kind of ornamentation in those species which possess it at any period of their lives; but in the case of *Astarte* it is not so. In the 'Crag Mollusca,' vol. ii, p. 173, I have said, that "in all the species of this genus the young state of the shell has its margin free from crenulations, and never until it has attained to maturity does it assume that character, and whenever a specimen has its margin crenulated, it may be considered to have arrived at its full growth." Mr. Jeffreys appears to be of a contrary opinion, and in his paper entitled "Additional Gleanings," published in the 'Annals and Mag. Nat. Hist.' for September, 1859, p. 5, says of *Ast. triangularis*, "the non-crenation of the margin does not depend on age, for I possess specimens which are evidently adult and of the same age, some of them having the margin quite plain, while in others it is strongly crenulated." Also in 'British Conchology,' vol. ii, p. 309, the same opinion is repeated. If by "evidently adult" it is meant that the full size is attained, I answer that size, though in general a good criterion of age, is not so *always;* there are dwarfs and giants in almost every species; and although occasionally one individual which has its margin crenulated may be *smaller* than another of the same species which has it smooth, it does not necessarily follow that the smaller one is an immature shell, or that the larger one had completely attained to full maturity. It is very difficult—perhaps impossible—to prove it so in this genus, but it bears great probability from an analogous case in the genus *Cypræa*, for example, where the adult state is denoted by an alteration of form. I have found specimens of the *full-grown state* of *Cypræa Europæa* which *in linear measure* is not more than one third the size of the largest adult of the same species, and yet the two extremes may fairly be assumed as full-grown individuals, indicated by their peculiar characters. I have never been able to find, although I have examined thousands of specimens of the genus *Astarte* (which is most abundant in the Coralline Crag), a single individual *with* a crenulated margin which could be assigned to the *young state* of a species which has a margin so ornamented when full grown.

In the diagnosis of the animal of the genus *Astarte* by Messrs. Forbes and Hanley, p. 455, vol. i, it is said, "the mantle is freely open in front, *plain* at the margins." The same *plain* condition of the mantle-margin is confirmed by Mr. Jeffreys, 'Brit. Conch.,' vol. ii, p. 308. Now, in order to produce the knobs which ornament the margin of the valves, I imagine the mantle would be fimbriated or pointed, to enable the animal to deposit calcareous matter in that form; and if it be not so in the young state—as I presume is the case—it would become so in the full-grown animal.

I once thought the fimbriated margin of the mantle might have indicated a sexual difference (see 'Mem. Geol. Surv.,' vol. i, p. 414, 1846), but I now consider the crenulated edge of the shell as probably analogous to the outer lip of some univalves, where the margin of the aperture is denticulated only in the adult state.

This genus does not appear to be present in the Eocene Formations of France; in our own country, I know it only from that portion of the Lower Tertiaries which is inferior to the Bagshot Sands, with the somewhat doubtful exception of the shell figured as *Astarte modicella.*

The Crag shells of this genus, though of thick and solid texture, are frequently perforated by some of the zoophagous feeders, but they seldom show any erosion at the umbones. Both these actions appear peculiar to some deposits only. Some of the older Tertiary specimens are much eroded at the umbones, while others of the same species from another locality are not at all so.

1. ASTARTE CLARENDONENSIS, *Edwards' MS.* Tab. XXIV, fig. 17 *a*, *b*.

Spec. Char. *Testâ magnâ, crassissimâ, irregulariter quadrangulatâ, tumidiusculâ, sublævigatâ, valdè inæquilaterali; pedi-regione brevissimâ, subtruncatâ, alterâ longiore, subquadratâ, compressiusculâ; impressionibus muscularibus profundis; marginibus crenulatis.*

Shell large, very thick and strong, irregularly quadrangular, slightly tumid, and nearly smooth; very inequilateral; umbones depressed, very excentric; pedal region short, anal side truncated, and somewhat compressed; muscular impressions deep; margins crenulated.

Length, $1\frac{3}{8}$ inch; *height*, $1\frac{1}{8}$ inch.

Locality. London Clay: Clarendon.

This species has yielded to Mr. Edwards a great number of specimens, but I do not see among them a very young individual, although one has its margin smooth, and as such I presume it is not full grown. The surface where perfect appears to have been nearly smooth, showing only very fine lines of growth. The umbones of all the specimens have been eroded, and I am unable to see if the very young state of the shell was covered with ridges. The shell has a tolerably large lunule not very strongly defined, but this varies according to the tumidity of the individual specimen. The proportional dimensions show considerable variation.

2. Astarte donacina, *J. Sowerby's MS.* Tab. XXIV, fig. 10 *a, b.*

Astarte donacina, *Prestwich.* Quart. Journ. Geol. Soc., vol. iii, p. 401, 1847.
— — *Morris.* Catal. Brit. Foss., p. 188, 1854.

Spec. Char. *A. testâ transversâ, inæquilaterali, crassâ, irregulariter quadrangulatâ aut donaciformi, partim lævigatâ, compressiusculâ; pedi-regione brevi, alterâ longiore, subtruncatâ; marginibus crenulatis.*

Shell transverse, inequilateral, thick and strong, of an irregularly quadrangular outline, slightly inclining to wedge-shape; pedal region short and rounded; siphonal side truncated; margins crenulated.

Length, 1 inch nearly.

Locality. London Clay; Railway Cutting, Old Basing, near Basingstoke (*Prestwich*).

This is an elegant shell. About half a dozen specimens have been procured by Mr. Prestwich, which he has kindly put into my hands for examination. It is, I think, quite distinct; and as it has passed under the MS. name of *donacina,* I have here adopted it. There is a difference in size among the specimens, all of which have a crenulated margin; but whether the smaller ones be young and immature—thus presenting an exception to the rule previously laid down—I cannot positively say; but I think they are all full-grown specimens. Mr. Prestwich said they came from an horizon about fifty feet higher than that at Clarendon.

3. Astarte rugata, *J. Sowerby.* Tab. XXIV, fig. 13 *a—f.*

Astarte rugata, *J. Sow.* Min. Conch., t. 316. 1821.

Spec. Char. *A. testâ crassâ, rugatâ, rotundato-triangulatâ; pedi-regione rotundatâ, siphoni-regione subtruncatâ; inæquilaterali; in juventate rugatâ, vel sulcatâ; umbonibus subprominentibus; lunulâ concavâ, profundâ; margine crenulato.*

Shell thick, roundedly triangular; pedal region rounded; siphonal side subquadrate or truncated; inequilateral; in the young state ridged or sulcated; umbones rather prominent; lunule deep and concave; margins crenulated.

Diameter, 1 inch.

Locality. London Clay: Highgate, Hampstead, Potter's Bar, Sheppey (*Edwards*).

Mr. Sowerby, in 'Min. Conch.,' has figured several sizes of this shell, which are no oubt from specimens of various ages; the larger one only has the inner margin, with crenulations. In the older shells the umbones are much eroded, and only slightly so in the younger specimens. This probably arises from the one possessing more animal matter than the other. Old shells are more easily decomposed.

Specimens from different localities present considerable differences from each other: those from Highgate are nearly smooth, except at the umbones. One specimen from Potter's Bar (fig. 13, *d*) is perfect at the umbo, which is much elevated, giving it a different outline; but I think it is merely a variety (*umbonata*). Figs. 13 *a* and *f* are from Sheppey; they are irregularly ridged all over, and may perhaps prove to be distinct; but the specimens I have seen are scarcely perfect enough for fair determination. Fig. 9, Tab. XXIV, is from Hampstead, and is considered by Mr. Edwards as a distinct species —called by him *A. filigera;* but the specimen is not in good condition, and I have placed it here as a variety for the present, though I suspect when better specimens are found they will deserve to be separated, as the ridges are very distinct and prominent. Figs. 11 *a*, *b* represent two specimens from Alum Bay, out of the bed which is there considered to be the attenuation of the London Clay. These specimens are fixed upon the matrix, and I am unable to see the interiors. In this genus, in which specimens are so very variable, even when perfect, I am unwilling to do more than consider them as varieties, and this latter I will call *A. rugata*, var. *subrugata.*

4. Astarte tenera, *J. Sowerby's MS.* Tab. XXIV, fig. 14 *a—c.*

Astarte tenera, *J. Sow.* MS., *Morris.* Catal. Brit. Foss., p. 80, 1843.
— — *Morris.* Journ. Geol. Soc., vol. viii, p. 265, pl. xvi, fig. 6, 1852.
— — *Id.* Catal. Brit. Foss., 2nd edit., p. 188, 1854.

Spec. Char. "*A. Testâ subtrigonâ, depressâ, tenerâ, inæquilaterali, concentricè, irregulariter rugosa; latere postico compressiusculo; umbonibus submedianis; lunulâ ovatâ, profundâ, lævigatâ; marginibus crenulatis.*"—*Morris.*

Shell subtrigonal, depressed, thin, inequilateral; concentrically but irregularly striated; siphonal region slightly compressed, and angulated; beaks subcentral; lunule ovate, deep, smooth; margins crenulated.

Length, $1\frac{1}{2}$ in.; *height*, $1\frac{1}{8}$ in.

Locality. Herne Bay.

The exterior of this shell in the young state is regularly ribbed or sulcated in the directions of the lines of growth, becoming smooth, or irregularly so, on the older half, giving the surface in some specimens a ridgy appearance. The shell figured by Mr. Morris is an adult individual—presumably so by its having a crenulated margin. I have not been able to see the very young condition of this species, but some specimens have the margins smooth, from which I imagine they are immature. The specific name would rather imply that it is a tender shell; but this does not appear to be so with Mr. Edwards's specimens.

It is well known that beds of *four* different ages occur in the Cliff near Herne Bay; but all the specimens of this species that I have seen appear to have come from the Thanet Sands.

Fig. 8, Tab. XXIV, represents a specimen from a well at Hampstead, which probably belongs to this species. It is rather more ridged than the Herne Bay specimens, and it has a more elevated umbo. I have given to it the provisional name of *A. tenera* var. *Hampsteadiensis*.

5. ASTARTE ? MODICELLA, *S. Wood.* Tab. XXI, fig. 2 *a*, *b*.

Spec. Char. *A. Testâ minimâ, ovato-subtrigonâ, compressiusculâ, lævigatâ, valdè inæquilaterali; latere postico brevissimo, obtuso, subtruncato, antico producto, obtuso; umbonibus minimis; cardine brevi, unidentato, dentibus lateralibus nullis; margine integro.*

Shell small, ovately triangular, somewhat depressed, smooth externally, very inequilateral; pedal side large and obtuse; umbo small; hinge of right valve with one denticle; margins smooth.

Diameter, $\frac{1}{12}$th of an inch.

Locality. Stubbington (*Edwards*).

A single valve, as represented, is in Mr. Edwards's cabinet. It is a right valve, with its dentition somewhat like that of *Astarte* in having only one triangular and slightly diverging cardinal tooth; but it has no lateral denticle on the pedal side. In my Monograph of the Crag Mollusca are introduced several species of small bivalves, which accord with the diagnosis of *Astarte*, one of which (*triangularis*) was made the type of a new genus (as is well known) under the name *Goodallia* by Turton, who erroneously considered it as having an internal connector; and it was called *Mactra* by his predecessor Montagu; but it possesses all the characters of *Astarte*.

There are some bivalves belonging to the Eocene Period which have been figured and described by M. Deshayes under the generic name of *Goodallia* ('Desc. des An. sans vert. du Bas. de Par.,' t. i, pp. 783—786, pl. 63). These resemble in outward form and magnitude the small species of Crag bivalves to which I have referred; but they appear to exhibit a difference in the dental furniture, reversing as it were the formula of the genus *Astarte;* the right valve having two diverging teeth or denticles with a triangular cavity between them, into which a large triangular tooth is inserted from the left valve (that is, according to the representations), contrary to what it is in *Astarte*, where the large triangular tooth is in the right valve, and the two diverging teeth in the left. It is expressly stated in the diagnosis of *Goodallia* by Deshayes, that the margins are invariably smooth. "Les bords sont simple sans aucune trace de dentalures;" p. 782.

If this diagnosis be adhered to, it is obvious that the living shell (*Mactra triangularis*) which M. Deshayes has taken for the type of the new genus *Goodallia* must be discarded from it, as it has a strongly denticulated margin.

Goodallia of Turton has by general assent been suppressed as untenable, and the resuscitation of the name by M. Deshayes will be at the expense of some confusion. If that name be admitted, it must stand upon its own merits wholly irrespective of Turton or of the *triangularis,* and upon the reversion of the dental formula. Should that be constant, it may be considered a generic distinction; and in these older Tertiary shells of M. Deshayes, as well as the shell under consideration, there appears to be an absence of the lateral tooth which is present in all the small species of true *Astarte.*

These shells of M. Deshayes seem to be the only representatives of our present genus in the Paris Basin.

WOODIA. *Deshayes*, 1858.

Generic Character. " *Testa subrotunda, æquivalvis, æquilateralis, clausa, lævigata vel excentricè striata; marginibus obliquè crenulatis. Cardo crassiusculus, in valvula dextra unidentatus; dente magno, triangulari, mediano; in medio subcanaliculatus, in valvula sinistra bidentatus; dentibus inæqualibus divaricatis; aliquantisper dentibus lateralibus obsoletis. Nymphæ minimæ depressæ, ligamentum minimum externum ferentes. Cicatriculæ musculares minimæ, æquales, ovatæ vel subrotundæ. Linea pallealis simplex.*"—*Deshayes.*

M. Deshayes has proposed the above name as generic for the reception of some species of shells of which he considers *Tellina digitaria*, Linn., to be the type. In my Monograph of the Crag Mollusca this shell is described under the name of *Astarte,* as I thought it merely an aberrant form of that genus; and although I feel complimented by the intention of that able conchologist, I am not now convinced that the differences between it and *Astarte* are sufficient to constitute a generic separation. I thought it possible that, when the animal of the Mediterranean shell became known, it might present some peculiar distinction; but I doubted whether the shell itself would justify a generic removal.

There are three species from the Paris Basin, figured by M. Deshayes under the above generic name, which cannot fairly be included in the genus *Astarte,* and also one from our English Lower Tertiaries, for which I have been obliged to adopt the name of *Woodia.* These older Tertiary fossils not only differ from the genus *Astarte,* but they appear to me to differ from the generic character pertaining to *Tellina digitaria,* Linn. In this latter shell the connector is placed wholly upon the exterior on a prominent fulcrum; but in the present fossils from the older Tertiaries the ligament is situated in a linear depression within the dorsal margin, although it probably acted in a ligamental manner over a fulcrum. The dentition, also, in *digitaria* is different, there being in the right valve of that shell one cardinal obtuse and truly triangular tooth, and two elongated and distinct and distant lateral teeth, with a similar arrangement of denticles in the left or opposite valve, so that the prominent parts of the hinge of the one interlock into the corresponding depression of the other; but in the Eocene shells there are no lateral teeth, only one large bifid or diverging cardinal tooth—or, I ought rather to say, they are two distinct diverging teeth in the right valve beneath the umbo. There are no oblique markings upon the exterior of the older Tertiary shells—only crenulations upon the inner margins of the valves, which diverge or run out in opposite directions; but in *digitaria* those oblique markings are wholly confined to the outer layer of the shell, and are not impressed upon the inner margin,—corresponding in that respect with those species of *Astarte* in which the exterior is ornamented with oblique ridges.

In the 'Journ. de Conch.,' vol. x, p. 141, M. O. Semper has enumerated nine species as belonging to this genus; and these he has divided into three groups, viz., 1st, espèces strieés, four species; 2ndly, espèces lisses, four species; and 3rdly, espèces inéquilatérales, surface striée où treillissée. With the exception of *digitaria*, Linn., they are all fossil.

1. Woodia crenulata? *Deshayes*. Tab. XXV, fig. 11.

Woodia crenulata (?), *Desh.* An. sans Vert. du Bass. de Par., t. i, p. 792, pl. lix, figs. 9—11, 1860.

Spec. Char. "*W. Testá minima, orbiculari, solidula, convexiuscula, lævigata, subæquilaterali; umbonibus tumidulis, oppositis; marginibus lateralibus latè et oblique crenulatis, margine inferiore tenuissime crenulato, dente cardinali unico in valvula dextra postice elongato; dentibus duobus in valvulá sinistrá subæqualibus.*"—*Deshayes.*

Shell small, orbicular, strong, slightly convex, smooth, nearly equilateral; umbones slightly prominent, inner margins broadly and obliquely crenulated; one cardinal tooth in the right valve, and two diverging teeth in the left.

Diameter, $\frac{1}{8}$th of an inch.

Locality. Barton (*Edwards*).

A single specimen of this genus is all that I have seen from the English Lower Tertiaries; it is in Mr. Edwards's cabinet, and it has affixed to it the MS. name of *W. orbicularis*, from which I presume that gentleman considers it to differ from the French shell. I feel unwilling, however, to found a new species upon the minor differences here presented; and it will require a comparison with the type specimen of M. Deshayes before a separation could be justified, and this I am not able to make. Our specimen is the right valve, and the cardinal "bifid denticule" is, in fact, composed of two teeth, diverging from beneath the umbo at an angle of 75°. These teeth are of unequal size and length, with a distinct separation between them: there are no lateral teeth. The crenulations on the margin are broad on each side, and diverge in nearly the same direction. They are confined to the inner and lateral margins, and do not extend to the outer layer of the shell, with which they are, apparently, unconnected.

CRASSATELLA. *Lamarck,* 1799.

TELLINA (sp.), *Solander.*
MACTRA (sp.), *Brug.*
PTYCHOMYA (sp.), *Agass.*
PAPHIA, *Roissy,* 1805.
GOULDIA, *C. B. Adams.*

Generic Character.—Shell thick and strong, transverse, occasionally sub-orbicular or triangular, closed; inequilateral, smooth, or covered with raised striæ, imbrications, or ridges (thickened lines of growth); lunule distinct; hinge with two cardinal diverging teeth. Connexus cartilaginous, placed in a triangular fossette; lateral teeth often obsolete; adductor muscles deeply impressed; pedal muscle-mark distinct; palleal impression entire.

Animal with the mantle lobes open or only united by the branchial septum; foot of moderate size, compressed and grooved.

This genus appears to be nearly related to *Astarte,* and, in like manner, most of the species have the inner margins of the valves covered with crenulations, but I cannot say that such differences constitute a mark of distinction between the young and aged. These crenulations are confined to the inner portion of the shell, and they appear to be smaller and finer in the young, as if the fimbriæ of the mantle were of the same number at all ages. Beneath the surface on some of the species (perhaps all) the shell is covered with radiating striæ. I am not able to say if the crenulations upon the margin be the outcrop of these rays, but I presume they are produced by a more or less fimbriated margin of the mantle.

The shells of this genus are not only thick and strong, but they are capable of being very firmly closed by powerful adductor muscles, which leave a deep impression in the interior, and they are furthermore secured from lateral motion by prominent denticles, which are sometimes ridged at right angles to their position, corresponding in that respect to some species of *Astarte.*

There is great variation in magnitude in the species of this genus. *Crassatella plumbea,* a shell common to the Paris Basin, but which, I believe, has not yet been found in this country, is of great thickness; a single valve weighs half a pound. Some American fossil species have a length of six inches; others, on the contrary, are very diminutive. The genus is abundant in species in the Lower Tertiaries of this country, but it has not, to my knowledge, been found in the Upper, although by no means rare in America in beds supposed to be of the age of our Coralline Crag.

As a recent genus it is widely distributed, but principally confined to tropical or sub-tropical regions.

The triangular species were erected into a genus by C. B. Adams, in 1845, under the name *Thetis*, but afterwards changed into *Gouldia*.

In this genus and in *Cardita* a great variety of forms will be seen in specimens from the Lower Tertiaries of this country, as also in France. Some of those which I have admitted to the rank of species may, perhaps, be considered by some Palæontologists as only entitled to the position of varieties. Whatever may be their claim in that respect, they will at least show well-marked distinctions in form and sculpture; and it is not, I conceive, a matter of much importance, geologically speaking, whether they be called varieties or species, as they will in either case afford a measure for a palæontological comparison of Faunas.

The line of separation between species and varieties is in our present knowledge most arbitrary, some authors sweeping into a single species a number of well-marked forms previously regarded as distinct; while others, or even the same authors, are erecting into specific importance forms not more, and often even less, distinct from each other than those thus swept into a single species.

The most rational course, as it seems to me, will be to assign specific value to all those forms which in any given deposit maintain constant characters, and do not by transition pass into others *occurring in the same deposit*. If, in the progress of research into existing Natural History, or into Palæontology, any of these should be found to pass *geographically* into each other, the soundness of their original separation would not be materially impaired, because it would be evident that, notwithstanding this geographical transition, the several races possessed that impress of permanency which caused them to maintain their distinct characters while living together in the same area, or under the same conditions; and what other than this can be said in justification of the separation of any nearly allied species? When a general repugnance between the respective sexes of any two groups of organisms living together becomes established, then, in my opinion, specific division is accomplished; for we have the existence of that state of things established which must preclude an intermingling of the races, and offer ready objects for the diverging action of external conditions upon living organisms.

With these views I must, of course, always feel that there is great uncertainty attaching to many of the specific identities which I have made of new forms nearly allied to some previously known one, whenever the specimen upon which such new form is founded is either unique or very rare, but when a suite of specimens wherein the characteristic peculiarities of either form are available for examination then the specific values attached seem to me more reliable. For this reason many of the forms to which I have attached the species-value, or have restricted to varieties, may be found hereafter to be incapable of being sustained in that category.

1. Crassatella Bartonensis, *Edwards* MS. Pl. XXIV, fig. 7 *a, b.*

Spec. Char. Cr. Testâ orbiculato-trigonulâ, crassiusculâ, subæquilaterali, compressâ; regulariter sulcatâ vel lamellatâ; lamellis distantibus, simplicibus; umbonibus acutis elevatis; pedi-regione vix minore; ani regione supernè declivi; lunulâ minimâ, depressâ, lævigatâ; cardine brevi; in valvâ dextrâ unidentato, valvâ sinistrâ bidentato; dentibus lateralibus elongatis; marginibus integris.

Shell roundedly trigonular, not very thick, nearly equilateral, compressed, externally sulcated or laminated; ridges distant, rounded and depressed; beaks sharp and prominent; pedal region a trifle the smaller of the two; dorsal margin sloping; lunule small, depressed, elongated; hinge short, denticles sharp; lateral teeth narrow, elongated; margin smooth.

Diameter, $\frac{5}{8}$ths of an inch.

Locality. Barton (*Edwards*).

Two specimens of this species are all that I have seen, and they are both from the same locality. The principal distinction is the exterior ornament, the ridges or lamellæ being more distant than on any other of the suborbicular species of this genus. These ridges are very regular and cover the entire surface. The diagonal ridge on the siphonal or anal side, so conspicuous on the transverse species, is scarcely perceptible.

2. Crassatella Bronnii (?), *Merian*. Pl. XXIV, fig. 2 *a—c.*

Crassatella Bronnii, *Merian*. In Litteris Sandb., 1853, sec. Deshayes.
— — *Desh.* An. sans Vert. du Bass. de Par., vol. i, pl. xix, figs. 12—14, and pl. xx, figs. 22—24, 1860.

Spec. Char. Cr. Testâ minimâ, ovato-trigonâ, inæquilaterali, transversim sulcatâ; umbonibus minimis, acutis, proeminentibus; latere antico breviore; postico subtruncato, lunulâ minimâ, depressâ, lævigatâ, ovato-lanceolatâ; cardine brevi, bidentato, alterâ unidentato, dentibus angustis, elongatis; marginibus integris.

Shell small, roundedly trigonal, slightly inequilateral, covered with regular and rather close-set concentric ridges; beaks small and somewhat prominent, sides unequally rounded; lunule small, smooth and ovately elongate; hinge narrow, one tooth in the right valve and two in the other; margins smooth.

Diameter, $\frac{1}{2}$ an inch.

Localities. Highcliff, Barton, Stubbington (*Edwards*).
France: Jeures, Etrèchy (*Deshayes*).

Though this species is said to be rare in France, it does not appear to be so in England; it seems to have taken the place of *Cr. trigonata;* this latter, although so abundant there, has not, to my knowledge, been found in England. Our present shell resembles *trigonata* in some respects, but it is, I think, distinct.

There are some specimens in Mr. Edwards's collection, to which he has given the MS. names of *Cr. æqualis* (fig. 4) and *Cr. tumescens* (fig. 5), which so closely resemble *Cr. Bronnii* that I have considered them only as varieties.

M. Deshayes describes his shell as "marginibus tenui-crenulatis." Our specimens have the margins smooth, as have all our triangular Eocene species.

3. Crassatella corbuloides, *Edwards* MS. Pl. XXIV, fig. 3.

Spec. Char. Cr. Testâ minutâ, ovato-trigonulâ, inæquilaterali, convexiusculâ; concentricè sulcatâ, sulcis distantibus; umbonibus elevatis, acutis, prominentibus; pedi-regione minore et breviore; supernè depressâ; siphoni-regione majore, margine convexâ; lunulâ parvâ, depressâ, lævigatâ; marginibus integris.

Shell small, ovately triangular, inequilateral, slightly convex, covered with ridges or periodical thickenings of growth, rather distant; beaks prominent, and sharp; pedal region small, rounded, and somewhat depressed; the other side larger, and convex; lunule small, smooth, and rather deep; margins smooth.

Diameter, $\frac{3}{8}$ths of an inch.

Locality. Stubbington (*Edwards*).

One specimen is in Mr. Edwards's cabinet with the above name, which I have here adopted, as it appears to differ from *Cr. Bronnii* in being more elevated, and the ridges with which it is covered are fewer and more distant. The nearest approach to this shell that I know is a recent Mediterranean species figured and described by H. Adams under the name *Gouldia modesta;* but that has a denticulated margin, and is otherwise distinct.

4. Crassatella compressa, *Lamarck.* Pl. XXIII, fig. 5 *a, b.*

Crassatella compressa, *Lam.* (non *Sowerby*). An. du Mus., vol. vi, p. 410, No. 4, and vol. ix, pl. xx, fig. 5 *a, b*, 1806.
— — *Desh.* Coq. Foss. des Env. de Par., vol. i, p. 37, pl. iii, figs. 8, 9, 1824.
— — *Id.* An. sans Vert. du Bass. de Par., vol. i, p. 744, pl. xx, figs. 9—11, 1860.

Spec. Char. C. Testâ transversâ, subtriangulari, compressâ, inæquilaterali; tenuiter sulcatoplicatâ; pedi-regione obtusè truncatâ, ano subsinuoso; umbonibus minimis, acutis, non-

prominentibus; lunulâ elongato-lanceolatâ, profundâ; ano angusto, elongato; cardine incrassato, unidentato, alterâ bidentato; dentibus obsoletè sulcatis; marginibus tenuiter crenulatis.

Shell transversely or ovately triangular, compressed, slightly inequilateral, finely and regularly sulcated; pedi-lateral margin obtuse and rounded; opposite side angulated and obscurely sinuated; beaks small; lunule deep and elongated; corselet large and lanceolate; hinge broad and thick; teeth obsoletely sulcated; margins finely crenulated.

Length, 1 inch; *height*, $\frac{6}{8}$ths of an inch.

Localities. Huntingbridge (*Edwards*).

France: Grignon, &c., Calcaire grossier (*Deshayes*).

In 'Les Coq. foss. des Env. de Par.' M. Deshayes has given three varieties to the above name, and in the supplement to that work he has elevated one of them to the rank of a species. The same differences appear to exist in specimens from our own deposits; and as they seem much more abundant in the Paris Basin I imagine that M. Deshayes may have better materials for determination than we have. The present shell is distinguished by the lamellæ or ridges, which are numerous, prominent, and cover the entire surface. These are obtuse; the interspaces are about the same width as the ridges. The shell is slightly inequilateral, the siphonal side being a little the longer, pointed and less deep; the pedal side is shorter and higher, so that one side is not much larger than the other. In perfect specimens the ridges are carried over the flattened anal area, and the crenulations extend over the entire edge of the inner margin, except the truncated portion of the siphoni-lateral side.

Fig. 1, Pl. XXIII, represents a specimen from Mr. Edwards's Collection which has the MS. specific name of *hemileia,* but which, I think, is not specifically distinct. I have, therefore, united it as a variety under that name. It differs principally in being sulcated only over the umbonal region. This variety is from Brook and White Cliff Bay.

5. Crassatella gibbosula, *Deshayes*. Pl. XXIII, fig. 15 *a—c*.

Crassatella gibbosula, *Desh.* Coq. Foss. des Env. de Par., vol. i, p. 37, pl. v, figs. 5, 6, 7, 1824.

Spec. Char. "*C. Testâ ovatâ, tumido-gibbosâ (?); angulo antico eminentissimo; lamellis transversis exiguis proeminentibus, et posticè tuberculo minimo seriatim interceptis; lunulâ profundè lanceolatâ.*"—*Deshayes.*

Shell elongate, transversely subquadrangular, or irregularly trapezoidal; very inequilateral; pedal side rounded; siphonal side produced, angular, and slightly pointed; lamellæ sharp, prominent, and distant; lunule distinct.

Length, $1\frac{7}{8}$ths inch; *height*, $1\frac{1}{8}$th inch.

Locality. Bracklesham Bay (*Fisher*).

France: Grignon, Courtagnon, Chaumont (*Deshayes*).

A single specimen is all that I have seen. It enriches the cabinet of, and was found by, the Rev. O. Fisher. The English specimen is the right valve, and it differs somewhat from the figure and description of the French shell, especially so from some specimens I have from Chaumont, which are much more gibbous or tumid, and broader or higher on the siphonal side. Our shell is also more rounded on the pedilateral margin than the French specimens. I feel unwilling to propose a new name, but, if some more specimens should confirm the great differences between the English fossils and those from France as being specific, I would call it *C. Fisheri.* M. Deshayes has figured a shell which he has called *C. distincta.* This is flatter than *gibbosula,* and it has fewer and smaller ridges than those upon our specimen, which appears of an intermediate character. This species is given from the nummulitic deposit in the province of Barcelona by M. Alex. Vezian, 'Bull. de la Soc. Géol. de Fr.', 2nd series, vol. xiv, p. 337.

6. Crassatella Grignonensis, *Deshayes*. Pl. XXIII, fig. 8 *a, b.*

Crassatella Grignonensis, *Desh.* An. sans Vert. du Bass. de Par., p. 748, pl. xx, figs. 3—5, 1860.

— compressa, var., *J. Sow.* In Dixon's Geol. of Sussex, p. 88, pl. xi, fig. 21, 1850.

Spec. Char. *C.* "*Testâ transversâ, ovato-trigonâ, inæquilaterali; antice obtusâ; posterius oblique truncatâ, angulo obtuso, inæqualiter bipartitâ transversim tenue et regulariter sulcatâ, sulcis adlatus posticum evanescentibus; umbonibus minimis, acutis, depressis, proeminentibus; lunulâ angustissima profundâ; ano depresso, lævigato, lanceolato; cardine angusto; dentibus minimis angustis simplicibus; marginibus in medio tenuissime crenulatis.*"—*Deshayes.*

Shell transverse, ovately triangular, or rather irregularly oblong, inequilateral; pedal side short and rounded; siphonal side produced, obtusely angulated; exterior with numerous and fine ridges, less distinct on the anal region, or side beyond the angular slope; beaks small, depressed; lunule elongate and narrow; margins finely crenulated in the middle, smooth at the sides; cardinal tooth serrated.

Length, $\frac{7}{8}$ths of an inch; *height,* $\frac{5}{8}$ths of an inch.

Localities. Bracklesham Bay (*Edwards*).

France: Grignon, Parnes, Calc. gross. (*Deshayes*).

Not having the French specimens to compare with, I have placed the English fossil as an identity, depending upon figures and descriptions above referred to. Fig. 10 is, I think, a variety of this species, which may be called *Anglica.* It much resembles, and at one time I thought it identical with, *Cr. donacialis,* Desh., but it appears to differ in form, and the exterior is more finely ridged over the centre, but the anal ridge beyond the siphonal slope is naked.

Fig. 12, Pl. XXIV, represents a shell from Bracklesham, called by Mr. Edwards *planiuscula*. This is more elongated, more inequilateral, and more compressed, and covered with finer and sharper ridges. When more specimens are found it may probably prove to be distinct. For the present I have inserted it here as a variety.

7. Crassatella plicata, *J. Sowerby*. Pl. XXIII, fig. 14 *a, b*.

Crassatella plicata, *J. Sow.* Min. Conch., pl. 345, fig. 2, 1822.
— — *Nyst.* Coq. Foss. de Belg., p. 85, pl. xli, fig. 3, 1843.

Spec. Char. Cr. Testâ transversâ, elongato-trigonâ, inæquilaterali, compressiusculâ; pedi-regione altiore; alterâ elongatâ et truncatâ; extùs sulcatâ, sulcis posticis evanescentibus; umbonibus minimis acutis, depressiusculis; lunulâ ovatâ, profundâ; siphoni-regione depresso, lanceolato; cardine angusto; dentibus parvis, simplicibus; marginibus in medio tenuiter crenulatis.

Shell transverse, elongately trigonal, inequilateral, somewhat compressed; pedal region the higher; siphonal side produced and truncated, covered externally with concentric ridges, which become obsolete over the anal region, where it is nearly smooth; hinge rather narrow, and inner margin crenulated in the middle.

Length, $\frac{1}{2}$ an inch; *height*, $\frac{3}{8}$ths of an inch.

Localities. Bracklesham and Barton (*Edwards*); Southampton (*J. Sow.*).

This was originally separated from *sulcata* by Mr. J. Sowerby, and I have retained it as a distinct species. M. Deshayes has given this name as a synonym to *Grignonensis*; but the shells appear to be specifically distinct. Our present species is more finely ridged; it is shorter and rather more rounded in outline, with the siphonal region less angular.

A small specimen, which, I think, must belong to this species, has very recently been found by Mr. Alfred Bell in the modern deposit at Selsey, called the "Mud-bed." This is, in all probability, a specimen washed out of the contiguous Eocene Formation. It much resembles our present species, more so than any other known to me, but the ridges upon the umbonal region are fewer and more distant than on the body of the shell, contrary to the general character of the exterior ornament in this genus.

8. Crassatella pumilio, *S. Wood.* Pl. XXIV, fig. 1.

Spec. Char. *C. Testâ minutissimâ, rotundato-trigonulâ; subinæquilaterali; umbonibus acutis, prominentibus; lunulâ minimâ, depressâ, ovatâ; cardine brevi, in valvulâ dextrâ bidentato, in alterâ unidentato; dentibus lateralibus, elongatis; marginibus integris.*

Shell very small, roundedly triangular, slightly inequilateral; beaks sharp and rather prominent; lunule small, ovate, and depressed; hinge short, with two cardinal teeth in the left valve and one in the right; lateral teeth narrow, elongated; margin smooth.

Diameter, $\frac{1}{16}$th of an inch.

Locality. Highcliff, Barton (*Edwards*).

Two small specimens exhibiting the interiors of the opposing valves are among the shells kindly sent to me for examination and description by Mr. Edwards, and the card to which they are attached has on it the name of *Goodallia trigona,* but I think the arrangement of the dental furniture corresponds better with the genus in which I have here temporarily placed them. The connector appears to have been cartilaginous or internal. The specific name of *trigona* is preoccupied in this genus, and the above one which I have proposed is more expressive of its diminutive character. It may possibly be the young state of *Cr. Bartonensis* or some other triangularly formed species, and its present name is merely provisional.

9. Crassatella sinuosa (?), *Lamarck.* Pl. XXIII, figs. 3 and 9.

Crassatella sinuosa (?), *Desh.* Coq. Foss. des Env. de Par., vol. i, p. 39, pl. v, figs. 8, 9, 10, 1824.

Spec. Char. *Cr.* " *Testa ovato-inflatâ anticè* (?) *angulatâ, sinuatâ, sulcis numerosis irregularibus, lævibus; margine crenato; lunulâ profundâ ovatâ.*"—*Deshayes.*

Shell ovately triangular, thick, strong, inequilateral; pedi-lateral margin rounded, the opposite side angulated, truncated, subsinuated; pedal region covered with depressed and rather irregular ridges, the other half of the shell nearly smooth, with an obtuse diagonal ridge on the siphonal side, beyond or above which the shell is flattish, with rough lines of growth; hinge thick and broad; margins crenulated.

Length, $1\frac{1}{2}$ inch; *height*, $1\frac{3}{16}$ths inch.

Localities. Barton and Bracklesham (*Edwards*).

France: Chaumont, Calc. gross. (*Deshayes*).

There are two specimens in Mr. Edwards's cabinet which appear to correspond with the French shell, but to which I have put a mark of doubt, one from each of the above-named localities. The shell in France is, I believe, not rare, and is subject to considerable variation. M. Deshayes says ('An. sans Vert. du Bass. de Par.,' p. 741), "La sinuosité du bord ventral, d'apres laquelle nous avons choisi le nom specifique, ne se presente que dans le plus petit nombre des individus." I have, therefore, upon that report, permitted the British fossil to stand doubtfully with the above name. Our shell does not exhibit a marginal sinuosity, but in other respects it seems to correspond.

10. Crassatella Sowerbyi, *Edwards* MS. Pl. XXIII, fig. 6 *a*, *b*.

Crassatella compressa, *J. Sowerby* (non *Lam.*). In Dixon's Geol. of Sussex, p. 88, pl. ii, fig. 2, 1850.

Spec. Char. Cr. Testâ transversâ, irregulariter triangulari, crassâ, compressiusculâ, inæquilaterali, sublævigatâ, aut ad umbonem sulcis paucis distantibus; pedi-regione ad marginem convexâ, alterâ majiore productâ, angulatâ et truncatâ; umbonibus depressis; lunulâ elongato-lanceolatâ; cardine incrassato, unidentato in valvâ dextrâ, in alterâ bidentato; marginibus in medio crenulatis.

Shell transverse, irregularly triangular, thick, rather compressed, inequilateral, sulcated in the umbonal region, smooth on the outer or older part of the shell; pedal margin rounded; siphonal side angulated and truncated; beaks rather depressed and obtuse; lunule elongate, not very deep; hinge thick, one tooth in right valve, and two in the left; ventral margins crenulated in the middle.

Length, $1\frac{1}{8}$th inch; *height*, $\frac{6}{8}$ths of an inch.

Localities. Bracklesham, Stubbington, White Cliff Bay (*Edwards*).

Mr. Edwards has separated this from *compressa* of Lamarck, in which I agree with him. It somewhat resembles the variety called *hemileia*, but it is distinguished by being constantly more free from ridges and more compressed. Fig. 13 of the same Plate represents a specimen which has had the MS. name of *Hantoniensis* affixed to it by Mr. Edwards. In Pl. XXIV I have also had represented two other forms, to which have been affixed the respective names of *C. semi-lævis* (fig. 15) and *C. obesa* (fig. 16 *a*, *b*). The first of these two is from Bracklesham; it varies in shape in being more elongated, and it has finer ridges over the umbonal region. The other is from Stubbington; it is shorter and more tumid. These have all been considered by Mr. Edwards as specifically distinct, and possibly they may be so, but for the present I regard them as varieties.

11. Crassatella subquadrata, *Edwards*. Pl. XXIII, fig. 12.

Spec. Char. Cr. Testâ transversâ, subquadrangulatâ, tumidâ, læviusculâ, inæquilaterali; pedi-regione minore; alterâ truncatâ vel subquadratâ; umbonibus obtusis, elevatis; siphoni-

regione obtusè angulatâ; cardine angusto; dentibus mediocris; lunulâ elongatâ non valdè depressâ; marginibus crenulatis.

Shell transverse, irregularly quadrangular, tumid or inflated, smooth in part, inequilateral; pedal region the smaller; siphonal side subquadrilateral or truncated; beaks obtuse, somewhat elevated; hinge narrow, with moderate-sized denticles; lunule elongated, slightly depressed; margins crenulated.

Length, $\frac{5}{8}$ths of an inch; *height*, $\frac{4}{8}$ths of an inch.

Localities. (var. *a*) White Cliff Bay, Isle of Wight, (var. *b*) Barton. *Edwards.*

This appears to be a rare shell. I have seen only one specimen from each locality. That from Barton is the more perfect, and shows broad ridges in the umbonal region, but they do not extend over the anal area or beyond the obtuse ridge which divides diagonally the siphonal side. The other, from White Cliff Bay, has lost its outer coating, showing a coarse and fibrous structure, from which, I presume, the inner margin is denticulated, although the inside is hidden by the matrix. This in form and appearance has the aspect of *Astarte*, but the connector is internal.

12. Crassatella sulcata, *Solander*. Pl. XXIII, fig. 11 *a—c*.

Tellina sulcata, *Solander* (in *Brander*). Fossilia Hantoniensia, pl. vii, fig. 89, 1776.
Crassatella sulcata, *J. Sowerby*. Min. Conch., pl. 345, fig. 1, 1822.
— — *Desh.* An. sans Vert. du Bass. de Par., vol. i, p. 747, pl. xx, figs. 12—14, 1860.

Spec. Char. C. Testâ elongato-trigonulâ, valdè inæquilaterali, convexâ, tumidiusculâ; siphoni-regione angulatâ, transversim sulcatâ; sulcis profundis; lunulâ ovatâ; cardine angusto, inæqualiter bidentato; dentibus lateralibus angustis, elongatis; marginibus crenulatis.

Shell elongately trigonal, very inequilateral, slightly convex, rather thick; siphonilateral margin angulated, transversely or concentrically sulcated; furrows deep, with elevated ridges between them; lunule acutely ovate; hinge rather narrow, with unequal denticles, two in each valve; lateral teeth elongated; margins with fine crenulations.

Length, $1\frac{3}{8}$ths inch; *height*, 1 inch.

Locality. Barton; (var. *gradata*) Huntingbridge.
France: Senlis, Pontoise, Valmondois, &c., Sables moyens (*Desh.*).
Province of Barcelona (*Vézian*).

This is one of the most abundant shells at Barton, where the two valves have been often found united; traces of the epidermis may be observed, but I have not seen the connector. There is much variation in regard to proportional dimensions, some individuals being very short and high comparatively, while others are much elongated; some of Mr. Edwards' specimens, of which I have had one figured (Pl. XXIII, fig. 7 *a*, *b*), are very abnormal, the length measuring nearly twice the height; these he has called *Cr. ensiformis,* with a mark of doubt against this specific name. I think they are only deviations from the more common type, as I can find no other difference than length, and almost every intermediate form may be observed. The anal area, or that flat space beyond the diagonal ridge, is divided into two unequal parts, produced, I presume, by the division or septum of the syphons.

This species is said by M. Deshayes not to be abundant in the Paris Basin, where it does not attain to so large a size. Some of our specimens show a little erosion at the umbones, while others are there quite perfect.

There is another shell of Mr. Edwards's marked as "*Cr. rostralis?*" which I have also had figured (Pl. XXIII, fig. 4 *a*, *b*), but which, I think, is scarcely entitled to specific isolation; it is narrow at the siphonal termination; it is, however, said to be always smaller and more compressed, with a less curve to the basal margin, and the external ridges rather narrower. I propose to call it var. *gradata*, as *rostralis* is another species. *Crassatella sulcata,* Sow., is a name given in a list of species from the Nummulitic deposit in the Province of Barcelona, by M. Alex. Vézian ('Bull. de la Soc. Géol. de France,' 2nd ser., vol. xiv, p. 387), but it does not appear to be admitted by M. Deshayes.

13. Crassatella tenuisulcata, *Edwards* MS. Pl. XXIII, fig. 2 *a*, *b*.

Spec. Char. *C. Testâ transversâ, elongatâ, tumidâ, tenui-sulcatâ, sulcis numerosis ad regionem ani evanentioribus; valdè inæquilaterali, crassâ; pedi-regione convexâ siphoni-regione majore productâ, elongatâ, margine dorsali depressâ, concaviusculâ; umbonibus elevatis obtusis; lunulâ depressâ; marginibus crenulatis.*

Shell transverse, elongate, tumid, covered externally with numerous and rather fine ridges, except over the anal region or above the diagonal ridge, where it is nearly smooth, or with numerous visible lines of growth. Siphonal side the larger, narrow and truncated; umbones rather prominent and obtuse; lunule depressed; ventral margins crenulated.

Length, $1\frac{1}{8}$th inch; *height,* $\frac{11}{16}$ths of an inch.

Locality. Barton (*Edwards*).

This is not rare, and the two valves are often found united. It differs from *C. sulcata* in the exterior ornament, which is not so coarse, and the siphonal or anal side is more produced, and the dorsal margin on that side is depressed. The finer sulci terminate at the angle formed by the diagonal ridge. The nearest approach to this species appears to be *C. donacialis,* Desh., but that shell is more equilateral, and it wants the carinated edge of this species. Another shell, called *lineatissima,* from Bramshaw and Brook (Pl. XXIV, fig. 6 *a*, *b*), is, I think, a variety of this species.

CHAMA. *Pliny, Linné,* &c.

Generic Character. Shell thick, strong, and adherent; irregular, rugose or foliated; inequivalved, subequilateral, with a somewhat involute umbo. Hinge with two teeth in one valve, and one in the opposite inserted between them; margins sometimes crenulated. Impressions by the adductors large and elongately oval; mantle-mark without a sinus; connexus ligamental.

Animal with the mantle margins united and the edges fringed; siphonal tubes short and large, not extending beyond the shell; branchial one fringed; foot short and bent.

The exterior of the shells of this genus in the recent state is more or less ornamented with spines, or otherwise elegantly fringed, and they are generally much coloured. The spines are sharp, pointed, subtubulous and fimbriated, or sometimes broad and spatulate. In fossils the shells are covered with rugosities or spinous fimbriæ, and are more or less radiated between them. Our Eocene species appear to have been attached by the left valve. *Chama gryphoides* of the Crag adhered by the right, and the recent species vary in this respect.

This is a pretty well-marked genus, and its nearest relative is *Diceras*, from which it has probably descended. In that genus the valves are more involute, and where may be seen the external connector retreating in a groove up the spire as the shell increases and the umbo recedes. The same is visible, in a minor degree, in some specimens of our present genus, where the shell has adhered only by the umbo. The valves are generally unequal, and occasionally there is no mark of adherence on either valve; at others the animal has attached itself by the greater part of the surface of the lower valve. In some of the species the inner surface of the shell is finely punctured in a regular manner, from the peculiar composition of the shell.

This genus is considered to indicate tropical or subtropical conditions, not extending northwards beyond the Mediterranean, and the animals live chiefly among coral-reefs. I am not aware of their having been found fossil lower than the older Tertiaries; and, until lately, have they been known only in the middle series of that period.

1. Chama calcarata, *Lamarck*. Pl. XXV, fig. 1 *a—c*.

Chama calcarata, *Lam.* Ann. du Mus., vol. xiv, pl. xxiii, figs. 4 *a, b*.
— — *Desh.* Coq. Foss. des Env. de Par., p. 246, pl. xxxviii, figs. 5—7, 1825.

Spec. Char. "*C. Testâ orbiculatâ, turgidâ, plicis transversis acutis distantibus; superioribus spinis prælongis, canaliculatis, radiatim echinatis.*"—*Deshayes.*

Shell irregularly orbicular, thick, and strong, covered by prominent sharp, reflected, and somewhat distant imbrications, with oftentimes elongated and sometimes tubular spinous processes; outer surface covered with radiations, inner margins smooth; mark of attachment variable.

Diameter, $1\frac{1}{4}$ inch.

Localities. Brackleshain Bay (*Edwards*).

France: Parnes, Chaumont, Grignon, Calc. gross. moyen et sup. (*Deshayes*).

Sinde (*Deshayes*).

The name of *punctata* was proposed for this species by M. D'Orbigny as one of prior date, but the shell to which this name was given by Bruguière is a species now living in the sea near Guadaloupe, as stated by M. Deshayes, and is quite distinct, in which opinion I coincide. Lamarck, therefore, appears to have been the first to describe the present fossil, and the above name has been generally employed. The inside lining of the shell is deeply and regularly punctulated, looking like the encrustation of Polyzoa, but this is not visible on the impressions of the adductor muscles. This is strongly marked; and the two valves are very differently ornamented. The principal characters are the long spinous fringes and the large radiating ridges between the laminæ upon the right or upper valve; between the distant laminæ of the lower valve the shell is ornamented with granules arranged in a somewhat zigzag manner, very visible in perfect specimens from Grignon, but indistinct upon the only individual of this lower valve that I have seen from our own beds. The shell is attached by the left valve, and the mark of adherence is generally small, as shown by the French specimens.

This is a rare shell in our English beds.

2. Chama fimbriata (?) *Defrance.* Pl. XXV, fig. 8.

Chama fimbriata, *Defrance.* Dict. des Sci. Nat., vol. vi, Suppl., p. 65, No. 3, 1818.
— — *Desh.* An. sans Vert. du Bass. de Par., vol. i, p. 584, pl. lviii, figs. 23—25, 1860.
— ponderosa, *Id.* Coq. Foss. des Env. de Par., vol. i, p. 248, pl. xxxvii, figs. 9, 10, 1825.

Spec. Char. *Ch.* "*Testâ orbiculatâ, incrassatâ, irregulari, convexâ, multilamellatâ, intùs lævigatâ; lamellis valvæ inferioris brevibus, simplicibus; valvæ superioris longioribus, laceris, plicatis; dente cardinale magno valdè sulcato.*"—*Deshayes.*

Shell orbicular, thick, irregular, convex, and covered with numerous and close-set lamellæ; inside smooth; reflected ridges close and numerous.

Diameter, 2 inches.

Localities. Bramshaw (*Edwards*).

France: Auvers, Valmondois, &c., Sables moyens (*Deshayes*).

An aged specimen in Mr. Edwards's cabinet appears to correspond with the one figured by M. Deshayes, as above referred to. It is covered with very close-set fimbriæ, which appear to be its principal distinction. The radiating lines are nearly obliterated by the numerous ridges, and from its thickness the valve has afforded a retreat for a *Gastrochæna.* Our specimen is the upper or right valve.

3. CHAMA GIGAS, *Deshayes.* Pl. XXV, fig. 2.

CHAMA GIGAS, *Desh.* Coq. Foss. des Env. de Par., vol. i, p. 245, pl. xxxvii, figs. 5, 6, 1825.
— — *J. Sow.* In Dixon's Geol. of Suss., p. 93, pl. ii, fig. 96, and pl. iii, fig. 26, 1850.
— — *Desh.* An. sans Vert. du Bass. de Par., vol. i, p. 581, 1858.

Spec. Char. "*C. Testâ ovato-rotundatâ, gibbosâ, crassâ, foliaceâ, lævigatâ; lamellis numerosis, concentricis, latis, irregulariter sectis; dente cardinali magno, sulcato.*" (*Deshayes.*)

Shell roundedly ovate, gibbous or irregularly tumid, thick and strong, covered with foliaceous and reflected lines of growth, with protuberant short spines; interspaces between lamellæ irregularly distant; cardinal tooth large and sulcated.

Diameter, $2\frac{1}{2}$ inches.

Localities. Bracklesham, Bramshaw Brook, Huntingbridge, Stubbington (*Edwards*).
France: Calc. gross., Parnes, Chaumont, &c. (*Deshayes*).

This species does not appear to be abundant, especially of the size of the specimen figured, although it is stated by M. Deshayes to have been found much larger in France. The name *gigas* is retained for this species, though by no means an appropriate one. *Chama gigas,* Linné, is a very different shell, and was appropriately applied to the largest species in the class *Bivalvia,* now known under the generic name of *Tridacna.*

Our present species seems to have adhered by its entire side when young, and occasionally so till nearly full grown. This attachment is by the anterior or pedal region. Fig. 3 is, perhaps, the young state of this species, resembling the shell called *papyracea,* and fig. 4 represents a specimen which, from its strong adherence, had produced a prominent ridge of reflected fimbriæ, like *plicatella.* These, I think, are only varieties of *gigas.* Although this genus stands pretty well isolated, there is a more than common difficulty in pointing out what are presumed to be their specific differences.

4. Chama squamosa, *Solander*. Pl. XXV, fig. 6 *a—d*.

Chama squamosa, *Solander* (in *Brander*). Foss. Hanton., pl. vii, figs. 86, 87, 1776.
— — *J. Sowerby*. Min. Conch., t. 348, 1822.
— — *G. B. Sowerby*. Genera of Shells (*Chama*), fig. 4, 1839.

Spec. Char. *Testâ crassâ, suborbiculatâ, irregulari, multilamellatâ, fimbriatâ, longitudinaliter multistriatâ aut radiatâ; lamellis numerosis, incrassatis, subplicatis; striis flexuosis; umbone valvæ inferiore majore, contorto, aliquando producto; cardine crasso, rugoso.*

Shell thick, suborbicular, irregular, covered with numerous fimbriated lamellæ, and numerous longitudinal or rather radiating and bending or undulating striæ; lower or left valve the larger, with the umbo sometimes much produced; hinge with a large rugose tooth; inner margin of valve smooth.

Longest diameter, $1\frac{5}{8}$ths inch.

Locality. Barton.

This is very abundant at Barton, but I do not know it from any other locality, although it is given in Morris's 'Catal. of Brit. Foss.,' 2nd Edit., p. 194, as from Bracklesham Bay. In the 'Ann. du Mus.,' vol. viii, p. 348, Lamarck refers his Paris Basin shell *C. lamellosa* to the British species figured by Solander. Deshayes omits Solander's name from his synonyms, giving his reasons for believing the French shell to be quite distinct; and I am of his opinion. Our shell is very variable, but it is always closely radiated and fimbriated. Sometimes specimens are much distorted, resembling in that respect *Diceras;* adhering only by the umbo, the shell twisting in a spiral manner, carrying up a depressed ridge of the deserted and disused connector (fig. 6 *d*). Some specimens are tinted with a reddish brown, which I imagine to be part of the original colour.

5. Chama sulcata (?), *Deshayes*. Pl. XXV, fig. 7.

Chama sulcata, *Desh.* Coq. Foss. des Env. de Par., vol. i, p. 250, pl. xxxviii, figs. 8, 9, 1825.
— — *Id.* An. sans Vert. du Bass. de Par., vol. i, p. 585, 1860.

Spec. Char. *C.* "*T. ovato-orbiculatâ, convexâ, turgidâ, profundâ, lamellosâ, longitudinaliter multisulcatâ; lamellis irregularibus, brevissimis; sulcis undulatis, numerosis, convexis; dente cardinali oblongo, brevi, sulcato.*"—*Desh.*

Shell irregular, ovate or orbicular, convex, thick, tumid, deep, and lamellated; longitudinally sulcated or radiated; concentrical or periodical lamellæ irregular and short; cardinal tooth short and sulcated.

Localities. Bracklesham Bay and Barton (*Edwards*).
France: Chaumont, Calc. gross. inf. (*Deshayes*).

The lamellæ are dwarfish and the rays broad, flat, and regular. The specimen figured is a lower valve, and had been attached by nearly half the entire surface. The rays are much more numerous than upon *Ch. squamosa*. The inner lining of this shell is without punctures. The tooth of the lower or adherent valve is rugose; so also is the place of its reception in the opposite valve.

6. Chama Selseyensis, *Edwards* MS. Pl. XXV, fig. 5.

Spec. Char. Testá orbiculato-rotundatá, inflatá, valvá sinistrá majore; umbonibus obliquis, incurvatis; lamellis transversis distantibus, acutis, interstitiis lævigatis; cardine unidentato in valvulá sinistrá.

Shell more or less rounded and inflated; left valve the lower and larger; beaks oblique and incurved, covered with smooth and sharp lamellæ; interstices free from radiations; one tooth in the left valve.

Diameter, 1 inch.

Locality. Selsey (*Edwards*).

Several specimens of what is here considered as a distinct species are in Mr. Edwards's cabinet, all exhibiting the same peculiarly smooth character like the one figured, from which it seems to have been entitled to specific isolation. I believe it is so, and have adopted the MS. name. It appears to be distinguished from *gigas* by the smoothness of the exterior and the freedom from fimbriated lamellæ. It somewhat resembles *Ch. inornata*, Desh. (pl. lviii, figs. 20—22), and might possibly be the same if a large series of each could be examined and compared; but the French shell seems to be elaborately ornamented with undulating fimbriæ, and I have preferred keeping it as a distinct species for the present.

7. Chama turgidula (?), *Lamarck.* Pl. XXV, fig. 9 *a—c.*

Chama turgidula, *Lam.* An. sans Vert., 2nd ed., t. vi, p. 585, fide *Desh.*, 1860.
— rusticula, *Desh.* Coq. Foss. des Env. de Par., p. 249, pl. xxxvii, figs. 7, 8, 1825.
— substriata, *Id.* Ibid., pl. xxxviii, figs. 1—3, 1825.

Spec. Char. Ch. Testá suborbiculatá, convexá, crassá, multilamellatá, longitudinaliter multistriatá; lamellis numerosis incrassatis, subplicatis; striis flexuosis, approximatis; umbone valvæ inferioris contorto.

Shell suborbicular, convex, thick, numerously striated with somewhat close-set fimbriæ; umbo of inferior valve incurved.

Diameter, 1 inch.

Locality. Barton.

This appears to differ from *squamosa* in having rather more fimbriated lamellæ, but it is doubtfully distinct. M. Deshayes has united two shells previously considered by himself as specifically separated. From this I presume the French specimens present great variations. Our specimen appears to be intermediate between the two varieties *rusticula* and *substriata*.

8. Chama prisca, *S. Wood.* Pl. XXV, fig. 10.

Locality. London Clay. Railway-cutting, Finchley.

The figure referred to represents a small shell received from Mr. Edwards with the above locality attached. This is the first specimen that either Mr. Edwards or myself have seen from any Eocene deposit in England below the beds of either Barton or Bracklesham. It is the upper valve, and has been somewhat rubbed. Its imperfect condition unfits it for satisfactory specific determination, but I imagine it to be distinct, from its strongly marked radiations and its imperfect or obsolete concentric fimbriæ.

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VOL I.

CORRIGENDA.

For *Ostrea prona*, p. 29, read *Ostrea ventilabrum*, Goldf.

Ostrea pulchra, p. 30 ; this name should be restricted to the small shell from Bromley ; the large shell from Reading, figured in Plate I, is probably a distinct species, which might be called *Ostrea pulcherrima*.

For *Modiola Deshayesiana*, p. 76, read *Modiola Deshayesii.*

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PLATE XXI.

Fig.

1, *a*, *b*. Cardita corpusculum, S. Wood, *p*. 153. Barton.

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3. Cardita alticostata, S. Wood, *p*. 143. Highgate.

4. ,, simplex. Edwards, *p*. 151. Roydon.

5, *a*. ,, planicosta. *b*. juv. *c*. var. *angusticardo*. *d*. var. *laticardo*, *p*. 150. Bracklesham.

6, *a*, *b*. Verticordia formosa, S. Wood, *p*. 139. Whetstone.

7. ,, propinqua, S. Wood, *p*. 140. Highgate.

8, *a*, *b*. ,, obliquata, Edwards, *p*. 139. Bracklesham.

9, *a*, *b*. ,, sulcata, J. Sowerby, p. 140. Highgate.

10. Cardita imbricata, Lamarck, *p*. 147. Bracklesham.

11. ,, oblonga (var. *trapezoidalis*), *p*. 149. High Cliff.

12. ,, simplex, Edwards, *p*. 151. High Cliff.

T. XXI.

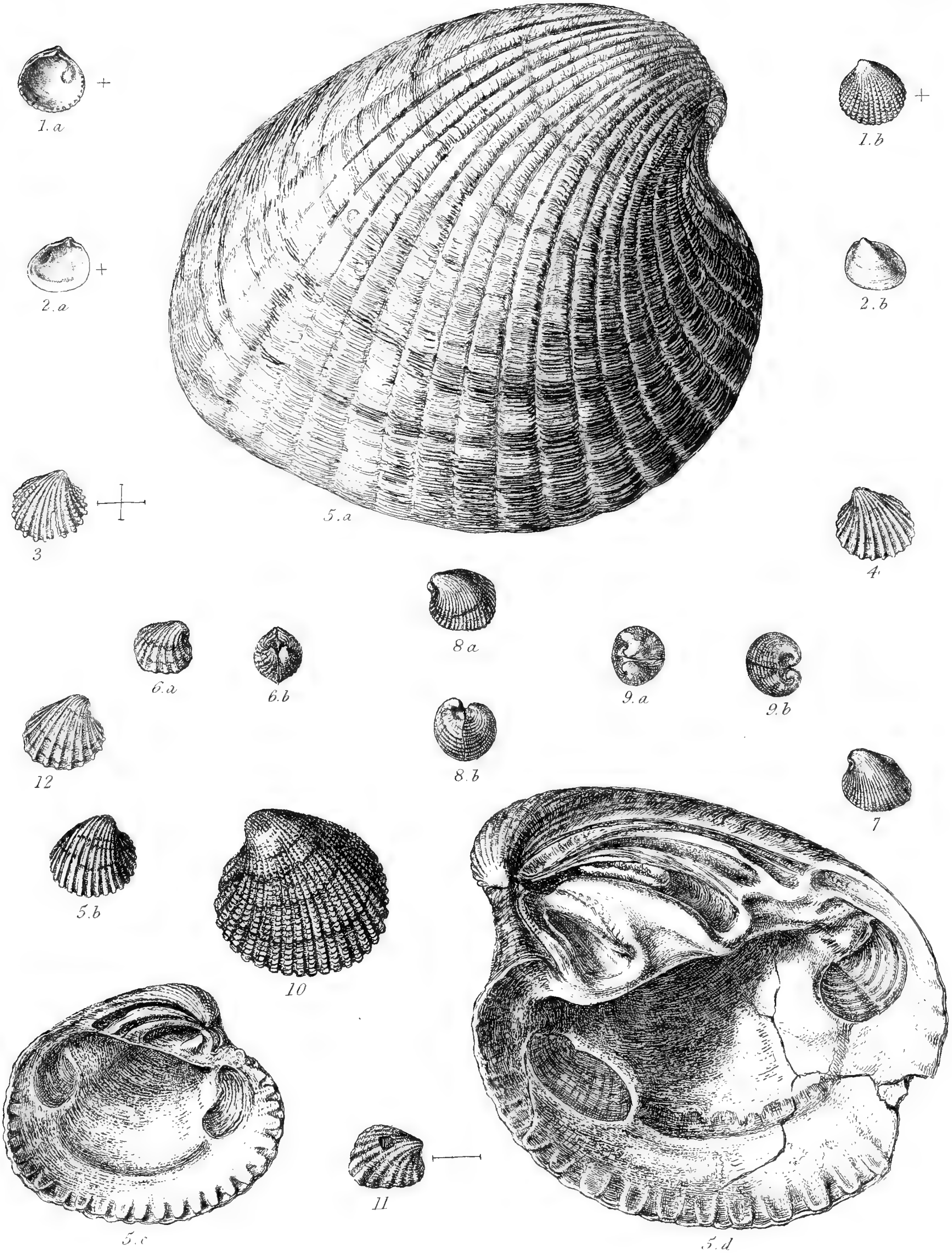

PLATE XXII.

Fig.

1, *a*, *b*. Cardita sulcata, Solander, *p*. 152. Barton.
2. ,, crebrisulcata (var. *subprofunda*), p. 144. Brook.
3, *a*, *b*. ,, mitis ? Lamarck, *p*. 147. Bracklesham.
4. ,, crebrisulcata, Edwards, MS., *p*. 144. Bramshaw.
5, *a*, *b*. ,, acuticosta ? Lamarck, *p*. 142. Bracklesham.
6, *a*, *b*, *c*. ,, paucicostata, Sandberger, *p*. 149. Headon Hill.
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9. ,, Brongniartii, Mantell, *p*. 143. Bognor.
10. ,, oblonga (var. *serratina*), *p*. 149. Mead End.
11. ,, acuticostata ? (var. *asperrima*), *p*. 142. Bramshaw.
12, *a*, *b*. ,, Brongniartii (var. *Clarendonensis*), *p*. 143. Clarendon.
13. ,, obovata, Edwards, MS., *p*. 148. Bracklesham.
14, *a*, *b*. ,, oblonga, J. Sowerby, *p*. 149. Barton.
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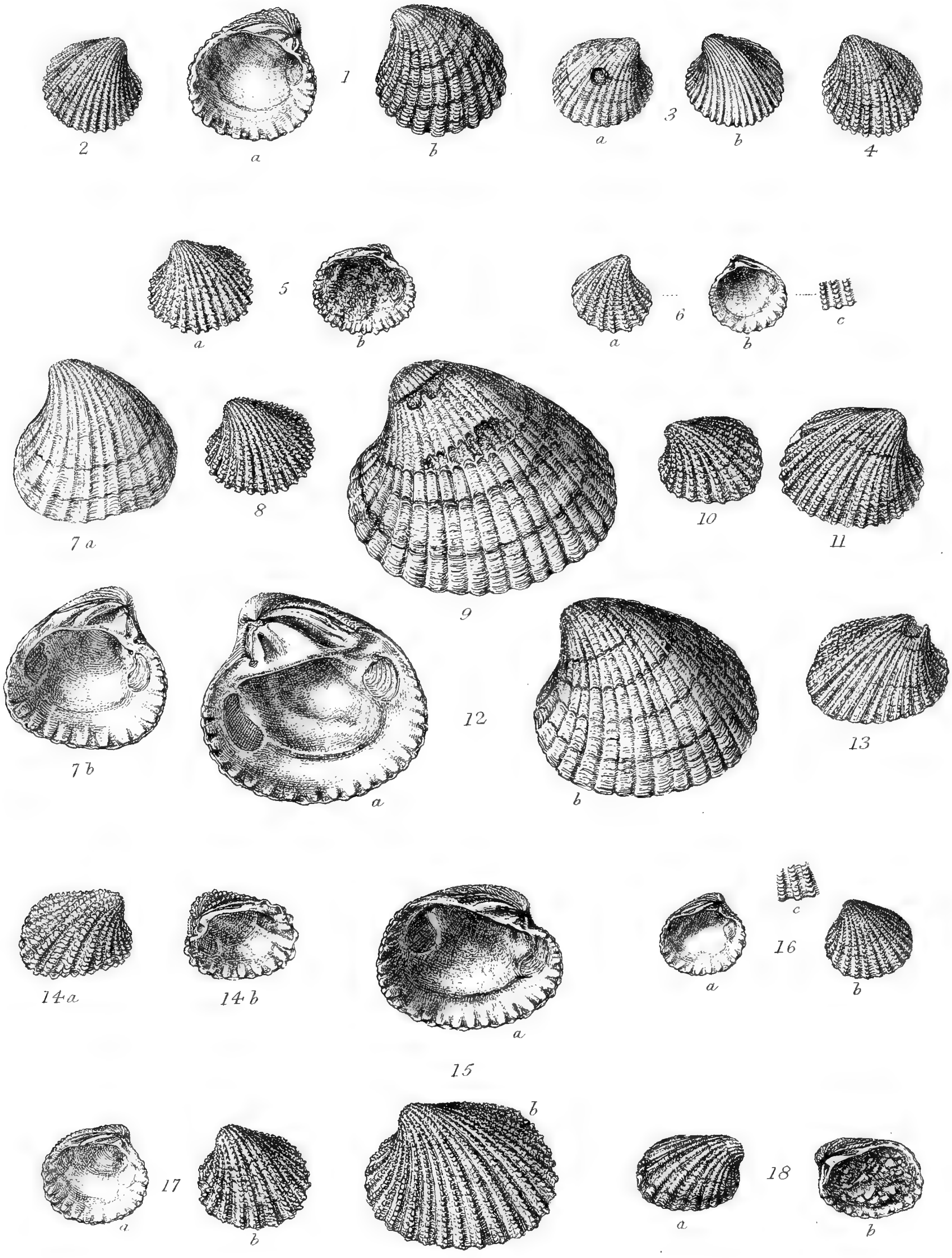

PLATE XXIII.

Fig.		
1, *a*, *b*.	Crassatella	compressa (var. *hemileia*), Edwards, *p*. 165. Brook.
2, *a*, *b*.	,,	tenuisulcata, Edwards, *p*. 171. Barton.
3.	,,	sinuosa, Lamarck, *p*. 168. Bracklesham.
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6, *a*, *b*.	,,	Sowerbyi, Edwards, *p*. 169, Stubbington.
7, *a*, *b*.	,,	sulcata (var. *ensiformis*), *p*. 170. Barton.
8, *a*, *b*.	,,	Grignonensis, Deshayes, *p*. 166. Bracklesham.
9.	,,	sinuosa ? Lamarck, *p*. 168. Barton.
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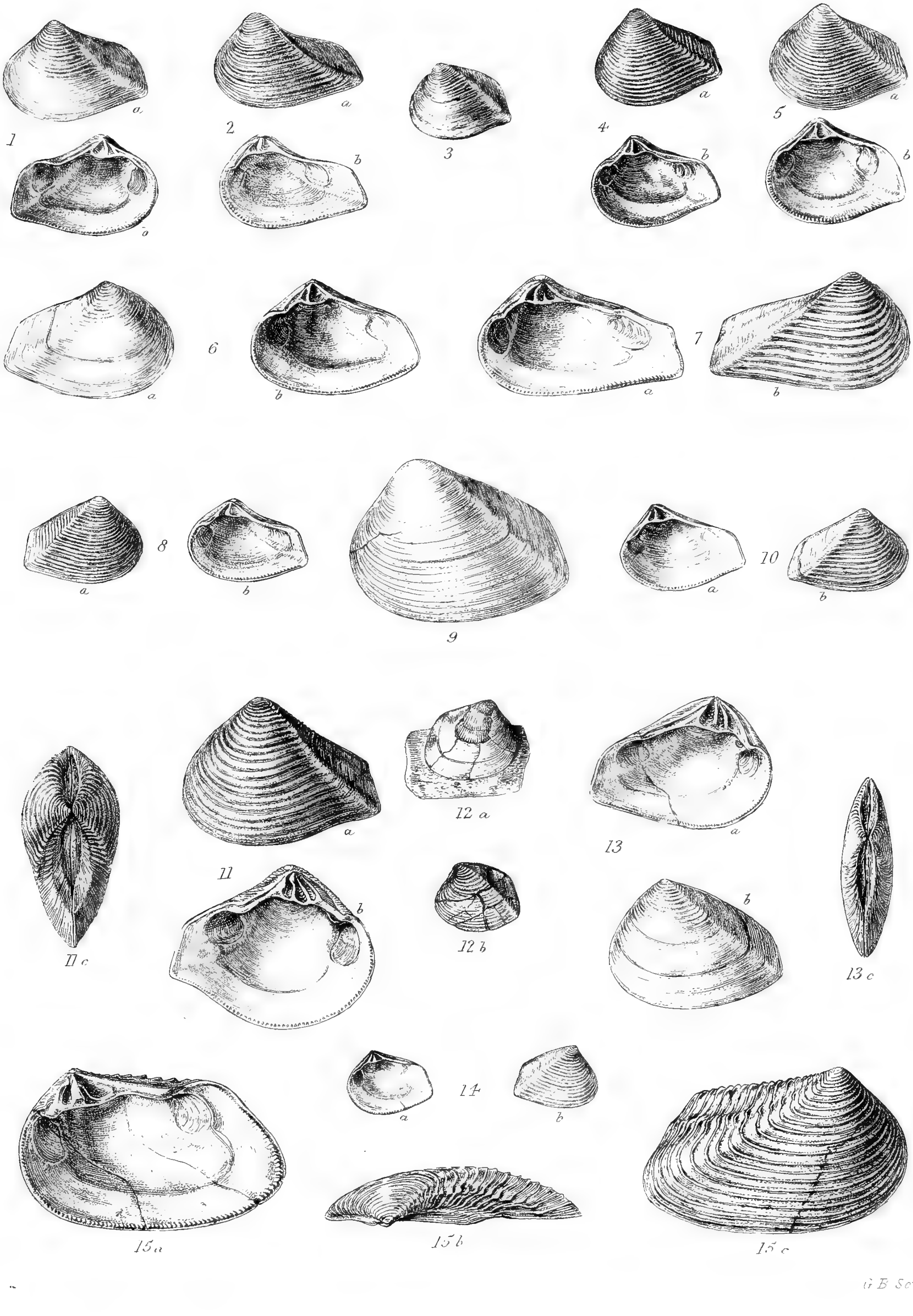
15, *a*—*c*.	,,	gibbosula, Deshayes, *p*. 165. Bracklesham.

T. XXIII



G B Sowerby

PLATE XXIV.

Fig.

1. Crassatella pumilio, S. Wood, *p.* 168. High Cliff.

2, *a—c.* „ Bronnii? Merian, *p.* 163. Barton.

3. „ corbuloides, Edwards, *p.* 164, Stubbington.

4. „ Bronnii? (var. *æqualis*), *p.* 164. Barton.

5. „ „ ? (var. *tumescens*), *p.* 164. Stubbington.

6, *a, b.* „ tenuisulcata (var. *lineatissima*), *p.* 171. Bramshaw.

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8. Astarte tenera? (var. *Hampsteadiensis*), *p.* 158. Hampstead.

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10, *a. b.* „ donacina, J. Sowerby, *p.* 156. Old Basing.

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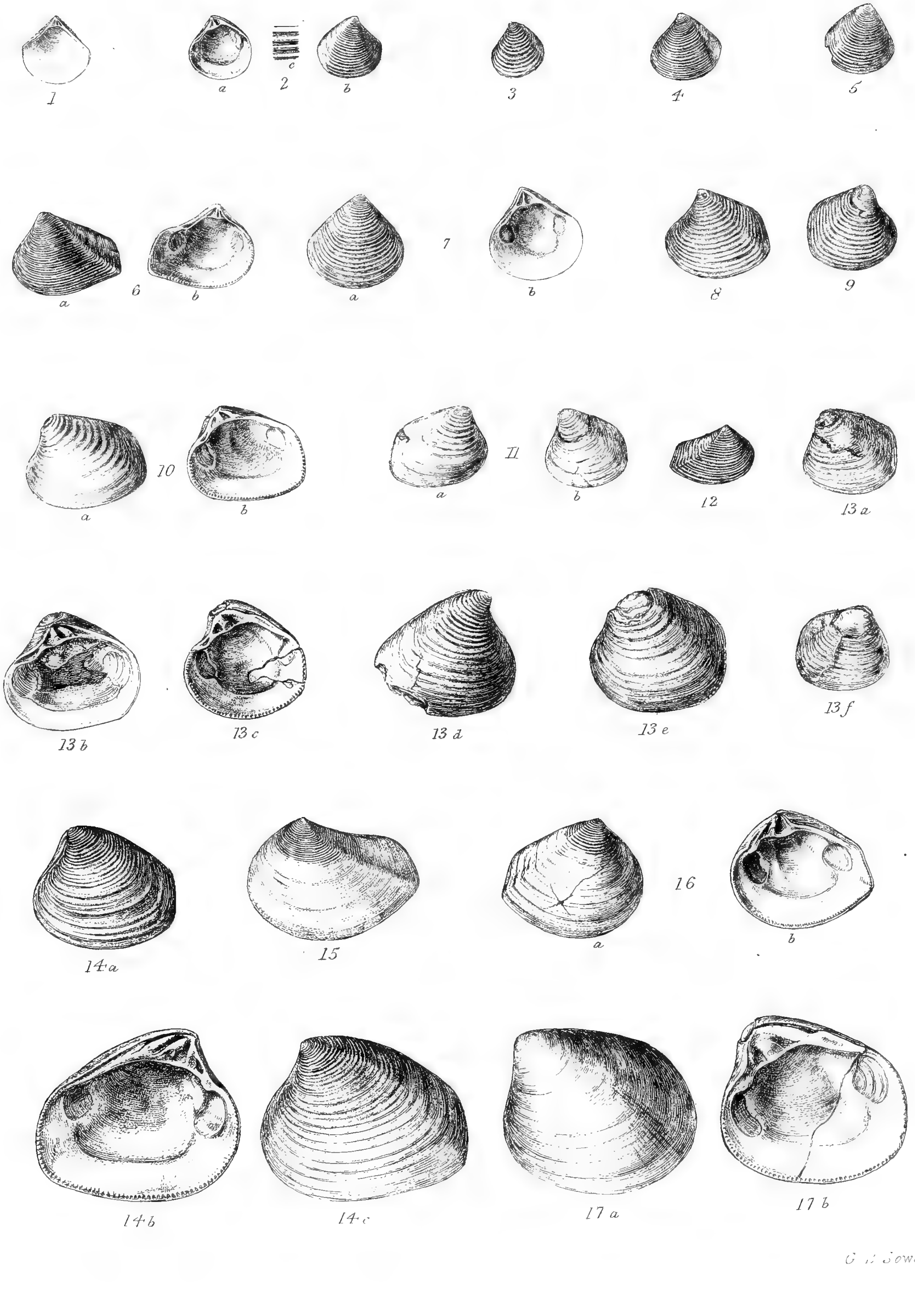
17, *a, b.* Astarte Clarendonensis, Edwards, *p.* 155. Clarendon.

T. XXIV.



G. B. Sowerby.

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Fig.			
1, *a—c*.	Chama calcarata, Lamarck, *p*. 172.		Bracklesham.
2, *a*, *b*.	„	gigas, Deshayes, *p*. 174.	Id.
3, *a*, *b*.	„	„ papyracea? *p*. 174.	Id.
4.	„	„ plicatella? *p*. 174.	Id.
5.	„	Selseyensis, Edwards, *p*. 176.	Id.
6, *a—d*.	„	squamosa, Solander, *p*. 175.	Barton.
7.	„	sulcata? Deshayes, *p*. 175.	Bracklesham.
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9, *a—c*.	„	turgidula? Lamarck, *p*. 176.	Barton.
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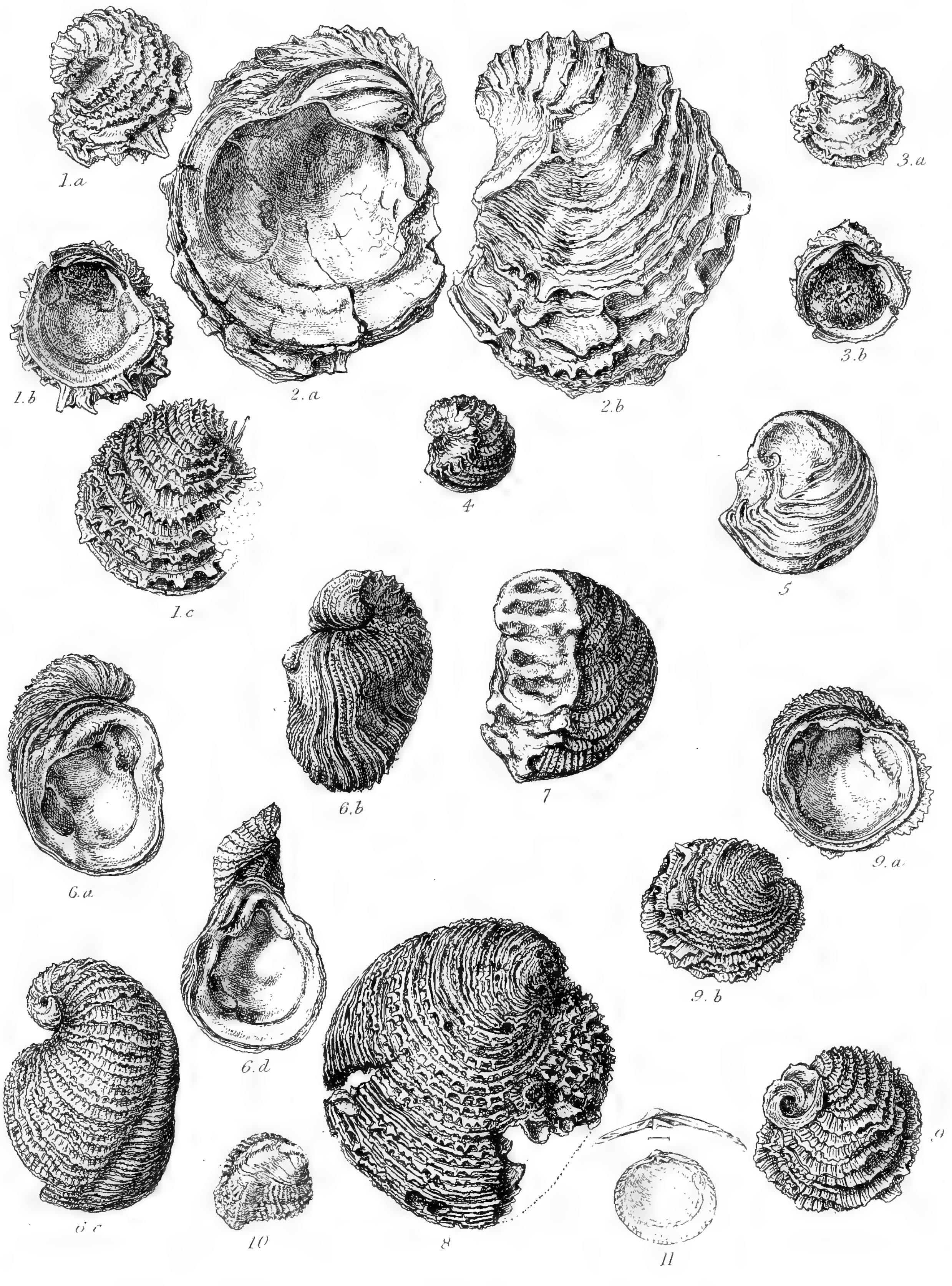
T. XXV.



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MONOGRAPH

OF THE

FOSSIL MAMMALIA

OF THE

MESOZOIC FORMATIONS.

BY

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ETC. ETC.

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MONOGRAPH

OF

BRITISH MESOZOIC MAMMALS.

§ I. INTRODUCTION.

SINCE 1839[1] there has not been further question of the occurrence of fossils of the Mammalian Class in Mesozoic deposits.

The number of confirmatory facts and the rapidity with which they have accumulated are significant and encouraging.

To two members of the University of Oxford Palæontology owes the acquisition of the first evidences from an Oolitic deposit of animals so high in the scale as the *Mammalia*. In 1812 Prof. BUCKLAND, D.D., F.R.S., and WILLIAM JOHN BRODERIP, then an undergraduate, were in friendly relations as professor and pupil. Mr. Broderip had early been initiated by his father, who had formed a fine collection of Natural History, in the elements of that science, and to him, therefore, the lectures of BUCKLAND had a peculiar charm; whilst the professor found in his pupil one to whose judgment he frequently deferred in the determination of Invertebrate Fossils. Mr. Broderip's fine and choice collection of shells was, in after times, purchased by the British Museum. The history of the acquisition of the original Mesozoic Mammalian Fossils was recorded by Mr. Broderip in 1828, as follows:—"Some years have elapsed since an ancient stone-mason, living at Heddington, who used to collect for me, made his appearance in my rooms at Oxford with two specimens of the lower jaws of mammiferous animals, imbedded in Stonesfield slate, fresh from the quarry. One of the jaws was purchased by

[1] GRANT (Prof. R. E.), "General View of the Characters and Distribution of Extinct Animals," in 'Thomson's British Annual' for 1839.

OGILBY (Wm., F.G.S.), 'Proceedings of the Geological Society,' vol. iii, p. 21, December, 1838.

my friend Prof. Buckland, who exclaimed against my retaining both, and the other I lent to him some time ago. Dr. Buckland's specimen, which wants incisor and canine teeth, has been examined by M. CUVIER, and is figured by M. Prévost as an illustration to his 'Observations sur les schistes calcaires oolitiques de Stonesfield en Angleterre.'[1]"

The other and more perfect specimen is described by BRODERIP in the 'Zoological Journal,' 8vo, vol. iii (1828), p. 408, pl. xi, from which the above quotation is taken.

Both professor and pupil believed in the mammalian nature of the fossil jaws thus acquired. But the exceptional character of remains of that high grade of organization in strata so ancient as Buckland had satisfied himself was the tilestone of Stonesfield, induced them to hold back the announcement of the discovery until they had the sanction of the great Palæontologist of the period.

This they had the gratification to receive on the occasion of the visit which Baron CUVIER paid to the University of Oxford in the year 1818, when he pronounced Dr. Buckland's specimen to be mammalian, resembling the jaw of a *Didelphys.*

So encouraged and confirmed in his belief, Dr. Buckland announced the fact in his "Memoir on the *Megalosaurus,*"[2] published in 1823, and referred the jaw, on the authority of Cuvier, to the genus *Didelphys,* although there is little doubt that Cuvier used the term in a wider sense than it signifies in modern systems of Mammalogy.

In 1825 M. Prévost, in a paper on the geology of Stonesfield, in the 'Annales des Sciences,' vol. iv, p. 396, refers to the specimen in the following words:—"Cette pièce unique était conservée dans la collection de l'unversité d'Oxford, lorsque M. Cuvier la vit en 1818. Une inspection rapide fit dire à ce savant anatomiste qu'elle avait des rapports avec la mâchoire de quelque Didelphe." Baron Cuvier himself, in the concluding volume of his great work on 'Fossil Remains,' published in 1825, appended the following note:— "M. Prévost, who is at present travelling in England, has just sent me a drawing of one of these jaws; it confirms me in the idea which my first inspection gave me of it. It is that of a small Carnassial, the jaws of which bear much resemblance to those of the Opossums; but it has ten teeth in a row, a number which no known Carnassial displays. At all events, if this animal be really from the schist of Stonesfield, it is a most remarkable exception to an otherwise very general rule, that the strata of that high antiquity do not contain the remains of Mammals."[3]

The above statements did excite close inquiry, first in regard to the geological relations of the bed of the fossil, and next as to the zoological characters of the fossil itself.

The arguments by which M. Prévost endeavoured to invalidate the conclusions of Buckland as to the relative position of the oolitic tilestone were satisfactorily rebutted by Dr. Fitton.[4] The antiquity of this bed (No. 8, fig. 2, p. 11), could not be reduced to

[1] 'Annales des Sciences Nat.,' Avril, 1825.

[2] 'Transactions of the Geological Society of London,' 4to, vol. i (2nd series), p. 399.

[3] 'Recherches sur les Ossemens Fossiles,' 4to, vol. v, pt. ii, p. 349.

[4] 'Zoological Journal,' vol. iii, p. 402, 1828.

correspond with the then presumed exclusively Mammalian epoch, and the attempts to do away with the supposed anomalous exception were afterwards confined to arguments in favour of the jaw in question having belonged to a cold-blooded oviparous animal, either fish or reptile.

The grounds of such conclusion will be found in the papers by Prof. AGASSIZ, in 'Leonhard und Bronn's Neue Jahrbuch für Mineralogie und Geologie,' 8vo. 1835, vol. iii, p. 185; by DE BLAINVILLE, in his "Doutes sur le prétendu Didelphe de Stonesfield," in 'Comptes Rendus de l'Académie des Sciences,' Paris, August 20th and October 6th, 1838; in Prof. R. E. GRANT's "General View of the Characters and Distribution of Extinct Animals," in 'Thomson's British Annual' for 1839; and in Mr. OGILBY's communication to the London Geological Society in December, 1838.

The facts and arguments for the mammalian character of the fossil in question are given in a paper by Prof. VALENCIENNES, in the 'Comptes Rendus de l'Académie des Sciences,' Septembre, 1838, p. 572, and in my Memoir containing a description and figures of Dr. BUCKLAND's, Mr. BRODERIP's, and subsequently discovered specimens from Stonesfield, published in the 'Transactions of the Geological Society of London; 2nd series, vol. vi, pp. 47—65, pls. 5 and 6.

Subsequent discoveries have not only confirmed CUVIER's conclusion, but have extended our knowledge of small Mammals in Secondary strata both older and newer than the Lower Oolitic one in which they were first discovered.

The subjoined table of the earth's strata containing evidences of life shows the relations to time of the first-known appearances of the warm-blooded viviparous Vertebrates (p. 4).

To the description of these fossils, for the most part British, I now proceed.

A. RHÆTIC MAMMALS.

§ II. *Genus*—MICROLESTES, *Plieninger*, 1847.[1]

Species 1—MICROLESTES ANTIQUUS, *Plieninger*. Plate I, figs. 14, 15, 15 A.

In 1847 Prof. PLIENINGER, of Stuttgart, discovered, in sifting the sand of a 'bone-bed' in the 'Keuper' of Diegerloch and Steinenbronn, two minute teeth, each showing a well-defined enamelled tuberculate crown, supported by two distinct roots or fangs.[1]

The professor, referring to my paper on the Stonesfield jaws, in which the supposed occurrence of that mammalian dental characteristic in the teeth of sharks and of the

[1] "Jahreshefte des Vereins für Vaterländische Naturkunde in Würtemberg," 8vo, Bd. ii (1847), p. 164, taf. i, figs. 3, 4; and "Nova Acta Cæs. Acad. Nat. Cur.," &c., vol. xxii (1850), p. 902, pl. 71, figs. 14, 15.

TERTIARY or NEOZOIC.	Turbary.	Pleistocene	**MAN**
	Shell Marl.		by Remains.
	Old-valley Drift. Bone-Caves.		
	Brick Earth.		by Weapons.
	Glacial Drift.		
	Norwich and Red Coralline } Crag.	Pliocene	**MAMMALS** under present geographical distribution.
	Faluns.	Miocene	Ruminantia. BIRDS, Orders of. Quadrumana.
	Molasse.		Proboscidia.
	Gyps, &c.	Eocene	Rodentia. Orders of Placentalia.
	London } Clays. Woolwich		Ungulata. Carnivora.
SECONDARY or MESOZOIC.	Maestricht.	Cretaceous	Cycloid. } FISHES.
	Upper Chalk.		Ctenoid. } FISHES.
	Lower Chalk.		BIRDS, by Bones.
	Upper Greensand and Gault.		Procœlian Crocodilia.
	Lower Greensand.		Pterodactyles.
	Weald Clay.	Wealden	
	Hastings Sand.		Iguanodon.
	Purbeck Beds.		**MARSUPIALS**: Spalacothere, &c.
	Portlandian and Kimmeridgian.	Oolite	Pliosaurus.
	Oxfordian. U.		Birds, by Bones and Feathers.
	Kellovian.		
	Forest Marble.		
	Bath-Stone. M.		
	Stonesfield Slate.		**MARSUPIALS**: Amphithere, &c.
	Lower Oolite. L.		
	Lias.		Ichthyopterygia.
	Bone Bed.		**MAMMALIA**, Microlestes.
	Keuper.	Trias	**AVES**, by Foot-prints.
	Muschelkalk.		Sauropterygia.
	Bunter.		Labyrinthodontia.
PRIMARY or PALÆOZOIC.	Marl and Sand.	Permian	
	Magnesian Limestone.		Sauria.
	Red Sandstone.		Chelonia, by Footprints.
	Coal Measures.	Carboniferous	**REPTILIA**, Ganocephala.
	Mountain Limestone.		
	Carboniferous Slate.		
	U. Old Red Sandstone.	Devonian	Heterocercal.
	Caithness Flags.		**PISCES** { ganoid.
	L. Old Red Sandstone.		placo-ganoid.
	Ludlow.		placoid.
	Wenlock.	Silurian	
	Llandovery and Caradoc.		Echinoderms.
	Llandeilo.		Annelides. Bivalves. Trilobites. Pteropods. Brachiopods. Gastropods. Cephalopods (4-gilled).
	Lingula Flags.		
	Cambrian.		Brachipods. Trilobites. Fucoids. Zoophytes.

Order of appearance of Vertebrates in Fossiliferous Strata.

Basilosaurus of Harlan is shown not to affect the rule of two roots, being exclusively mammalian,[1] concluded that he had evidence of a Mammal from that Mesozoic group of strata now termed 'Rhætic,' which is older than the Oolitic or Jurassic group, and he proposed for the small species represented by the two teeth the name *Microlestes antiquus,*[2] rightly referring it, notwithstanding the diminutive size indicated by the fossils, to have been a predaceous or zoophagous Mammal.

The long diameter of the crown of the larger of the two teeth (op. cit., taf. I, fig. 4) is one eighth of an inch; it is divided into two low subobtuse lobes or cones, each of which shows tuberculate subdivisions; the lobes are united at the exposed side by a basal ridge or 'cingulum.' Each root contracts to a subobtuse closed end. This tooth is preserved imbedded in the matrix.

The second tooth (ib., fig. 3, *a–d*) is of smaller dimensions; the fore-and-aft diameter does not exceed one line ($=\frac{1}{12}$th inch); the transverse diameter is little more than a third of a line, the tooth being of compressed form, from side to side. The outer side of the crown (Pl. I, fig. 15, of this Monograph) presents one chief cone at the anterior half, succeeded by a low tubercle, and then a smaller one; the inner side of the crown (ib., fig. 14) shows three or more smaller tubercles, decreasing in size as they approach the hind end of the tooth, but the foremost is lower than the one on the outer side of the crown. They are joined anteriorly by a small basal talon. Thus, the grinding surface of this tooth (Pl. I, fig. 15 A) shows an irregular longitudinal mid depression between an outer and an inner tuberculate ridge or rising of the crown. It is a type of molar which prevails in a still existing member of the multidentate division of the Marsupial order (*Myrmecobius fasciatus,* Wth., Pl. I, fig. 19, from upper jaw, magn. 4 diam.; fig. 20, from lower jaw, magn. 4 diam.), and which we shall find repeated in the ultimate molar of the lower jaw of a small predaceous paucidentate Marsupial from an Upper Mesozoic deposit (comp. Pl. I, figs. 14 and 15, with Pl. IV, fig. 9 B, *Plagiaulax minor,* and ib., fig. 12 B, *Plagiaulax Becklesii*).

The tooth (Pl. I, figs. 14, 15, 15 A) from Degerloch is, most probably, a mandibular molar, and, like those in *Myrmecobius,* is supported by an anterior longer and narrower root and a posterior shorter and rather broader root, both tapering, with progressive widening of their interval, to their implanted end.

The crown is short or low in proportion to its fore-and-aft breadth, constituting about one third the length of the entire tooth, which is about two lines. The teeth of the microlestian type still manifested by the Australian Insectivore (Pl. I, fig. 24) are quite as minute, with as short crowns, as in *Microlestes antiquus;* they are carried by an animal with a

[1] "Nachdem auch das unter dem Namen '*Basilosaurus*' bekannte, mit 2-wurzlichen Zähnen versehene Fossil, mit welchem man die Stonesfielder Kiefer zu Reptilien-resten stempeln wollte, unter die *Cetaceen* versetzt war."—Loc. cit.

[2] Gr. *μικρος*, small; *ληστής*, ravener; op. cit., p. 165.

skull two and a quarter inches long, and having a total length of body of eight inches, with a tail of six inches.[1]

The keenness of observation and patient research with which were scrutinised, lens in hand, bushels of a formation rife with organic and mostly fragmentary remains,[2] cannot be sufficiently praised; and Plieninger was worthily rewarded with this capital discovery of the oldest known Mammal.

Species 2.—Microlestes Moorei, *Owen*. Plate I, figs. 1—13.

To like perseverance and qualities of discovery applied by Charles Moore, Esq., F.G.S., to the fossils of breccia of Rhætic bone-bed and Limestone, filling a fissure in the Mountain Limestone at Holwell, Frome, in Somersetshire, is due the discovery of teeth corresponding in size and general character with those of the *Microlestes antiquus* of Plieninger.[3]

These teeth, with other fossils, were submitted to my inspection in 1858, referred to the genus *Microlestes*, and the following notes were taken of their characters.

Pl. I, figs. 1—4, represent (the natural size in outline, and magnified four times in tint) an upper molar tooth, of which the grinding surface (fig. 1) consists of a central smooth depressed area enclosed by a low thick tubercular wall. The inner side of the tooth is indicated by the more prominent part of the wall, which is divided into three tubercles; the outer side by the lower wall with indications of subdivision into smaller and more numerous tubercles, the largest forming the hind part of the wall and a great part of that end of the tooth. The working surface of the crown is oblong, narrowest transversely, with the inner and hinder end most produced.

The length (vertical diameter or depth) of the crown is very short compared with its breadth (fore-and-aft diameter) and thickness (transverse diameter). It is divided by a well-defined constriction or 'neck' from the roots, which are four in number. Of these the post-internal root is the best preserved, the other three being broken off near their base.

A second upper molar is represented in Pl. I, fig. 5, from the outer side. In this tooth the enamelled crown has been worn almost to the cement-covered base. One of the larger tubercles at, probably, the fore part of the crown remains. At this part there are the beginnings of two fangs, or of the division of a broad anterior root; the base of a third smaller root supports the opposite end of the crown. The indenta-

[1] Waterhouse, "Description of a new Genus of Mammiferous Animals from Australia, &c.," 'Trans. Zool. Soc.,' vol. ii, p. 149, pls. 27 and 28.

[2] "Eine ungeheure Masse von Zähnen, Schuppen, Coprolithen und unkenntlichen Skelettheilen von Fischen und Sauriern."—Op. cit., p. 165.

[3] For a description of the Rhætic Beds of Somersetshire and an excellent account of the geology of the district in which these Microlestian remains were found, see Mr. Moore's paper "On the Abnormal Condition of Secondary Deposits," &c., in the 'Quarterly Journal of the Geological Society of London,' December, 1867.

tion of the coronal basis continuing to the fang from between two of the coronal tubercles may be noted, in elucidation of the like character described and figured (in Letter) by Prof. Phillips, F.R.S., in the tooth of *Microlestes rhæticus,* which is decisive against the alleged resemblance and affinity signified by the generic name *Hypsiprymnopsis* imposed upon that tooth by Mr. Boyd Dawkins, F.R.S. (‘Quart. Journ. Geol. Soc.,’ vol. xx, p. 411.)

Pl. I, fig. 6, represents the crown of a lower molar, showing a well-defined neck and the beginnings or bases of two equal fangs. The circumference of the crown describes an irregular ellipse, the compression being from without inward.

The Microlestian generic character of a smooth subdepressed central area, enclosed by a thick tubercular wall, is well shown in this tooth. The outer part of the wall developes three tubercles, the divisions between which extend from their outer side upon that surface of the base of the crown toward the fangs. The inner part of the wall (*a*) developes four small tubercles, the anterior one, forming the antero-internal angle of the crown, being the largest and most prominent.

Were this tubercle to be broken off and the outer part of the tooth worn down as far as the line *b,* the portion left of the working surface of the crown would offer an instructive subject of comparison with the portion of the crown of the *Microlestes* (*Hypsiprymnopsis*) *rhæticus* represented in Pl. I, fig. 16, from a drawing of the original kindly made for the author by Prof. Phillips, F.R.S.

The subject of figs. 7 and 7 A, Pl. I, is the crown, with the base of the two fangs, of a lower molar; the working surface is more worn than in fig. 6. Consequently the three outer tubercles of the coronal wall are represented by a plicate outline such as would be presented by the premolar of *Hypsiprymnus murinus,* (ib., fig. 17) if it were worn down to near the base of its enamel-foldings; only the contrasted extreme shortness of the crown in *Microlestes* brings the intervals of the tubercles nearer to the origins of the roots of the tooth. The smaller tubercles of the inner side of the wall are almost obliterated in this tooth, and the smooth central area is proportionally enlarged. A fourth lower molar in an old *Myrmecobius* closely repeats this character.

Pl. I, figs. 8, 8 A, show the crown and beginning of the roots of a lower molar with the trituberculate outer wall, and the summit of the anterior angular larger tubercle of the inner wall. Fig. 8 A gives a view of the crown from the fore end or side, showing the degree of compression from without inwards; it also shows the hindmost of the three outer tubercles, and the summits and intervals of the smaller tubercles of the inner wall extending to the hind end of the crown.

Pl. I, fig. 9, represents the crown of a lower two-fanged molar with the working surface but little worn, showing the three outer tubercles and the five smaller inner ones, with the characteristic anterior large and prominent corner tubercle (broken off in fig. 16 A).

Pl. I, fig. 10, represents the crown of a small molar viewed obliquely from the inner side, showing the anterior larger tubercle followed by three smaller ones; the three larger tubercles of the outer wall are also brought into view.

Pl. I, fig. 11, represents a smaller, probably anterior, tooth, with one fang supporting a crown or portion of crown, showing its extreme shortness, increased seemingly by attrition, which has reduced the intervals of the coronal tubercles to low notches of the enamel, with intervening exposed dentine.

Pl. I, fig. 12, shows a minute tooth with a crown of more simple character than the larger molars; it, nevertheless, repeats the characteristic shortness or lowness of the crown, but shows a more simple tubercular accentuation of the grinding surface, and an indication of two fangs of unequal size; this indication may, however, be due to a basal fracture of a large single fang, as in fig. 11.

Species 3.—MICROLESTES RHÆTICUS, Plate I, figs. 16, 16 A.

HYPSIPRYMNOPSIS RHÆTICUS, *Boyd Dawkins,* 1864.[1]

In 1864 Mr. Boyd Dawkins, F.R.S., F.G.S., discovered a small two-fanged, laterally worn molar in Rhætic marlstone at Watchet, Somersetshire, and, assuming a common or persistent level of the detached patches or 'pockets' of bone-bed in that county, claims for the marlstone a higher antiquity than the matrix of "the Microlestian teeth of Frome and Diegerloch."[2]

This tooth is figured of the natural size and magnified four diameters, in Pl. I, figs. 16, 16 A.

The crown, as in *Microlestes,* is very short in proportion to its fore-and-aft width, being 1 line (1-12th in.) in height at the bifurcation of the two fangs, and 2 lines (1-6th in.) from the front to the hind border. The total length of the tooth, including the entire fang, very slightly exceeds the fore-and-aft diameter of the crown. The breadth or transverse diameter of the tooth, cannot be accurately determined, for the side imbedded is "entirely concealed,"[3] and the side exposed to view has been subject to attrition, presenting "a smooth polished surface, which extends without interruption from the crown into the fangs,"[3] and exposing "a dark band, from *b* to *b*, crossing what would be called the base of the crown."[3] This part of the base shows "four grooves passing downwards from the crown towards the fangs."[3] Whether these grooves (fig. 16, *c*) are due to the wearing force or indicate original structure is uncertain; if the latter, they are repeated in the lower molars of *Microlestes* and in one of the molars of *Plagiaulax,* but not in the trenchant premolars of either this genus or of *Hypsiprymnus.*

The higher side of the tooth (*a b*, fig. 16 A) is the one imbedded in the matrix; so much of it as is exposed shows the upper and inner, not the outer, side; it is the thick enamelled border of a low crown bounding the inner side of a pounding surface which

[1] "On the Rhætic Beds and White Lias of Western and Central Somersetshire," &c., 'Quarterly Journal of the London Geological Society,' vol. xx, 1864. p. 396, &c.

[2] Op. cit., p. 410.

[3] Letter to the Author from Prof. Phillips, F.R.S., dated Oxford, 29th August, 1870.

was depressed, flat and smooth in the centre. This coronal border (fig. 16, *a*) was disposed in four, probably five, tubercles; on the latter alternative the fifth is broken away, most likely as being the largest and most prominent. The attrition of the masticatory tubercles of the preserved border of the crown of this little molar has exposed the dentine. "The crown of the tooth," writes Prof. Phillips, "is obliquely worn, and on the worn surface are little cusps, as in my figure, also worn, but a little projecting at the edges, as at fig. 16 A, as if they were formed of enamel and dentine within the general border of enamel."[1]

Now, this is precisely the appearance which the similarly worn multituberculate border of certain molars of *Microlestes* present. The lofty compressed trenchant premolars of *Hypsiprymnus* (fig. 17) lose all trace of the grooves and ridges at the basal part of the crown in proximity with the fangs. The bulging basal part of the premolar is covered by a smooth polished coat of enamel in both *Plagiaulax* (Pl. IV, figs. 9, 10), *Hypsiprymnus* (Pl. I, fig. 17), and *Bettongia,* (ib., fig. 18).

In *Hypsiprymnus* it is very true that the 'length' or vertical diameter of the crown of the tooth is great compared with the breadth or transverse diameter; but in this 'main characteristic' the Rhætic tooth, like those of *Microlestes* and the true molars of *Plagiaulax,* differs widely from the premolar of *Hypsiprymnus.* The oldest Rat-Kangaroo shows no such wearing down of the crown as must have happened to the rhætic tooth (fig. 16), if it ever possessed one as lofty as that of the hypsiprymnal premolar (figs. 17, 18). "The implantation by two fangs [is] seen alike in both" the Rhætic tooth and the premolar of *Hypsiprymnus*[2]: add, also, in *Microlestes* (lower molars). Only there is a vagueness of meaning in Mr. Boyd Dawkins' phrase "seen alike;" for though, doubtless, the Rhætic molar and the hypsiprymnal premolar, with divers other teeth, are each implanted "by two fangs," those fangs are not "alike" in the teeth compared; and where the field of comparison is so restricted—where so few characters can be securely got out of the worn and broken fossil denticle in the slab of hard marlstone—it is satisfactory to have anything so plain and conspicuous to reason from as the two fangs so unlike in form and proportions as are those in *Hypsiprymnus* (fig. 17) and in the so-called *Hypsiprymnopsis* (fig. 16 A). The proportions of the fangs in the Rhætic tooth, supposing them to be the only two it possessed, are much more alike in it and in the lower molar of *Microlestes* (Pl. I, figs. 7 A, 14, 15).

The hind fang in *Hypsiprymnus* is more than twice the breadth, antero-posteriorly, of the front fang; it is subcompressed like the crown it helps to support, and in *Hypsiprymnus minor* (Pl. I, fig. 17) its proportion of the crown is such as to include all the four vertical ridges and grooves that impress the upper half of the crown.

Mr. Boyd Dawkins figures the anterior (broken) root of the Rhætic denticle as stouter, *i.e.* antero-posteriorly broader, than the posterior root, and describes the

[1] Letter, ut suprà.

[2] B. Dawkins, op. cit., p. 410.

"stout" fang which supports "all the plicæ" of the "four-plicated premolars" of *Hypsiprymnus murinus*, &c., as the anterior one.[1] Prof. Phillips's figure gives a more equal share of the crown to the two supporting fangs. The stouter fang of the premolar of *Hypsiprymnus* (Pl. I, fig. 17), always posterior in position, is impressed by a longitudinal groove. In the mandible of *Hypsiprymnus minor* the front fang is much smaller than the hind one, and the interval relatively much less than in the Rhætic tooth.

In sum, the Watchet denticle has two fangs and a crown, and a "well defined cervix" between them; and so has the premolar of *Hypsiprymnus:* their composition in regard to enamel and dentine is the same. Further than this no point of resemblance can be truly predicated as between the Rhætic tooth and the premolar of any living form of saltatory herbivorous Marsupial.

The microlestian denticles are comparable with the molars of *Myrmecobius* and *Plagiaulax*, and with these alone in the Marsupial order. The molars of *Myrmecobius* form a larger proportion of the entire dental series than do those of *Plagiaulax.* If these genera were represented by detached fossil teeth, it is, numerically, probable that *Plagiaulax* would be represented by some of its sixteen[2] obliquely ridged carnassials, and *Myrmecobius* by some of its tuberculate molars.

Now, the numbers of such minute tubercular molars as have brought to light the former existence of a small-toothed predaceous, probably insectivorous, Marsupial, in times so far back as the Triassic, lead me to surmise that the extinct species more resembled the multidentate *Myrmecobius* and *Amphitherium* than the paucidentate *Plagiaulax.*

The small tooth figured in Pl. I, fig. 13, nat. size in outline, closely resembles a mammalian canine, and bears the same proportion to the molars of *Microlestes* as does the canine to the molars in *Myrmecobius.*

B. Oolitic Mammals.

The geological relations of the bed from which the fossils next to be described have been obtained will be understood by reference to the diagram, fig. 2, of the section at Stonesfield from Fitton's Memoir.[3]

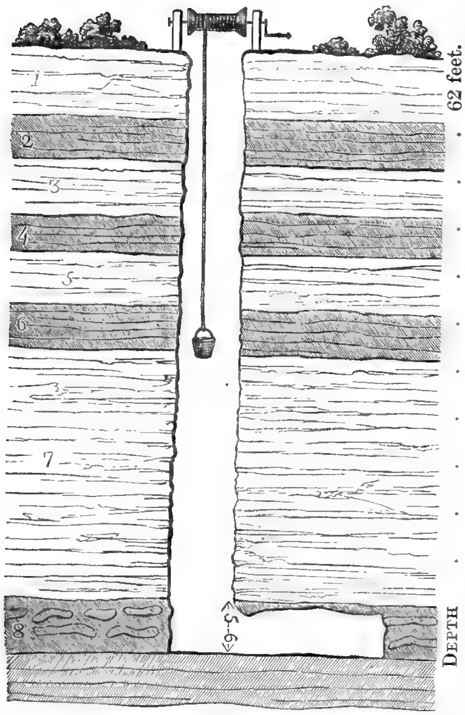
On the side opposite the right hand is marked the depth of the shaft to the horizontal gallery where the "slate" is worked which contains the mammalian fossils; on the opposite side the strata are numbered in succession as follows:

[1] Op. cit., p. 410.

[2] On the assumption that there were as many premolars in the upper as in the lower jaw of *Plagiaulax minor.*

[3] 'Zoological Journal,' loc. cit.

Fig. 2.



1. Rubbly limestone (Cornbrash).
2. Clay with Terebratulites.
3. Limestone rock.
4. Blue clay.
5. Oolitic rock.
6. Blue clay.
7. 'Rag,' or Oolitic limestone.
8. Sandy bed, containing the 'Stonesfield slate.'

To this succeed other Lower Oolites, leading to the Lias. Prof. Sedgwick[1] was the first to point out the removal of the upper members of the Oolitic or Jurassic series from the locality, near Oxford, where the above shaft is sunk.

It may be acceptable to some readers to have a brief statement of the generalisations from the exhaustive survey of mandibular and dental characters of *Vertebrata* required for an effectual grappling with the question discussed, in 1838, before the Academy of Sciences in Paris and the Geological Society of London.

The mandible in *Mammalia* consists of two symmetrical halves or 'rami,' which in some coalesce at the symphysis. Each ramus is a single or continuous bone, and offers a convex or flattened surface for the joint with the cranium; not a concavity, as in lower Vertebrates. In most placentals the lower and hind part of the ramus projects backward and is called the 'angle.' In some *Carnivora* (*Hyæna crocuta*, e.g.) the angle is excavated on its upper and inner surface with a semblance of inflection, but the sharp inner margin is not produced beyond the vertical plane of the coronoid. In the Hare the lower border of the angle expands, so as to project a little beyond both the outer and inner surfaces of the 'ascending ramus:' viewed from the inner side, it appears to be slightly inflected. But the inward bending of the part answering to the 'angle of the jaw' in higher Mammals is peculiar to the *Marsupialia*, and in some species (*Phascolomys*, e.g.) to a remarkable extent.

[1] 'Trans. of the Geol. Soc.,' 2nd series, vol. iv (1835), p. 26, *note*.

The implantation of certain teeth by two or more roots in correspondingly complex sockets, to which the roots do not coalesce, is a mammalian peculiarity, though not common to the entire class.

§ III. *Genus*—Amphitherium, *De Blainville*, 1838. "Doutes sur le prétendu Didelphe fossile de Stonesfield;" 'Comptes rendus de l'Acad. des Sciences,' August 20th, 1838.

> Amphigonus, *Agassiz*, 1835. Neues Jahrbuch für Mineral. und Geolog. von Leonhard und Bronn, Bd. iii, p. 185. (This name was proposed to express the, then, ambiguous nature of the fossil.)
>
> Thylacotherium, *Valenciennes*, 1838. Comptes rendus de l'Acad. des Sciences, Septembre, 1838, p. 572.

Species 1.—Amphitherium Prevostii, *Owen*. Plate I, figs. 21, 21a, 22, 22a, 23, 23a.
Brit. Foss. Mammals, 8vo, 1846, p. 29.

> Thylacotherium Prevostii, *Val.* Comptes rendus de l'Acad. des Sciences, September, 1838.

Pl. I, fig. 21, gives the natural size in outline, and fig. 21 a, part of the same four times that size, in tint, of the original specimen examined by Cuvier in 1818, and noticed by him in 1824.[1] The fossil partly exhibits, partly represents by impression in the matrix, the left half of the lower jaw, with the fore extremity broken off. A thin layer of the original bone adheres to that part of the impression which was formed by the joint or 'condyle' (*b*); the impression above gives the size and shape of the coronoid process (*c*); a portion of the angle (*a*), remains, which is continued backward nearly as far as the condyle. The part of the jaw containing the three hindmost grinders is almost entire; the outer wall of the rest of the bone is left imbedded in the Oolitic slate, but this part retains seven of the molar series, with their roots, undisturbed in their sockets.

From what has been premised of the mammalian characters of the lower jaw and teeth, those which led Cuvier to conclude that the present fossil belonged to that class will be readily appreciated. The convexity of the condyle and the implantation of the teeth, each by two fangs, are decisive on this point.

Ten molars are shown in the present fossil, and the two long implanted fangs are exposed in seven of these teeth, lodged in deep sockets.

A subsequently acquired half-jaw of the same species (Pl. I, fig. 23, 23 a), with the whole dentition of that mandibular ramus, shows that the first four teeth of the original fossil, counting backward (fig. 21, a), correspond with the third, fourth, fifth, and sixth premolars,

[1] "Carnassier de Stonesfield, voisin des Sarigues," Cuvier, 'Ossem. fossiles,' tom. v, pt. ii, 4to, 1824, p. 349. Id., 8vo ed., 1836, tom. x, p. 484.

and the remaining six to the true molars. The crowns of the fourth, fifth, and sixth premolars are entire, and consist of a single compressed conical cusp, with a minute tubercle at the hind part of its base, and a more minute one in front; the base of the crown is slightly tumid, and from it are continued, without the intervention of a cervix, the two slender and slightly diverging roots. The fractured crown of the first true molar shows more distinct anterior and posterior basal cusps; those of the second and third show an increased thickness. The fourth gives a view of the anterior cusp, of the large middle cone, and of part of the posterior cusp; the thicker and more complex crowns, as compared with those of the premolars, are unequivocally shown in the last three molars. The roots of the teeth are seen in the specimen, fig. 21, to descend half way or more toward the lower border of the ramus; their substance is contrasted by its denser texture and deeper colour with the surrounding bone, from which the tooth-roots are separated by a thin layer of a distinct substance, infiltrated apparently from the matrix into the sockets. In most Reptiles the base of the fully developed tooth is confluent with the bony substance of the jaw; in the few in which the implanted base remains distinct it is simple; in both cases, with a series of seven contiguous teeth exposed as in the jaw in question, the germ of a successional tooth would be found beneath some of the teeth.

The broad, elevated, slightly recurved coronoid process resembles that in *Didelphys*, *Dasyurus*, *Perameles*, *Erinaceus*, and the like small predatory mammals; the position of the condyle, on a level with the teeth, is also a character of a feeder on animal substances.

The position and form of the entry of the canal (*d*) transmitting the nerve and vessel of the teeth accord with the mammalian type of the jaw. The (mylohyoid) groove is present in the jaw of *Myrmecobius* (fig. 24, *g*); its depth and length are greater in the fossil. Comparative anatomy supports the inference that the Stonesfield fossil examined by CUVIER belonged to a small ferine[1] mammal with a jaw much resembling that of an Opossum, but differing in the great number of the molar teeth, in this respect exceeding the *Myrmecobius*, Pl. I, fig. 24), in which they are nine in number.

Four names have been proposed for the Mammalian genus represented by this jaw; of these *Amphitherium* is the one adopted in my 'History of British Fossil Mammals,' and which I here retain.

The second fossil of this species (Pl. I, figs. 22, 22 A)—also a ramus or half of the mandible—discovered in the Stonesfield slate, supplied additional evidence of the osseous structure. It is preserved in the Geological Museum at Oxford, and is described and figured in my Memoir of 1838.[2] With the exception of parts of the coronoid, condyloid and articular processes, the exposed inner surface of the ramus is entire; the symphysis (*s*)

[1] I use the word 'ferine' as equivalent to the French 'carnassier,' the term by which Cuvier signified collectively the *Cheiroptera*, *Insectivora*, *Carnivora*, and *Marsupialia*.

[2] 'Geol. Trans.,' ser. 2, vol. vi (1839), p. 49, pl. v, fig. 1.

is very characteristic of the mammalian nature of the bone; it is long, narrow, and continued forward in the same line with the gently convex inferior margin of the jaw, precisely as in *Didelphys*, as well as in some other Ferines of both the marsupial and placental series; its lower margin presents a small notch corresponding with that in the symphysis of the jaw in *Myrmecobius*. A greater proportion of the convex articular condyle (*b*) is preserved in this than in the preceding specimen; sufficient of the coronoid remains to show that it had the same size and shape as that process in the type specimen. A groove (*g*) is continued from below the dental canal (*d*), gradually contracting to a point at the middle of the ramus. There is a broader and shorter groove in the corresponding part of the jaw in the *Myrmecobius*, and a narrower groove in that of the *Sarcophilus ursinus*. The posterior molar shows a small middle internal and part of a larger external cusp; the premolars (4 and 5) are entire, and show the principal and posterior basal cusp, as in fig. 21. The sockets of the missing teeth give not less than sixteen teeth in each ramus of the jaw, viz. three incisors and one canine, each with a simple socket; six premolars and six true molars, each with a double socket.

Thus, *Amphitherium* was seen to differ from *Didelphys* even more than was inferred from the evidence possessed by Cuvier. The only known existing Mammal with a dentition approaching to the above is the Marsupial *Myrmecobius* (fig. 24), peculiar to Australia. It has *i* 3—3, *c* 1—1, *p* 4—4, *m* 5—5 = 13 teeth, in each ramus. The incisors are conical, separated at their base, the first the largest; the premolars have compressed conical crowns with a hinder talon; the molars are relatively smaller than in *Amphitherium*, and of the type of those of *Microlestes*.

The additional evidence, from the second jaw, strengthens the inference from the first, viz. that the *Amphitherium* was a true warm-blooded Mammiferous species, unguiculate and insectivorous, with a probability of its being marsupial.

The third jaw in the order of discovery of Amphitherian fossils (Pl. I, fig. 23, 23 A) is the most complete one, containing the whole series of molar teeth, the last six being quinque-cuspidate; the first six unicuspidate, with basal cusps either on one or both sides; it also displays the socket of one small canine (*c*) and three longish slender incisors (*i*) *in situ*, altogether amounting to sixteen teeth on each side of the mandible, as was indicated by the sockets of the second specimen above described.

This specimen is the right mandibular ramus presenting the outer side to view. The convex condyle, the broad and high coronoid process, the backwardly projecting angle, the lower margin of which bends slightly inward, the varied kinds and double-rooted implantation of the teeth—all unequivocally displayed in this unique fossil—establish beyond question the conclusions deduced from the foregoing specimens of the existence of a small insectivorous Mammal during the Lower Oolitic epoch.

Dr. Buckland kindly transmitted to me this specimen, soon after it came into his possession, and acceded to my request to make some further explorations with a view to determine the shape of the angular process. The result showed that the lower margin of this process (*a*) was inflected, so as to render the outer surface convex, yet not in so great and traceable a degree as in *Didelphys*, *Phascogale*, and *Dasyurus*. The outer surface of the ramus presents no trace of the fissures or sutures which, in Lizards and other cold-blooded Vertebrates, separate the angular, dentary, and other, in them, distinct elements of the lower jaw.[1] The broad and simple coronoid process (*c*) of the fossil shows the wide concavity and the anterior marginal ridge, such as were deduced from the impressed matrix in the second specimen of *Amphitherium;* the entire and prominent condyle (*b*) rises somewhat higher above the level of the molar teeth than was indicated by its incomplete remains in the former specimens, and the outer surface of the fore part of the present jaw shows four or five small outlets of the dental canal, as in *Myrmecobius*.

Species 2.—Amphitherium Broderipii, *Owen*. Plate I, figs. 25, 25a, 25b.

History of British Fossil Mammals and Birds, 8vo, 1846, p. 58, fig. 19.

The fourth specimen of *Amphitherium*, discovered in the Oolitic slate at Stonesfield, was obtained there by the Rev. H. Sykes, M.A., and was presented by him to the Museum of the Philosophical Institution at York, where it is now preserved. It contributes as much additional information in respect to the shape of the crowns of the teeth as the third specimen had done in respect to that of the jaw-bone. It consists of the left ramus of the jaw, and offers its inner surface to the observer. It presents at its anterior part the sockets of three incisors and one canine, of small and nearly equal size; then follow the empty sockets of three small premolars, each with two fangs; to these succeed three larger premolars, in place, each having two fangs protruded to a certain extent from their sockets. Each of these teeth shows a small anterior as well as posterior tubercle at the base of the large middle cusp, and there is a slight ridge, or 'cingulum,' along the inner side of the base of the hindmost of these premolars. The first true molar is wanting, the next four have their crowns entire, the last is a little mutilated. The crowns of these molars present a different form from that which might be inferred from the fractured molars of the foregoing specimens, they are more compressed, and have not two cusps on the same transverse line. Each presents a large middle cusp, with a smaller but well-developed and pointed one, at the fore and back part of its base; the 'cingulum,' a part peculiar to mammalian teeth, plainly traverses the inner side of the crown, where it developes three small cusps, one at the base of the large external cusp, and the other two forming the anterior and posterior extremities of the crown of the tooth. This form of tooth is unknown in existing *Mammalia*, but is as well adapted for crushing the cases of

[1] 'Owen, Anatomy of Vertebrates,' 8vo, vol. i, figures—88 *Arapaima*, 91 *Chelone*, 92 *Emys*, 93 *Crocodilus*, 97 *Python*, 272 *Cyclodus*, &c.

coleopterous Insects as are any of the insectivorous multicuspid molars of the Bats and Shrews. The existence of the wing-covers of Insects in the Oolitic slate of Stonesfield has been long known; many of them approach most nearly to those of a *Buprestis*, a genus now best represented in warm climates.

In the present jaw the condyloid and coronoid processes are wanting, but have left their impressions on the matrix; there is the same wide and shallow groove near the lower margin of the hind part of the ramus, and the same notch at the symphysis, as in *Amphitherium Prevostii* and in *Myrmecobius*.

The chief value of the present specimen arises out of the very perfect state of the crowns of the molar teeth (fig. 25, B). If the structure they exhibit be really the same with that of the teeth of the *Amphitherium Prevostii*, yet they differ in number, there being but five instead of six premolars. The York jaw also differs in size to a greater degree than has been observed in mature individuals of the same species of Insectivorous Mammal in a state of nature.

I referred this jaw, therefore, to a distinct species, dedicated to my lamented friend the accomplished naturalist and scholar, WILLIAM JOHN BRODERIP, F.R.S. It probably, indeed, indicates a distinct genus, for which, if confirmed, the name *Amphilestes* might be appropriated.

§ IV. *Genus*—PHASCOLOTHERIUM, *Owen*, 1839.[1]

Species 1.—PHASCOLOTHERIUM BUCKLANDI, *Owen*.[2] Plate I, figs. 26, 26A.

DIDELPHYS BUCKLANDI, *Broderip*, 1828. Zoological Journal, vol. iii, p. 408, pl. xl.

This genus and species are founded on the right half or ramus of a lower jaw imbedded in a slab of Stonesfield slate, and presenting the inner side to view. The natural size is shown, in outline, in Pl. I, fig. 26; and a carefully finished view of the specimen, twice the natural size, is given in fig. 26A.

The teeth, *in sitû*, include three incisors, a canine, and seven molars; it is open to conjecture that a fourth incisor may have projected near the symphysis.

The incisors in place have long slender crowns, divided by interspaces rather exceeding the breadth of the tooth. A similar interval divides the hind incisor from the canine (*c*). This tooth (*c*) is longer, larger, and rises almost vertically with a slight backward curve of the crown. The incisors incline more forward as they recede in position from the canine.

An interval of twice the breadth of the canine divides that tooth from the first of the molary series. The first molar (1) is divided by a space of about half the breadth of the crown from the second (2), which, with the rest of the seven molars, are nearly or quite in contact with each other.

[1] 'Geological Transactions,' 2nd series, vol. vi, p. 58, pl. vi. [2] Ibid.

Of the three incisors present in the fossil, only the inner and hinder parts of the somewhat mutilated crown are seen, not the entire breadth of the crown, so that these teeth appear to be narrower and farther apart than they really were. Nevertheless, they could not have been so closely in contact as in *Sarcophilus* or *Thylacinus,* nor have occupied so short a relative extent of the alveolar tract, nor a situation turned inward at such an angle from the line of the rest of the teeth. In all these characters the incisors of *Phascolotherium* more resemble those of *Myrmecobius.* The canine, also, in its proportion to the incisors and molars much more resembles that tooth in the above existing insectivorous Marsupial (fig. 24, *c*) than the canine in the carnivorous genera of recent Marsupials.

In the proportions of the molars, *Phascolotherium* resembles *Myrmecobius* more than it does *Didelphys, Sarcophilus,* or *Thylacinus;* but the hinder grinders decrease more gradually, and the last two in a greater degree, than in *Myrmecobius.* In the form of the crown the molars of *Phascolotherium* resemble those of *Thylacinus* more than those in *Myrmecobius* or other existing Marsupials. There is, however, a well-marked distinction in the molar type of the present Mesozoic fossil. A principal cone rises from the middle of the crown, but there is no small cusp on the inner side of this, as in the true molars of *Didelphys* and *Phascogale.*

Herein *Phascolotherium* resembles *Sarcophilus* and *Thylacinus;* but it differs in the presence of a basal ridge or 'cingulum,' shown along the inner side of the tooth in the specimen described, which ridge projects as a 'talon' beyond both the anterior and the posterior subordinate cones, giving the quinquecuspid character of the crown of the tooth in the second to the sixth of the series inclusive (fig. 26 A). The molars increase in size from the first to the third, and decrease from the fifth to the seventh, but in slight and gradual way.

In this series there is no distinction, by way of form, between false and true molars. The character given by the successional premolar in existing Marsupials would be arbitrarily applied to mark off the first three from the last four of the molary series of *Phascolotherium.* The distinction, by way of specialisation of form, between the (three) false and (four) true molars is much more strongly established in the modern Opossums and Dasyures, as it is in a minor degree in *Sarcophilus* and *Thylacinus.*

Phascolotherium shows a closer affinity in the molar type, and in the gradual assumption of that type as the teeth gain in size, to its contemporary *Amphitheria;* from which, however, it differs in the reduction of the number of the molary series to the prevailing formula in existing Marsupials.

Phascolotherium differs from the extinct and recent 'multidentate' Marsupials, and resembles the *Sarcophilus* and *Thylacinus,* in the direct and broad inbending of the mandible below the mandibular condyle, and in the low position of the latter. It is entire in the present specimen (*b*), and stands out in bold relief from the matrix. It presents the same convexity from before backward as in *Sarcophilus* and *Thylacinus,* but is relatively less extended transversely, and is rather more convex in that direction. The inflected part or 'angle' is continued more directly from the inner end of the condyle, and, being broken away, its base constitutes the ridge which runs forward, bounding below the large shallow depression on the inner side of the ascending ramus. Viewing the under surface of that ramus in *Sarcophilus* and *Thylacinus*, the flattened plane formed by the inbent angle inclines from without inward and rather downward (see Cut, fig. 5, p. 73); in *Phascolotherium* the slope of the same part is rather upward and inward; so that it needs the mylohyoid groove (*g*) and symphysis (*s*) to convince one that it is the inner and not the outer surface of the ramus which is exposed. The entry to the dental canal (*d*) is more advanced in position than in the existing Australian genera above cited. The coronoid process in direction and proportion and in the depth of the notch between it and the condyle resembles that in *Thylacinus* more than that of *Sarcophilus;* but the anterior border is more convex, the fore-and-aft breadth is relatively greater, and the posterior apex a little more produced. In the gentle curve by which the lower margin of the mandible is continued to the incisive alveoli, *Phascolotherium* more resembles *Phascogale* than it does *Thylacinus* or *Sarcophilus*.

The mylohyoid groove is narrow and sharply defined; it runs from below the entry of the dental canal almost straight forward and downward, terminating at the under border below the third molar tooth; it has been mistaken for a suture, and looks very like one, but the bottom of the groove is entire. In size this fossil mandibular ramus equals that of the existing marsupial *Phascogale penicillata*.

The specimen of *Phascolotherium Bucklandi* above described is in the British Museum.

§ V.—*Genus*—STEREOGNATHUS, *Charlesworth*.[1] 1854.

Species—STEREOGNATHUS OOLITICUS, *Ch.* Pl. I, figs. 27—30.

The fact of a genus and species distinct from any mammalian fossil at that time got from deposits of Mesozoic age was made known by EDWARD CHARLESWORTH, Esq., F.G.S., to the Geological Section of the British Association at the meeting at Liverpool in 1854. But there appears to be no record of generic or specific characters.

The fossil itself was submitted to me for description,[2] at Mr. Charlesworth's instance, by its possessor, the Rev. J. P. B. DENNIS, M.A., F.G.S. It consists of a portion of jaw with teeth imbedded in a slab of the Oolitic slate of Stonesfield, Oxfordshire.

The portion of bone exposed to view is about nine lines in extent, and is part of a ramus of the lower jaw, containing three molar teeth (Pl. I, figs. 27 and 27 A). It is nearly straight; the side exposed is convex vertically, which indicates it to be the outer side; a slight increase of vertical diameter towards the end (A) indicates it to be part of a

[1] 'Report Brit. Assoc.' (Liverpool), 1854, Rep. Sect., p. 80.

[2] See 'Quarterly Journal of the Geological Society of London,' vol. xiii (1857), pp. 1, &c., pl. i.

left ramus: the inclination of the cusps of the teeth (figs. 27, 28) towards the opposite end might, indeed, be deemed evidence of its belonging to the right ramus; but neither this degree of inclination nor the position of the accessory cusp (fig. 29, *a*) is decisive of the way in which that end of the fragment points. Not more of the matrix could be safely meddled with, on the small chance of further evidence to this comparatively unimportant particular being had; and the description of the fossil assumes that the shallower end is the front one, the deeper one (A) the hind end of the fragment, and that it is part of the left ramus of the mandible.

This ramus is unusually shallow, and broad or thick below, the side passing by a strong convex curve into the lower part; a very narrow longitudinal ridge, continued after its subsidence by a few fine lines, forms a tract which divides the lateral from the under surface; elsewhere the bone is smooth, without conspicuous vascular perforations. The depth or vertical diameter of the ramus is not more than two lines.

This portion of jaw contains three teeth, the middle one of which is the least mutilated; and, by carefully removing the matrix which partly covered its crown, I exposed the whole of its singularly modified grinding surface. The first of the three teeth (fig. 27, *a*) appears to have been smaller than the others, but its crown has been too much broken to show its original characters. The third tooth (*c*) is less mutilated: it is of the same size and had the same structure as the middle one (*b*). Of this tooth, fig. 30 shows the grinding surface magnified about five diameters. It is of a quadrate form, three millimeters by three and a half millimeters, of very little height, and supports six subequal cusps, in three pairs, each pair being more closely connected in the antero-posterior direction of the tooth than transversely. In the Plate its position is at right angles to that in the jaw, fig. 27.

The outer side of the crown (fig. 29), supported by a narrow fang which contracts as it sinks into the socket, shows two principal cusps or cones (*o*, *o′*) and a small (anterior) accessory basal cusp (*a*). A small portion of the outer side of the anterior cone (*o*) has been chipped off; that of the second cone (*o′*) shows a well-marked convexity. The hard and shining enamel which covers these parts of the crown contrasts with the lighter cement that coats the root. The two outer lobes or cones are subcompressed, and placed obliquely on the crown, so that the hinder one is a little overlapped externally by the front one, the fore part of the base of the hinder one being prolonged inward on the inner side of the base of the front cone. The two middle cones are subcompressed laterally, with the fore part of their base a little broader than the back part. The two inner cones have their inner surface (fig. 28) convex, with their summits slightly inclined forward; a small portion of enamel has been chipped off the hinder lobe. The fore part of the base of the hinder cone is prolonged obliquely towards the centre of the crown, beyond the contiguous end of the base of the front cone, so as to cause an arrangement like that of the two outer cones; the obliquity of the posterior cone of both the outer and the inner pairs being such that they slightly converge as they extend forward.

In the hindmost tooth (fig. 27, *c*) the two outer cones are broken off, showing that their common base is divided from the two middle cones by a deeper groove than that which separated the two outer cones from each other.

Thus, the crown of these molars might be described as supporting three parallel antero-posterior ridges; the outer (fig. 29, *o*, *o'*) and the inner (fig. 28) ridges being each divided by an oblique cleft converging forward towards the middle of the tooth; whilst the middle ridge is divided by a curved cleft having its concavity turned forward (fig. 30).

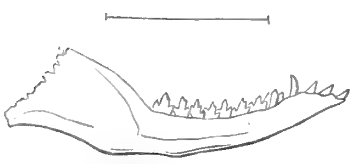
The more mutilated state of the front tooth (fig. 27, *a*), of which only the base of the middle ridge of the crown remains, throws no additional light on the modifications of the very remarkable type of the grinding surface of the mandibular molars of *Stereognathus.*

This type of tooth differs from that of all other known recent or extinct Mammals. The nearest approach to it is made by the true molars of some of the latter from the most ancient of the Tertiary strata, as, *e. g. Pliolophus*, from a septarian nodule of the London Clay[1] (Pl. I, fig. 31, lower molar), and *Hyracotherium.*[2]

The proportional size and regularity of form of the cones of the grinding teeth of the *Stereognathus* give a different character of the crown from that of the multicuspid molars of the *Insectivora*, and cause it to resemble more the pentecuspid or sexcuspid molars of the extinct hoofed genera above cited. No Mesozoic Mammal save *Stereognathus ooliticus* shows better grounds for being regarded as a diminutive form of the Ungulate order of *Mammalia;* but, assuming its position in that order, it is probable that its food, if we may judge from the existing Hogs and Peccaries, was of a mixed nature. There is certainly no other known Mesozoic Mammal which has so good a claim to be considered in any degree herbivorous.

Dr. EMMONS has described and figured the mandibular ramus, 9-10ths of an inch in length, of a Mammal (fig. 3) from the 'Chatham Coal-field' in North Carolina. It contains three incisors, one canine and ten molars; of the latter series, the first three have simple subcompressed conical crowns, the next four are multicuspid, and the last three are tricuspid (according to the figure); the incisors are separated by intervals, as in *Myrmecobius* and *Phascolotherium.*

FIG. 3.



Dromatherium sylvestre.
Magn. 2 diam. (After Emmons.)

I opine that *Dromatherium* was Marsupial. The extinct species indicated by this mandible Emmons calls '*Dromatherium sylvestre.*' The carbonized remains of ancient vegetation in which the foregoing, with two other similar mandibular fossils, have been found, is probably, like the coal of Brora, Sutherlandshire,

[1] 'Quart. Journ. Geol. Soc.,' vol. xiv, p. 54, pls. ii—iv. [2] 'Geol. Trans.,' 2nd ser., vol. vi, p. 203, pl. 24.

not later than the Lower Oolite; or, like the Lettenkohle of Germany, of Triassic age. The Mammalian remains are associated in the Carolina-Virginia Coal-fields with those of thecodont Reptiles.[1]

c. Mammals from Purbeck Beds.

The strata of the Isle of Purbeck, on the Dorset coast, intervene between the 'Upper (Portland) Oolites' and the 'Wealden' (see Table I, p. 4). They have been successfully studied and accurately described by Mr. Webster,[2] Dr. Buckland,[3] and Dr. Fitton,[4] whose conclusions have been verified with additional details, both palæontological and geological, by subsequent observers, especially by the able and accomplished officers of the Geological Survey of Great Britain, to one of whom, Robert Etheridge, Esq., F.G.S., Palæontologist to the Survey, I am indebted for the subjoined diagram of the deposits at Durdlestone Bay (Fig. 4), including those from which the Mammalian Fossils of the 'Purbeck' described in the present Monograph have been obtained.

§ VI. *Genus*—Spalacotherium, *Owen*, 1854.[5]

Species 1—Spalacotherium tricuspidens, *Ow.* Pl. I, figs. 32, 32 a, 32 b, 32 c, 33, 33 a, 33 b, 33 c.

Quart. Journ. Geol. Soc., vol. x, p. 426, 1854.

After Emmons' discovery the next evidence of a Mesozoic Mammal was obtained from a deposit of later date, one of those which are known as the 'Purbeck Series,' richly developed in the peninsula of that name, at Durdlestone Bay, near Swanage, Dorsetshire.

In the year 1854 a series of small fossils from that locality were sent to me for determination by Messrs. Wilcox and Brodie, of Swanage. The majority of the specimens were Saurian, and afforded characters of the lacertian genera *Nuthetes*, *Macellodus*, *Saurillus*, &c.;[6] but some appearances of the teeth in small jaws among Mr. Brodie's specimens, suggesting evidence of a higher grade of life, attracted and excited close and continued scrutiny.

At first sight the specimens appeared, as their discoverer had supposed, to differ only in species from the similarly sized jaws of the Saurians with which they were associated, and it was only after a careful removal of the matrix concealing their most characteristic

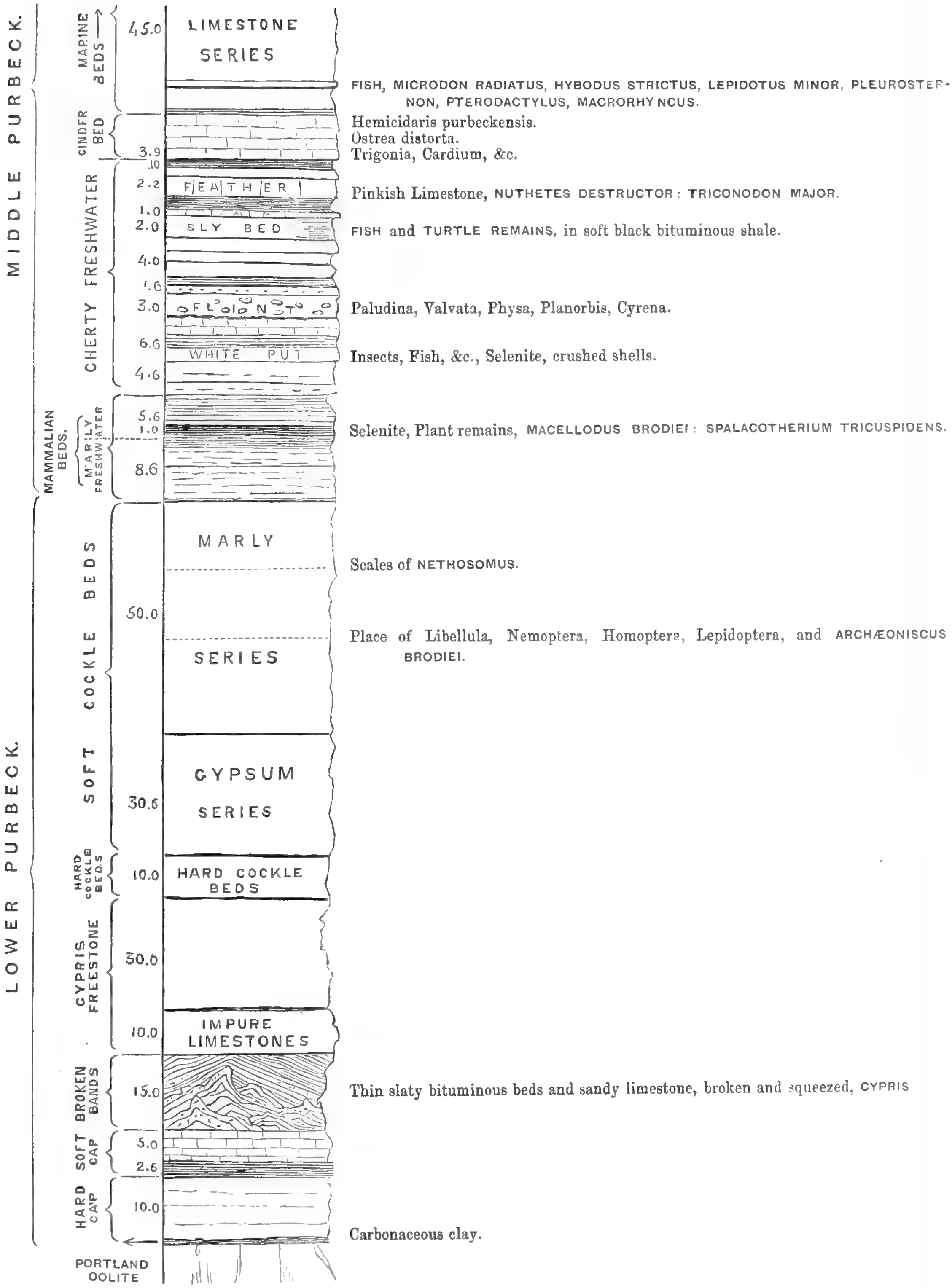
[1] 'American Geology,' part vi, 1857, p. 93. A copy of Emmons' figure, and of the reference thereto, in my 'Palæontology,' 8vo, 1860, p. 302, is given in Dana's excellent 'Manual of Geology,' 8vo, 1864, pp. 426, 429, and fig. 650.

[2] 'Geol. Trans.,' 2nd series, vol. ii, p. 36. [3] Ib., vol. iv, p. 11. [4] Ib., ib., p. 208.

[5] 'Quarterly Journal of the Geological Society of London,' vol. x, p. 426.

[6] Ib., p. 420.

Fig. 4.



Section of Middle and Lower Purbeck Beds.

features that I became satisfied of their relationship to the Mammalian class. I proceed to give results of re-examination of these specimens.

In a slab of Purbeck shale, showing part, and the impression of more, of a mandible, with teeth, nearly the whole of the hinder half of the ramus is exposed (Pl. I, fig. 32, natural size, in outline; 32 A, twice natural size). This contains four teeth, not quite in contact, having a long and rather slender crown, terminated by a sharp-pointed sub-triedral cone (fig. 32 C, *o*), the inner side of the base of which is produced before and behind the main cone into a short small cusp (*e*, *s*). This tricuspid crown is implanted by two roots (fig. 32 B) in a distinct bifurcate socket of the jaw-bone.

The four teeth in fig. 32 A gradually diminish in size to the hindmost; the jaw becomes slightly contracted vertically behind the teeth, and then expands to include a smooth depression, recognisable as the fore part of that for the insertion of the crotaphyte muscle; the upper swollen boundary (*b*) indicates the fore part of the base of the coronoid process; the lower boundary ridge (*a*) is that which would have been continued to the condyle and the angle of the jaw. We have here a left mandibular ramus with the outer side of the preserved bone and teeth exposed. The outer surface is vertically convex; the inner one, as indicated by the impression, is flatter, and faintly shows the termination of a longitudinal channel.

Fig. 32 B is an oblique view of the anterior side of the crown of the first of the four teeth in fig. 32 A; it shows the basal ridge of the outer side of the crown, ascending to be lost on the anterior accessory cusp; fig. 32 C gives the form of the summit of the crown of the tooth viewed vertically.

In the number, proportion, and relative position of the cusps, this modification of the insectivorous molar resembles that in the Cape Mole (*Chrysochloris*); but in the proportion of the mid-cone (*o*) and the definition of the side ones it accords more closely with the type of the Amphitherian molar (Pl. I, fig. 25 B).

The inner antero-posterior extent of the crown is considerable as compared with the proportion of that diameter with the height of the crown in the true molars of any of the modern Moles and Shrews, except the *Chrysochloris*. The impressions of the inner side of some teeth anterior to those in place show plainly the tricuspid character of the crown, and indicate also a greater number of such molars in the fossil than in any of the recent Mammalia, with the exception of the marsupial *Myrmecobius*. Of this further and more important affinity of the *Spalacotherium* to the *Amphitherium* the following specimens yield more decisive evidence.

A portion of the marly fresh-water shales from the Purbeck series at Durdlestone Bay, marked 'mammalian beds' in fig. 4, had imbedded in it part of the lower jaw of the *Spalacotherium*, wanting the ascending branch; the alveolar tract includes one incisor, a canine or canine-shaped premolar, and ten succeeding teeth. It is represented of the natural size in outline Pl. I, fig. 33, and magnified in tint twice the natural size at fig. 33 A. The incisor (*i*) seemed to be the smallest of these teeth, but is represented only by a portion of the crown, of a subquadrate or obtusely conical shape, convex externally. The canine or canine-shaped premolar (*c*) is more than twice as long and broad as the incisor, with a sub-compressed, sharp-pointed conical crown, a little inclined backward; it appears to have been inserted by a divided root, like the similarly shaped and proportioned first premolar in the Mole. The two succeeding teeth (1 and 2) are one third smaller than the canine, with subcompressed, conical crowns, at the fore and back part of which the base is slightly produced; each is implanted by two distinct fangs. The third and fourth teeth have a similar form and complex implantation, but are somewhat larger, and the basal cusps are more developed; in the fourth tooth this development gives a distinctly tricuspid character to the crown, the middle cusp, representing the crown of the preceding teeth, being the largest and highest. The six following teeth (5 to 10) repeat the same unequal tricuspid form, with increased but varying size, the middle teeth (6, 7 ,8) being the largest, and the last tooth (10) diminishing in size in a greater ratio than the penultimate one (9). These six last molar teeth are seen to be close together when the base with the ridge or 'cingulum' is exposed. The lateral cusps incline inward, and project from a plane more internal than the longer middle cusp. The inner side of the crown presents a wide longitudinal groove at the base of the middle cusp, between the inwardly inflected lateral cusps; the base of the crown presents externally a well-defined narrow cingulum, beneath which the two fangs, or the two external fangs, descend into the substance of the jaw. The last four teeth (7 — 10) show an inferiority of size, as compared with those of fig. 32 A, which may be sexual.

In the state in which this instructive portion of the Spalacothere reached me, the matrix concealed all save the large middle cusp of the molar teeth, which teeth seemed to be wider apart, and presented a more lacertine aspect. By the careful application of a fine needle and graving tool I succeeded in displaying the lateral cusps and grinding surface of the crown, and the other teeth, as shown in the enlarged view given in fig. 33 A. Fig. 33 B gives a magnified view of the antepenultimate molar (8), viewed obliquely from behind; and fig. 33 C is an outline of the crown viewed vertically. We have here a right mandibular ramus, with the outer side exposed.

So much of the jaw-bone as is preserved in this specimen (fig. 33) nearly corresponds in size and shape with the portion and impression of the opposite (left) ramus (fig. 32), and shows the vertical contraction or decrease of that diameter behind the molar series, prior to the expansion of the jaw into the ascending ramus. The horizontal ramus has suffered an oblique fracture since its fossilization across the alveolar series, with a very slight depression of the fore part containing the four anterior teeth; a second fracture crosses the contracted part of the jaw behind the last molar in place. There is not any clear evidence of a smaller molar tooth behind the last in place, marked 10. Between the large laniariform tooth (*c*) and the fore end of the ramus of the jaw there is a space for three incisors like the portion of the small one preserved (*i*), and also for a small canine-shaped tooth, which is demonstrated in one of the specimens next to be noticed.

The specimen, fig. 34, nat. size, and magnified twice nat. size at A, is the anterior half and an impression of most of the remaining part of the left ramus of the lower jaw, its inner surface exposed, showing the canine or canine-shaped premolar, *c*, and five following teeth in place, a fragment of a sixth molar, and impressions of four succeeding molars. The crown of the canine-shaped tooth is long, subcompressed, slightly recurved, pointed, with a small post-basal tubercle. The adjoining tooth (1) has a compressed, pointed crown, scarcely half the height of the canine and two thirds as broad at the base, with a ridge along the inner side of the base, and a more developed posterior basal tubercle: it is divided by a small interval from the canine. The second molar (2), with a slight increase in size and a similar shape, has the fore part of the basal ridge developed into a low point, and the hinder tubercle is relatively larger and more pointed. The third tooth (3) is larger than either of the two preceding, but resembles them in form. The fourth (4), with the same antero-posterior extent, has a lower crown, the middle cusp being relatively shorter, but both the anterior and posterior ones are larger, and now begin to assume the character of independent cusps; their bases almost meeting upon the inner side of the base of the middle cusp. The fifth molar, with a slight increase of size, shows a still further development of the accessory cusps, which are slightly inclined backward, or project from a more internal plane than the middle cusp. The impressions of the succeeding teeth show that their middle cusp was longer in proportion to its basal breadth; and thus agree, like the foregoing teeth, with the teeth similarly marked in fig. 33. The canine-like tooth seems to have a bifid fang; the three succeeding premolars, implanted each by two fangs, in this respect as in the general form and proportion resemble those of *Amphitherium*.

The proportion of mandibular ramus here preserved and indicated is 1 inch 1 line, or 27 millimeters, in length, that of the Mole being 1 inch, or 25 millimeters. The crown of the laniariform tooth is relatively longer, and the fourth tooth counting therefrom is of a different form, being of much smaller size and of a more simple structure than is the corresponding tooth, which forms the first true molar of the Mole. The greater number of molar teeth indicated in the present and displayed in other specimens of the *Spalacotherium* demonstrate its generic distinction from any known existing insectivore, placental or marsupial, the Myrmecobius having nine and the Chrysochlore having not more than eight lower molars. The multident marsupial Myrmecobius is the sole existing Mammal, with incisors and canines, that approaches the Spalacothere in the excessive number of the molar teeth. Fig. 34B is a magnified view of the teeth marked 4 and 5 in fig. 34A, showing the meeting of the accessory cusps on the inner side of the crown.

The last two specimens afford grounds for determining the teeth in place in fig. 32: they are accordingly denoted by corresponding numerals.

The evidence of the Mammalian nature of the above-described specimens, briefly submitted to the Geological Society in 1854, excited an interest in further explorations of their place of deposit. This was undertaken with characteristic ardour by SAMUEL H.

Beckles, Esq., F.R.S., and the success of his explorations, carried on at much cost and personal risk, may be estimated by what follows of the present Monograph, the subjects of which were exclusively brought to light by Mr. Beckles.

I commence with those which tend to complete our knowledge of the mandible and mandibular dentition of *Spalacotherium.*

Pl. I, fig. 35, represents, of the natural size, in outline, and magnified three times, in tint, at A, the fore part of the left mandibular ramus, showing its outer side, and an impression of the hinder part to near the beginning of the rising branch of the same jaw. The horizontal ramus is vertically narrow, but is thick, being convex outwardly; it is flatter on the inner side, the impression of which shows a trace of the longitudinal groove (*g*). The ramus gradually contracts, with a gentle inferior convex curve, to the fore end, which is not abruptly raised, or bevelled up. There are four rather close-set simple alveoli, anterior to the three premolars, with more or less mutilated crowns, in place. The fourth alveolus is that of the canine (*c*). The second premolar (2) shows, as in fig. 34, the main cone less raised in proportion to its breadth than in the succeeding teeth. The tip of the higher cone of the third premolar (3) is preserved, with the impression of the two inner basal cusps. The fourth and fifth of the molar series are not preserved. The sixth and seventh are shown by impressions of the two inner cusps (see fig. 34B, *e*, *s*). Impressions of the two or three following teeth are less recognisably preserved. There is a small outlet of the dental canal beneath the first premolar, and a second beneath the alveolus of the third or last incisor (*i* 3).

Figures 36 and 37 show the portions and impressions of a mandibular ramus with teeth of *Spalacotherium tricuspidens* preserved in counterpart slabs of a split block of Purbeck shale.

In fig. 36, a portion of the middle of the horizontal ramus exposes its inner surface, and includes three teeth (3, 4, 5) more or less mutilated, with part of a fourth (6). In fig. 37 the continuous hinder part of the ramus is preserved, showing the outer surface, and includes the basal half of the crown of the sixth and seventh molars, with indications of the sockets of the eighth and ninth molars. The tenth molar (10) is in part preserved, together with the hind part of the ramus, broken off, and somewhat displaced, showing the characteristic contraction preceding the expanse into the ascending branch with the crotaphyte fossa.

The impression anterior to the portion of jaw preserved in this block answers to the part of the ramus preserved in the counterpart block: in advance of which impression a small portion of the fore part of the ramus remains, showing the posterior outlet beneath the socket of the first premolar.

The teeth retained in the block (fig. 36) are the third, fourth and fifth of the molary series. Anterior to them is the impression of the second, showing the same proportions of the main-cone as in 2, fig. 34. That of the third premolar (3) in fig. 36 wants the apex.

The fourth tooth (4) preserves the summit of the main cone; but the base of the crown is mutilated. The main cone is broken away from the fifth tooth, but the two inner cusps, characteristic of *Spalacotherium*, are instructively shown. The accentuation of the inner, less bulging, surface of the ramus is well shown in the present slab. The thin inner alveolar wall descending sheer from the outlets of the sockets is at first slightly concave vertically; then swells out into a convexity toward the lower border; near which, at the hind part of the fragment, may be discerned, when the specimen is held in a strong light, the termination of the longitudinal (mylo-hyoid) groove (*g*).

In the hind portion of jaw (fig. 37 A) the equally characteristic base of the external main cone, with its basal cingulum, is seen in the teeth answering to the sixth and seventh molars. The impression of these before and behind are less intelligibly preserved in the matrix.

As far as I can safely work away the matrix from the inner side of these teeth, the base (horizontal section) thereto turned seems to be indented; the working surface terminating on that side in two low cusps, as shown in fig. 36B, answering to those shown in the tooth (5) of fig. 34.

All the evidence concurs in giving a tricuspid crown to the molar teeth in the present Purbeck fossil, of the character of that of the type-specimens of *Spalacotherium* (figs. 32—34), with which the mandibular ramus, so far as it is preserved, corresponds.

The last specimen referable to *Spalacotherium tricuspidens* supplies very satisfactorily the characters of the hind end and rising part of the lower jaw.

It consists of the left mandibular ramus, wanting the symphysial end, with five more or less mutilated molars in place, the inner side being exposed. It is figured of the natural size in fig. 38, and of twice the natural size at A. This specimen includes the condyle (*b*) and great part of the coronoid process (*c*).

From the inner end of the condyle (*b*) a ridge curves forward, bounding below the depression, terminating anteriorly in the entry of the dental canal (*d*). The hinder two thirds of the ridge has been broken away in exposing the specimen, indicative that it has extended inward or transversely to the plane of the rising ramus above, to a greater degree than is here shown. The lower border of the ramus is entire and convex, showing that the angle of the jaw was represented by the inflected ridge, plate or process.

This marsupial character is well shown in *Sarcophilus* and *Thylacinus* (fig. 5, p. 74); but the entry to the dental canal is more advanced in the present extinct marsupial than in those existing species. The condyle is transversely extended, and holds the same relation of level to the alveolar tract as in *Thylacinus*. A deep emargination divides it from the hind border of the coronoid. The shape of this process resembles that in *Sarcophilus*. A linear groove is continued from the inner border of the dental foramen to beneath the third molar here in place.

The most perfect molar—the first in place—shows a fine but well marked 'cingulum' along the inner side of the base of the crown expanding into an anterior and a posterior basal cusp; between which the crown rises in two inner and lower cones, and one outer and higher cone.

Indications of the same structure are more or less clear in the four succeeding molars, which retain nearly the same fore-and-aft basal breadth. There is an empty socket of a smaller molar between the last in place and the base of the coronoid, and the empty two-chambered socket in front of the first molar in place may have held an anterior one of the same complexity, making seven molars. There is sufficient demonstration of the multidentate character to warrant the reference, suggested by the type of molar teeth, to the genus *Spalacotherium.*

The contour of the lower border of the ramus is not an even curve, but is slightly wavy, the convexity changing to a slight concavity beneath the entry of the dental canal. There is an indication of a slight vertical constriction behind the molar series, as in the previously described specimens of the present genus.

Species 2.—SPALACOTHERIUM MINUS, *Owen.* Plate I, figs. 39, 39A.

The best preserved molar tooth in the specimen (Pl. I, fig. 39, nat. size, and 39 A magnified three times, in tint) shows the generic type of *Spalacotherium,* the ant-internal and post-internal cusps meeting at the inner side of the base of the main cone. But the specimen is not only inferior in size to the type species, but differs in the absence of the constriction of the horizontal ramus anterior to the expansion into the ascending branch. The horizontal ramus preserves, however, the degree of vertical extent forward as far as the socket of the canine, which tooth is shown in fig. 34. The base of the ascending ramus indicates a curve upward toward the condyle, as in fig. 38. The dentition is not sufficiently preserved to afford any ground for generic separation; and I therefore retain it as a smaller species of *Spalacotherium.*

This species is represented by a left mandibular ramus with the inner surface exposed, retaining four juxtaposed teeth belonging to the middle of the dental series with indications of sockets before and behind them. Two of the retained teeth are molars, the hindmost yielding the Spalacotherian type of crown as above described. The next in advance gives a main cusp and indications of an accessory one in front, and a lower and more remote one behind; but the crown of this tooth is too much mutilated for precise definition. The teeth are compressed. There are indications of sockets of two molars between the last *in sitû* and the ascending ramus. The premolars show a reduction of fore-and-aft breadth more immediately than in *Spalacotherium tricuspidens:* their crown consists chiefly of a sub-compressed sharp-pointed cone. In advance of the two hinder mutilated teeth in place are sockets of four others, decreasing in size, and then a large and more outwardly projecting alveolus of a canine, the crown of which has left its impression. In advance of this, the symphysis with the incisive alveoli has been broken off.

The inner side of the ramus is marked by the linear groove continued further forward than is indicated in the specimen (Pl. I, fig. 38, *g*) of *Spalacotherium tricuspidens*. The vertical extent of the horizontal ramus is preserved as far forward as the socket of the canine, both upper and lower borders being nearly straight and parallel.

§ VII. *Genus*—Amblotherium,[1] *Owen.*

In the type of the present genus (Pl. II, fig. 1, nat. size and 1 A, magn. 3 diam.) the true molars do not exceed in number those of the lower jaw in *Amphitherium* (Pl. I, fig. 25), and of the upper jaw in *Peralestes* (Pl. II, fig. 3); but the incisors are four in each mandibular ramus, equalling in number those in *Phascolestes* (Pl. II, fig. 4). The two hind premolars have crowns exceeding in size those of the succeeding molars.

The present species, with the full or adult complement of teeth, is markedly smaller than any of the foregoing Mesozoic mandibles save *Spalacotherium minus*.

Species 1—Amblotherium soricinum, *Owen.* Plate II, figs. 1, 1A, 1B.

This species is founded on a right mandibular ramus, the inner side exposed (Pl. II, fig. 1, nat. size; 1 A, magn. 3 diam.) showing four incisors (*i* 1—4), the canine (*c*), four premolars (*p* 1—4), and six molars (*m* 1—6), with a trace of what may have been the alveolus of a seventh molar.

The condyle (*b*) projects midway between the summit of the coronoid (*c*) and the angle of the jaw (*a*), its lower end being on the level of the alveolar outlets. A thin ridge (*a'*), or rather the base of one showing fracture, projects inward from the lower border of the ascending branch, bounding below the groove leading to the entry of the dental canal (*d*). From the fore part of this entry the groove (*g*) begins, which extends as a linear fissure, simulating a suture, from a little above the rounded lower border of the ramus to the hind part of the symphysis (*r*, *s*).[2]

The hind border of the coronoid process descends from the fine recurved point (*c*) in a bold or deep regular concave curve to the condyle, as in *Amphitherium* and *Phascolotherium*, but its apex does not reach so far back. The state of preservation of the articular process shows clearly enough its convexity, but not its precise size; it is somewhat crushed, and appears larger in the specimen than it was in the recent bone.

[1] 'αμβλόω, to abort; θηρίον, beast.

[2] It is remarkable that a groove corresponding in position with that lodging the mylohyoid nerve and vessels in the human mandible, but of which no trace exists in most lower placentals and existing marsupials, should reappear, as it were, so distinctly, in these small Mesozoic mammals. It may be questioned whether it was due to the same mechanical cause and relations as in man; whether it may not rather indicate a more definite "splenial" harmonia, remaining longer open than in later mammals; but which is, nevertheless, entirely closed in all the subjects of the present Monograph.

Below the condyle the hind border of the ascending ramus describes a deep curve to the backwardly produced end of the inflected angle of the jaw. The lower border of this inflected part is straight, and is not continued into that of the horizontal ramus with the undulated contour shown in *Spalacotherium*, *Phascolotherium*, and *Amphitherium*. The depth of the ramus gradually lessens to the horizontal sloping symphysis, as in *Amphitherium*.

The first incisor (*i* 1) of *Amblotherium soricinum* is procumbent, and continues forward, as it were, the gentle curve of the lower border of the symphysis; it has a long, slightly expanded, obtusely terminated crown, but this is the worn configuration of the fossil tooth and may not have been exactly its condition in the recent subject. The crown of the second incisor (*i* 2) is less than half the length of that of the first, but is almost as broad; it rises at a distance equal to its own basal breadth from the first. The third incisor (*i* 3) is similar to the second, and rises closer thereto. The crown in each of these incisors is hollowed on the hinder and inner surface, so that the apex is subrecurved, as in *Myrmecobius* (Pl. 1, fig. 24). After a longer interval comes the crown of a fourth small incisor (*i*, 4). Near this rises vertically, with a slight backward curve, the crown of a tooth which, by its length, represents the canine (*c*); it terminates more acutely than do the incisors, and the crown is narrower in proportion to the height than in them.

Behind the canine, with an interval like that before the canine, is the simple low conical crown of a minute premolar (*p* 1). In closer proximity rises that of the second premolar (*p* 2). From the apex of the cone, which is near the fore part of this tooth, the hind border slopes or curves backward, swelling inwardly, and representing a hind basal prolongation or talon. The third premolar (*p* 3) presents a like type of crown, with marked gain of size. The fourth premolar (*p* 4) increases in height, but not in basal breadth. Each premolar is implanted by two fangs.

The series of true molars begins by teeth much inferior in size to *p* 4 and *p* 3: they have acquired, abruptly as it were, their characteristic shape and complexity of crown (fig. 1, B, magn. 6 diam.). This consists of a long and slender main cone, with an anterior (*e*) and a posterior (*s*) well-marked cusp, the anterior being the larger, and on a higher level. The intervening tract of the inner part of the crown represents there a low cingulum, rising to, without being well defined from, the base of the principal cone (*o*) which rises in great proportion from the outer part of the crown. In one of the molars, the third (fig.1, B), the intervening part of the inner side of the crown forms a small low prominence before inclining to blend with the main external cone. The molars increase in size to the third; then gain, perhaps, a little in basal breadth to the sixth; which, therefore, by the analogy of hinder decrease of size in the molars of *Myrmecobius Spalacotherium,* I do not regard as the last. The traces in the fossil at the interval between *m* 6 and the coronoid process would be, I think, rightly interpreted as those of a socket.

The molars and the last premolar form a series uninterrupted by any 'diastema.'

The projecting front teeth are made to catch, the canine and premolars to kill, the molars to pierce and crush chitinous integument; and, by the analogy of Moles, Shrews, and Opossums of like size (*Didelphys dorsigera*, e. g., p. 105, fig. 22B), we may guess the prey to have been Insects and other *Annulosa.*

The mandibular dentition of this little marsupial ferine may be formularised as :—

$$i.\ \frac{}{4-4},\ c.\ \frac{}{1-1},\ p.\ \frac{}{4-4},\ m.\ \frac{}{7-7} := 32.$$

The analogy of *Myrmecobius* checks any hasty conclusion as to there being precisely as many teeth in the upper jaw as in the lower one of *Amblotherium.*

The dental formula of *Myrmecobius* is:—

$$i.\ \frac{4-4}{3-3},\ c.\ \frac{1-1}{1-1},\ p.\ \frac{3-3}{3-3},\ m.\ \frac{5-5}{6-6} := 52.$$ [1]

The mandibular dentition of *Amphitherium* is :—

$$i.\ \frac{}{3-3},\ c.\ \frac{}{1-1},\ p.\ \frac{}{6-6},\ m.\ \frac{}{6-6} := 32.$$

The multicuspid character of the molars of *Myrmecobius*, and the almost uniform small size of the cusps, are associated with a smaller relative size and a looser or more open arrangement of the teeth than in *Amblotherium.* The affinity of *Amblotherium* to *Amphitherium* is closer than to *Myrmecobius.* The present species, *Amb. soricinum,* as represented by the mandible with the full adult complement of teeth, above described, is smaller than any of the previously characterised species so represented.

Species 2—AMBLOTHERIUM MUSTELULA, *Owen.* Plate II, fig. 2, 2A.

The present specimen (Pl. II, fig. 2, nat. size, and 2 A, magn. 3 diam.) agrees generically in the character of the crown of the true molars (as exemplified by the tooth marked *m* 3, in fig. 2 A) with the type of *Amblotherium,* and it presents the same general configuration of the ascending branch and symphysial end of the jaw. The difference of size is such as to lead me to regard it as specific, and this conclusion is strengthened, if not confirmed, by modifications of shape and proportion of the hinder or ascending portion of the ramus.

The species *Ambl. mustelula* is represented by a right mandibular ramus, the inner side exposed, showing five or six of the molary series *in sitû,* but with crowns more or less mutilated; there are also some feeble indications of incisors.

The jaw has a larger ascending branch and coronoid process than in *Amb. soricinum* or in *Amphitherium;* remarkably larger than in *Myrmecobius.* The condyle (*b*) projects

[1] Waterhouse, "Description of a new Genus of Mammiferous Animals from Australia," &c., 'Trans. Zool. Soc.,' vol. ii (1836), p. 149, pl. xxviii.

from above the level of the molars, apparently with a longer relative interval between it and the angle than in *Amb. soricinum,* but the outline is not so well preserved.

The anterior border of the coronoid, so far as preserved, is more vertical and less curved than in *Amblotherium soricinum* or in *Amphitherium.* The lower margin of the horizontal ramus is continued by a gentle convex line to the end of the symphysis, which is long, narrow, and very little raised from the horizontal level. The breadth of the rising ramus between the fore part of the base of the coronoid and the back part of the condyle almost equals the extent between the fore part of the base of the coronoid and the hind end of the symphysis (*r*). In *Amb. soricinum* the same dimension of the rising ramus is equal to three fourths of the extent from the fore part of the base of the coronoid to the hind part of the symphysis (fig. 1, *r*). In the present jaw, as in that of *Amb. soricinum,* the mylohyoid groove (fig. 2A, *g*) is represented by a fine linear one, extending from near the entry of the dental canal (*d*) to the symphysis. The ridge (*a'*) retrogrades from that entry, and augments in depth, or inward inflection, as it approaches the angle (*a*). The angle which the line of the ridge (*a'*) forms with the fore margin of the coronoid is more open than in *Amb. soricinum.*

The best preserved of the molar teeth (*m* 3) shows the inner side of the crown divided into two tubercles answering to *e* and *s* in fig. 1 B : the anterior one, in like manner, being longer and inclined forward, from a higher level. The main cone rises vertically from the outer side and middle or body of the tooth. The hindmost molar in place seems to answer to *m* 5 in fig. 1, and, from its relation to the coronoid, should be the antepenultimate molar. There possibly may have been three teeth behind it, if they decreased in size, as in *Spalacotherium,* but this I think unlikely. An interval for one molar divides the tooth in place (*m* 5) from the next in advance (*m* 3). The molar (*m* 2) in front of that is obliquely tilted up. The one marked *m* 1 is obviously smaller : its two roots have slipped from the socket, and the crown is broken off. This would give seven molars, reckoning the last *in sitû* as the antepenultimate one. In advance of the first molar are three premolars, losing size as they advance in position. They are too much mutilated for any conclusion as to the relative length or height of the main cone. Each is implanted by two roots, and the base of the main cone gives indications of fore and hind cusps. The socket of one antecedent premolar is definable. Then comes the base of a small canine in its socket, and next, one of a small incisor, in advance of which there is space for two or three sockets of other incisors before the symphysis terminates anteriorly, where the extreme end seems to be wanting.

The lower border of the horizontal ramus describes a more marked convex curve than in *Amb. soricinum.*

The conclusions arrived at from close scrutinising of the indications of teeth in this well-marked form of mandible (fig. 2) are more favorable to generic conformity with the dental formula shown in *Amb. soricinum* than otherwise. I, therefore, limit myself to regarding the species it represents as being generically allied to the smaller type (fig. 1).

§ VIII. *Genus*—PERALESTES,[1] *Owen.*

The present genus, like *Amblotherium,* differs from *Spalacotherium* by a more marked distinction between the premolars and molars; the former being necessarily characterised, through the want of developmental evidence of these long-since extinct Mammals, by shape and relative size of crown.

In *Spalacotherium,* as in *Amphitherium* and *Phascolotherium,* it is difficult to draw the line between the members of the numerous molar series, as may be appreciated by reference to the subjects of figs. 23, 25, 26, 33, Pl. I. Here, however, the superior length of crown serves to determine the last and penultimate premolars by contrast with the smallness of the tooth by which the molar division of the 'cheek-series' begins.

Species 1.—PERALESTES LONGIROSTRIS, *Owen.* Plate II, figs. 3, 3 A, B, C.

Of the molary series of teeth evidence is given in the present species by instructive portions of the dentition of both upper and lower jaws.

Pl. II, fig. 3, represents of the natural size, in outline, a portion of the right upper jaw, which at A is figured, in tint, magnified 3 diam.; whilst at B, the grinding surface of the preserved upper molars is represented on the same scale.

This specimen includes the external alveolar wall of the maxillary with the last premolar and six following true molars *in sitû.* As much of the upper jaw as equals in length the series of preserved teeth extends in advance of them: it is a fragmentary tract, but shows part of the bony palate and a few alveoli. A vacuity near the fore end of the palate, and a corresponding fissure on the outer wall of the jaw, may indicate the hind limits of a premaxillary; but this portion of bone is not entire anteriorly.

The interest and instruction afforded by this specimen lie in the demonstration given of the character of the crowns of the upper molar teeth, and especially of the configuration of their outer side.

In a direct side view of the exposed part of the specimen the outer wall or division of the crown shows but little vertical extent compared with the fore-and-aft, or with the transverse, diameter; but the inner half is developed into a longer cone. The front half of the outer wall presents the form of a smooth subhemispheric protuberance (*a*), from which the hind half extends backward at a lower level; its outline being broken by a few slight notches dividing it into two or three minute tubercles (*b*). The larger antero-external tubercle (*a*) contracts to a low cusp (sharper in *m* 4 and 5 than in *m* 3), from which the grinding surface curves outward to the loftier or longer and more acutely terminated cone of the antero-internal lobe (*c*). The post-external lobe or tract (*b*) contracts as it extends inward, and ends there in a low cusp (ib, fig. 3 B, *d, d*) at the hind and inner part of the base of the long antero-internal lobe (*c*). The horizontal section of

[1] πήρα, pouch; ληστής, robber.

the crown is triangular, with the base turned outwards, and the apex formed by the antero-internal lobe: the anterior half of the base projects more outward than the posterior half.

Of the six molars *in sitû* showing the type above defined, the crowns increase in size from the first (*m* 1) to the third (*m* 3) and decrease from the fourth to the sixth (*m* 6), which seems to be the least of all. Of this tooth the outer side is turned obliquely backward, the low posterior portion of that side being much curtailed: thus the fore-and-aft dimension of *m* 6 is less than that of the antecedent molars. Moreover, the outer surface of the maxillary runs inward behind the sixth molar without appearance of fracture, and confirms the ascription of six molars, and not more, to the series on each side of the upper jaw.

The Mammal indicated by the present specimen is nearly allied to *Amblotherium.* It belongs, however, to a distinct genus, here represented by a species as large as *Amb. mustelula.* In extending the comparison to other genera known by the upper as well as the lower teeth, *Stylodon* alone arrests attention. But, besides the differences in the number of molars behind the long-crowned premolar, there are differences of configuration of the grinding-surface of the molar teeth, as compared with the fossil upper jaw (Pl. II, fig. 14, *e.g.*). True it is that this unique example presents the inner side of the maxillary teeth to view: but, though there be some increase of fore-and-aft breadth as the crown extends outward, there is no accessory cusp in the molars of that specimen, answering to the one marked *d,* which is plainly shown at the middle of the hinder border of the crown in the molars of fig. 3: the fore-and-aft extent of the outer part of the crown in fig. 3 is relatively greater than in fig. 14.

The last premolar in *Peralestes,* with a fore-and-aft breadth not exceeding that of *m* 1, has a crown of twice the length. It is a long, sharp cone, and answers serially to the inner one in the true molars. A 'cingulum' is indicated along the outer side of the base of the cone (*p,* fig. 3 A) and develops a minute cusp both before and behind that base, or at least behind it. The front talon may be described as a mere thickening there of the cingulum. The outer tubercular wall of the crown in the succeeding teeth seems to be a development of the cingulum. This premolar, like the succeeding molars, shows two external roots, the front one being the largest. The seven teeth are close-set.

An upper strip of the maxillary, in advance of these teeth, indicates a long and slender-snouted form of head, recalling that in *Myrmecobius* and *Perameles.*

Sarcophilus ursinus comes nearest in the character of its upper molars to the present species of *Peralestes.* The outer part of the crown (ib., fig. 3 C) is low in proportion to its fore-and-aft extent. It develops anteriorly a cusp, *a,* similar in its proportions and position to *a* in *m* 3 and *m* 4, A. The hinder tract of the outer part in the second true molar of *Sarcophilus* develops two cusps, the larger of which answers to *d* in fig. 3 B. The inner cusp (*c*) is the longest and sharpest cusp in both *Sarcophilus* and *Peralestes.* The ground-work pattern is the same, with a generic distinction indicated by the accessory low inner basal tubercle, and also by the minor number of molars in the large existing typodentate zoophagous Marsupial.

Species 2.—PERALESTES (PHASCOLESTES ?) LONGIROSTRIS, *Owen*. Plate II, figs. 4, 4 A, B, C.

From the size and shape of the last two premolars and the contrast they present to the small succeeding molars, together with the shape of so much as is preserved of the crowns of these, which show a corresponding similarity with the lower molars of *Sarcophilus*, with that indicated in the upper molars of fig. 3, I am disposed to refer the specimen to be described (Pl. II, fig. 4, nat. size, fig. 4 A, magnified 3 diam.) to the same genus; although, it is true, that there are indications of a greater number of true molars than in the upper jaw of *Peralestes longirostris*.

Since, however, in *Myrmecobius*, the only known existing form of multidentate Marsupial, there is one more true molar on each side the lower jaw than in the upper jaw, I am unwilling, especially as the actual teeth are not preserved in the mandible under consideration, to separate it from the genus showing so marked a resemblance in the proportions of the contiguous premolars and molars, and so close correspondence in the characters of upper and lower molars with those in *Sarcophilus*. If an upper jaw should eventually be found showing seven or eight true molars of Peralestian type, following the large cuspidate premolar, the generic name *Phascolestes* might be accepted for the species represented by the present mandible.

The specimen is the anterior half of a left mandibular ramus, showing the symphysis and inner surface with an impression of the posterior part as far as the beginning of the coronoid process.

The teeth in place are the four incisors (*i*, 1, 2, 3, 4), the canine (*c*), four premolars (*p* 1, 2, 3, 4), the basal part of the erown of five succeeding teeth (*m* 1, 2, 3, 4, 5), and the impressions of three successive long and slender cones, which, if belonging each to a distinct tooth, would make the premolar-molar series twelve in number on each side of the lower jaw, which is that in *Amphitherium* (Pl. I, fig. 23).

The present specimen is fully one fifth longer and is proportionably deeper at the corresponding part than the jaw of the type of *Amphitherium* there figured (and in the work cited below[1]); it has a longer and larger canine, and also unequivocally shows four incisors *in sitû*, making eight in front of the lower jaw. These incisors, instead of being arranged transversely at right angles with the canine and molar series, as in *Thylacinus* and *Dangarus*, form a series of sockets curving gradually forward to that of the foremost, due to the symphysis, as in *Amblotherium*, *Amphitherium*, *Phascolotherium*, and *Myrmecobius*. As in the latter Marsupial, also, the foremost incisor is the largest, and is subprocumbent in position. The last three incline rather forward, but less so than does the first. The second incisor is the smallest; the third and fourth increase without gaining the dimensions of the first. Each stands apart from the other by a short interval, as in *Myrmecobius*. They are

[1] 'History of British Fossil Mammals and Birds,' 8vo, 1846, fig. 15.

set closer together than in *Amblotherium*, and the foremost is relatively larger. The crown of the canine (c) rises vertically, with a slight backward curve to its sharp summit. It is relatively narrower, antero-posteriorly, at its base than in *Myrmecobius*. It shows a well-marked longitudinal groove at the inner side of its basal half near the hind border. It is relatively longer and larger than in *Amblotherium*.

The first premolar (p 1) is minute, with a low indication of one main cone and a hind basal production: it stands distant by more than twice its own fore-and-aft breadth from the canine. The second premolar (p 2) is one third larger than the first, with its main cone and hind talon better marked: it stands half its breadth distant from the first. The third premolar (p 3) is twice the size of the second; its main cusp is large and lofty; the basal talon relatively low and small: it rises a little further from the second than does that behind the first. The fourth premolar (p 4) increases chiefly in vertical extent; its main cone is a long subcompressed piercer; the hind talon is feebly marked: it stands at the same distance from the third as that tooth does from the second premolar.

The bases of the five succeeding teeth indicate a more complex type of crown. An anterior as well as a posterior basal cusp is marked off from the main cone, and the anterior cusp is larger and higher than the posterior one. One may infer the main cone from the preserved impressions of the last three molars to have been long and slender; it rises chiefly from the outer side of the crown. Supposing each tooth preserved or indicated in this portion of mandible to have worked upon a maxillary fellow, its generic distinction from *Peralestes* would be established, and the dental formula of *Phascolestes* would be, $i\,\frac{4-4}{4-4}\;c\,\frac{1-1}{1-1}\;p\,\frac{4-4}{4-4}\;m\,\frac{8-8}{8-8} = 68$, being four more than in *Amphitherium*, and fourteen more than *Myrmecobius*. But, by the analogy of the latter genus, as above remarked, the number of the molar series may have been less in the upper jaw. The lower contour of so much of the ramus as is preserved in the subject of fig. 4, Pl. II, is gently convex, curving gradually up to the incisive areolar border. The symphysial articulation is long and narrow. There is a feeble indication of the notch which is present at the anterior border of the symphysis in *Myrmecobius* (Pl. I, fig. 24), and is conspicuous in *Amphitherium Broderipii* (ib., fig. 25). The anterior terminations of the linear groove near the lower margin of the ramus, shown in the inner side of most of these small mesozoic mammalian jaws, is here also visible. A fine line is continued from it to the lower end of the symphysis.

Incertæ sedis. PERALESTES, sp. ?

In the proportion of depth to length of jaw the fragment of the right ramus (Pl. I, fig. 40 and 40 A), figured in my original memoir on *Spalacotherium*,[1] and referred to that genus, more resembles the present. Seeing, also, that the fore part of the ramus has been broken off behind the long symphysial articular surface, one might hazard a supposition that the teeth, there referred to a canine and anterior premolar, might be the

[1] 'Quart. Journ. Geol. Soc.,' vol. x, p. 431, fig. 12.

homologues of the last two premolars in *Phascolestes.* The molar series in Mr. Brodie's specimen are, however, in too mutilated a state to support more than the conjecture that it may belong to a Peralestian species.

§ IX. *Genus*—ACHYRODON,[1] *Owen.* Plate II, figs. 5—8.

The present genus is represented by four more or less mutilated mandibular rami of small size (Pl. II, figs. 5—8), retaining molar teeth (fig. 7 B) of the general tricuspid type exemplified in *Spalacotherium* and *Amblotherium,* but with the externo-median or main cusp (ib., *o*) sharp and slender, longer in proportion to its basal breadth, and with the antero-internal cusp (ib., *e*) of similar shape and proportions, and of nearly equal height. The resemblance of these cusps to needle-points suggested the generic name. The postero-internal cusp (ib., *s*) retains the small proportions shown in fig. 1 B, Pl. II). The main cusp (fig. 6 B, *o*), inclines slightly forward, and the front one (*e*) in a greater degree, overlapping the hind cusp of the antecedent molar.

The specimens exemplifying this curious needle-toothed type of Marsupial are less perfect than some of those exemplifying the preceding genera; but enough of the dentition and alveoli may be recognised to show that the genus enters into the polyprotodont and multimolar group of *Entomophaga.*

Species 1.—ACHYRODON NANUS, *Owen.* Plate II, figs. 5, 5 A, 6, 6 A, 7, 7 A, and B.

The first exemplar of this species is a right mandibular ramus mutilated at both ends, but including eight molars of the generic type and two contiguous premolars (Pl. II, fig. 5, nat. size; 5 A, magn. 3 diam.). The inner surface is exposed. In advance of a vertical line dropped in front of the foremost of these premolars begins the symphysis (*r*), and as much of the symphysial end of the ramus continues forward as forms the alveoli of two teeth, probably, also, premolars. The last two premolars, in place (*p* 3, *p* 4, fig. 5 A), have crowns higher than those of the succeeding molars: that of *p* 4 is twice the height of that of *m* 1, and is rather higher than that of *p* 3. Both are conical, subcompressed, with apices polished and a little blunted by use. A low cingulum crosses the base obliquely from before downward and backward. Both are implanted by two fangs. The coronal pattern of the molars is at once assumed. The long, slender, anterior cusp rises obliquely forward from the fore end of the cingulum. The longer main cone contrasts by its slenderness with that of the antecedent premolar. The low hind cusp is as well marked as in the succeeding teeth. These very gradually increase in size to the third (*m* 3), the seventh and eighth decreasing again.

As much of the fore part of the coronoid process as is preserved rises straight and slopes but little from the vertical: it resembles the corresponding part of the coronoid of *Amblotherium mustelula* (Pl. II, fig. 2), not the more sloping convexity of that in *Ambl.*

[1] ἄχυρον, acus; ὀδοὺς, dens.

soricinum (ib., fig. 1). The pterygoid fossa is bounded by a well-marked inwardly produced ridge, which has declined to the lower border of the ramus at the hind fracture. The dental canal (ib., fig. 5 A, *d*) begins at the fore part of the fossa, below that border of the coronoid. The mylohyoid groove (*g*) begins in advance of the lower bounding ridge of the inner fossa, and, if it lodged a nerve of that name, this must have perforated the ridge anterior to the entry of the mandibular nerve-trunk, in order to emerge upon the groove. The groove is well-defined, linear, and extends at first straight forward, then very slightly bends up to the back part of the symphysis (*r*). This is narrow, long, and continues the feeble convexity of the under border of the ramus. without any abrupt upbending from that contour. Below the last three molars the inner alveolar plate is subconvex vertically to the groove. Beneath the anterior five molars the bone is flatter: in advance of the premolars the inner surface bends inward as it sinks to the symphysis.

Achyrodon differs from *Amblotherium* in the greater relative length of the anterior cone of the molars, which projects over the hind cusp of the antecedent tooth, exemplifying the closer, and as it appears interlocked, array of the molars in the present genus. Admitting that one molar may be wanting in the type of *Amblotherium* (Pl. II, fig. 1), the seven molars then would occupy the same relative extent as do the eight molars in *Achyrodon*. They are, nevertheless, in other respects so closely alike as to have led me long to hesitate, and repeatedly pass under comparative review all the Purbeck specimens showing this general slender-coned type of molar, before concluding to indicate the differences above defined by a generic name.

The specimen (Pl. II, fig. 6, nat. size, fig. 6 A, magn. three diam., in tint) might seem to be the left ramus of the same mandible as the right one last described, but that it appears more slender. Like that, it is mutilated at both ends, but in a less degree, retaining the two anterior premolars, and rather more of the reflected lower border of the 'ascending ramus.' There are five molars (*m* 1—5) and sockets for three, if not four, behind the teeth in place. The crown of the best preserved teeth show the base of the long anterior cone and the smaller and lower posterior basal cusp, united by a low oblique smooth rising; external to which, or from which, ascends the principal cone, chiefly supported by the outer side of the coronal base. The molars are close-set; and, indeed, their bases seem, as in the right ramus (fig. 5), obliquely to overlap each other.

The apex of the main cone is broken in all, or more worn than in fig. 5. The last premolar (*p* 4) shows the usual simple type of one chief subcompressed pointed cone; which, though broken, evidently had the characteristic superiority of height over the succeeding true molar (*m* 1). It is implanted, as in fig. 5, by two roots.

The ramus is slender, almost straight. The slight curve of the lower border, and the indications of the ascending ramus (*a′* and *c*) repeat the characters in the mandible (fig. 5). The deep pterygoid fossa leads to the entry of the dental canal (*d*) which is below the anterior margin of the coronoid process, as in the right ramus (fig. 5). A well-marked linear groove (*g*) traverses the whole length of the inner surface of the portion of the horizontal ramus preserved, about one third of the depth from the lower margin, ending at the hind part of the symphysis. Its curve and commencement in advance of the anterior boundary of the pterygoid fossa repeat the characters noted in the subject of fig. 5, Pl. II.

The left mandibular ramus (Pl. II, fig. 7, nat. size, 7 A, magn. three diam. in tint), wanting the ascending branch, has four well-preserved molars in place, the inner side exposed. The mylohyoid groove (*g*) has the same commencement and course. The better preserved, long, narrow, almost horizontal symphysis (*r*, *s*) shows that the slender ramus gradually tapers to the obtusely pointed anterior end.

The molars are closely arranged, and well display the anterior slender sharp-pointed cusp (fig. 7, B, *e*) rather inclined forward; next, a similar, but rather larger, longer, and more nearly vertical, main cone (*o*), behind which is the basal cusp (*s*): a very minute accessory cusp could be detected at the inner and hinder part, near the base of the main cone.

There is space for one or two such molars, especially if the last one lost size, as in the type jaw (fig. 5 A, *m* 8), behind those in place; the extent of the empty alveolar tract in advance of the molars indicates teeth in number according to those shown in fig. 6.

The four molars in place answer to those marked *m* 3—6, in Pl. II, fig. 5 A. If the proportion which those four teeth there occupy of the extent of alveolar tract from the fore part of the coronoid to the fore end of the symphysis be compared with the corresponding proportion in *Amblotherium soricinum* (ib., fig. 1), their superiority, both absolutely and in relative size to the jaw, in the present fossil, will be appreciated. But the difference of structure, according to the taxonomic value assigned by Mammalogists to the characters of true molars, is more than specific. The mylohoid groove (*g*) describes a somewhat different curve from that in *Amblotherium*.

Species 2.—ACHYRODON PUSILLUS, *Owen*. Plate II, figs. 8, 8 A.

The mandibular character last referred to has not more than specific value, if so much. The curve, convex upward, of the hinder half of the mylohyoid groove (Pl. II, fig. 8 A, *g*) in the portion of jaw showing in the few molars preserved the generic coronal characters of *Achyrodon* is, however, associated with other differences.

The specimen (ib., fig. 8, nat. size; 8 A, magn. 3 diam.) is the hinder half of the horizontal portion of a left mandibular ramus with the inner side exposed, showing four molars *in sitú*, which I determine to be the third to the sixth inclusive, as in fig. 7; there are sockets of teeth, before and behind those in place, indicative of the same excess of number as characterises the dentition of the preceding species of *Achyrodon*. I quote the note originally made of the characters of these teeth, before the relations of this specimen to any other in the series had been determined by comparison.

"The last two molars, seen from the inside, have a crown of two cusps and a hind talon. The cusps are remarkable for their hight, slenderness, and sharpness, resembling needle-points. They do not rise straight up; the anterior one curves gently forward before it ascends, retaining a slight forward obliquity; the second cusp is more nearly vertical, but little longer, and slightly inclines forward. The first and second of these teeth *in situ* seem to consist each of one main cusp, which is long, slender, and pointed, with a fore and a hind basal cusp; they resemble the two hind molars, with the reduction of the anterior cusp to a talon; but the second of these teeth has suffered fracture, and the difference in both may be due to mutilation (as I subsequently satisfied myself was the case). The impression of the fore part of the jaw indicates space for five or six molars or premolars, besides a canine and three or, perhaps, four incisors. There is room for two molars behind the teeth in place, of equal size with them."

The best preserved teeth in the present mandible are rather less, both absolutely and in proportion to the depth of the supporting part of the jaw, than in *Achyrodon nanus;* and, coupling this with the course of the mylohyoid groove, I venture to indicate the species represented by the present mandibular fragment as an *Achyrodon pusillus.*

Genus—PERASPALAX,[1] *Owen.*

Species 1.—PERASPALAX TALPOIDES, *Owen.* Plate II, figs. 9, 9 A, B.

The molar teeth of this genus, agreeing in general character with those of *Amblotherium,* are more complex, inasmuch as they show a distinct cusp-like rising or prominence (Pl. II, fig. 9 B, *n*), from the inner side of the base of the main or external cone (*o*). In this respect they make a nearer approach to the type of the lower molar in *Didelphys* (ib., C) than does any of the preceding Purbeck Marsupials. The antero-internal cusp (ib., fig. 9 B, *e*) projects obliquely forward, and from a higher level than the shorter and smaller hind basal cusp (*s*), above which the anterior cusp of the following molar projects, giving an interlocked kind of disposition of the close-set series of molars, recalling that in *Achyrodon.*

The main cone (*o*) is shorter and basally broader relatively than in *Amblotherium,* much more so, therefore, than in *Achyrodon.* The molar teeth are also larger, and of a more robust character in proportion to the jaw. This character is well seen in comparison with *Amblotherium mustelula* (fig. 2, Pl. II), a species of about the same size as that represented by fig. 9.

The present species is represented by a portion of the left mandibular ramus, with the inner side exposed, retaining six molars (*m* 2—7) and one premolar (*p* 4) *in situ.* It shows the socket and impression of the first small molar (*m* 1), and the impressions of the three

[1] πήρα, pouch; ἀσπάλαξ, mole.

anterior premolars and of a canine. The molars exemplify the generic didelphid modification of the multicuspid mechanism for insect-crushing above defined. They slightly increase in size from the first to the sixth; the third (*m* 3) is a little displaced, exposing the two roots. The molars are close-set, and the anterior oblique lobe of one overlies the posterior talon of the tooth in advance; but it is much shorter, and more obtuse and procumbent than in *Achyrodon* (fig. 7).

The last premolar (*p* 4), with the well-preserved crown, shows distinctly the front and hind basal talon, the main cone rises higher, and the whole tooth is larger than the three succeeding molars. It is divided by the socket of the small first molar from the second one. Impressions of the crowns of two or three anterior premolars, and of that of a longer, sharp, recurved canine, are preserved in the slab of the matrix.

§ XI. *Genus*—PERAMUS,[1] *Owen.* Plate II, figs. 10—13.

In this genus the teeth, implanted in a jaw characteristically long and slender, are large in proportion, and that in fore-and-aft extent rather than in height. The main outer cone in the true molars has a base almost equal to its height, and offers a marked contrast with the proportions of that of *Achyrodon*. There is an indication of an accessory internal cusp (*n*, fig. 10, c, Pl. II), from the main cone (ib., *o*), distinct from the antero-internal basal cusp (ib., *e*), which, with the general proportions of the main cone, approximate *Peramus* to *Peraspalax*. But the five molars retained in the mandible (fig. 10) decrease in size in a greater degree than do those, *m* 4—7 (Pl. II, fig. 9 A), in the type of *Peraspalax*. Such indications have the greater value in the endeavour to interpret materials so minute and fragmentary and often obscure. It is certain that there is not sufficient evidence for the determination of generic conformity of the specimens above cited and compared in their dental system; and the marked difference in the form and proportions of the mandible, as exemplified in Pl. II, fig. 9 (*Peraspalax*) and fig. 10 (*Peramus*), sways with me in offering the present evidence for comparison with future possible acquisitions under the above generic name.

Species 1.—PERAMUS TENUIROSTRIS, *Ow.* Plate II, figs. 10, 10 A, 10 B, 10 C.

This species is represented by three fossils. The first to be described is a left mandibular ramus (Pl. II, fig. 10, nat. size, and 10 A and B, magn. 3 diam.), wanting the symphysial extremity (probably supplied by fig. 11), with the last four molars *in sitû*, and sockets of five antecedent teeth. In the last three molars the main cone is high and boldly convex across, as in *Stylodon*, but is broader at the base, and lower than in that genus. The front border is shorter and more nearly vertical than the hind one, at the base of which is a short thick talon (fig. 10 c): the anterior basal talon (ib., *e*) is much smaller: the sharp apex of a small cusp (*n*) rising from the fore and inner part

[1] πηρα, pouch; μυς, mouse.

of the base of the main cone indicates an accessory part, which represents the antero-internal cusp in *Peraspalax* and *Didelphys.* The three molars showing the above structure progressively, but slightly, decrease in size as they recede in position.

The main cone in the foremost of the four teeth in place (*m* 4) has its outer surface less bulging or convex across, and its acute apex is on a lower level than that of the next molar (*m* 5). The anterior cusp is better marked; but the posterior basal cusp is still the largest, though less than in the succeeding molars. The antecedent alveoli sufficiently show the multidentate character of the fossil; but it would seem that the premolar shape and degree of coronal simplicity prevailed over a greater proportion of the molar series than in *Peraspalax.*

The condyle (*b*) projects backward on the level of the dental series. The angle of the jaw (*a*) bends downward and backward, as a short triangular process, in advance of the condyle and from a lower level. Working out the matrix with careful avoidance of disturbance or breakage of so rare a feature in the present series of small jaws, I got the evidence that the angular process was slightly inflected, as shown in the view from below, in fig. 10 B, *a.* The fractured surface at the fore part of this process was probably due to the original exposure of the fossil. The dotted line in fig. 10 A indicates the proportion of the process which I suppose may then have been broken off. The crotaphyte depression is deep and extensive from behind forward; its fore and under boundary ridges are well marked. The ridge, continued from its anterior margin, curves forward midway between the molar alveoli and the lower border of the ramus, and, blending with the lower ridge, subsides in advance of the four teeth in place.

Peramus tenuirostris differs from *Spalacotherium tricuspidens* in the non-constriction of the mandible behind the molar series; in the sharper angle at which the external crotaphyte boundary-ridges meet anteriorly; in the lower position of the condyle (*b*); as well as in the deflected angle (compare fig. 10 with fig. 38 in Pl. I). *Peramus* also differs in the two last-defined characters from *Amblotherium,* and notably from *Amblotherium mustelula,* in the greater slope of the fore margin of the coronoid process.

Sufficient of the jaw of *Achyrodon* is preserved, in figs. 6 and 6 A, Pl. II, to show a difference of contour of the lower border of the ramus, but the generic distinction is more decidedly manifested in the forms and proportions of the molar teeth. The contrast which the mandible of *Peramus* presents with that of *Amphitherium* and *Phascolotherium* will be seen by a glance at figs. 23 and 26 in Pl. I.

The next example of *Peramus tenuirostris* is the fore end of the left mandibular ramus wanting in the preceding specimen. It is outlined of the natural size, Pl. II, fig. 11, and given in tint at 11 A, magn. 3 diam. It includes the bases of three incisors, a canine, and five premolars.

The jaw tapers in a singular degree to its fore extremity, the line of the incisive alveoli coming down to meet that of the symphysis, while this is nearly horizontal or slightly concave. It plainly indicates a produced and slender fore-part of the head, recalling the physiognomy of the insectivorous marsupial Bandicoots (*Perameles*) and Myrmecobians. This mandibular character suggested the 'nomen triviale' proposed for the present species.

Of the incisors (Pl. II, fig. 11 A, *i* 1, 2, 3) it can only be said that their crowns have been slender, and were probably long; the first or foremost procumbent, the second and third progressively, though slightly, rising from the horizontal position. The canine (*c*) is rather more raised, and shows its characteristic curvature to a sharp summit. A slight interval separates each of these front teeth from the other. At a similar interval from the canine rises the compressed sharply conical crown of a small premolar (*p* 1). The next (*p* 2) has been forced forward and turned round, the curved hind slope of the cone being pushed behind the base of *p* 1: the divided socket of this two-rooted tooth is exposed. The third premolar is in place, and well shows the shape of the crown, with the convex front border and concave hind one, produced at the base without any cusp-like elevation of this part. The socket of the fourth premolar is vacant.

The fifth tooth (*p* 5) shows a change of shape, approaching that of the first of the retained molars in figs. 10 and 10 A. The fore and hind borders of the compressed cone slope or diverge from the sharp apex at almost the same angle, and each end of the base developes a minute cusp or talon. The body of the cone is markedly convex antero-posteriorly, as in the hinder molars. There is no indication, impressional or alveolar, of any premolars between the last (*p* 6, if it be a premolar ?) in place and the molars *in sitû* (in fig. 10 A), suggesting the character shown in both upper and lower jaws of *Peralestes*. Otherwise it might be questioned whether the type of upper molars in *Peralestes* (Pl. II, figs. 3 and 3 A) might not probably be that of *Peramus*. But, even if *Peramus* had shown the marked superiority of height and size of the last two premolars over the succeeding true molars, the present must have been a different and smaller species from the *Peralestes longirostris* represented by figs. 3 and 4 in Pl. II.

PERAMUS TENUIROSTRIS (?). Plate II, figs. 12, 12 A.

This is represented by the anterior portion of a left mandibular ramus, with the outer surface exposed, and the symphysial end with its alveoli and teeth broken away: it also shows the premolars, which have suffered some displacement in the foregoing specimen. They accord in proportions and shape too closely with the dental characters of *Peramus* to justify generic separation.

The first tooth in place is a premolar, two-rooted, with a simple subcompressed conical crown. The next tooth seems to show a lower conical crown, with the same fore-and-aft basal extent; but there is evident trace of mutilation by fracture. The third tooth gains in height and fore-and-aft extent. The fourth is similar in size to the third. The fifth seems to be smaller, but one cannot be sure that size may not be masked by matrix, which I have thought it too hazardous to endeavour to clear away. The basal cusps are best marked in the fourth and sixth teeth.

At the fractured fore part of this jaw is the crown of a small tooth, which slopes obliquely forward (as in *i* 3, fig. 11 A); it is probably an incisor. The socket of a larger simple tooth follows, answering to the canine in fig. 11 A.

PERAMUS TENUIROSTRIS (*minor ?*). Plate II, figs. 13, 13 A.

The left ramus, wanting the ascending portion, of a long and slender mandible with the inner side exposed (Pl. II, figs. 13 and 13 A), I refer, from its shape and the character of the few teeth it retains, to the same genus, if not species, as the two foregoing specimens.

The angle at which the pterygoid depression terminates anteriorly suggestively resembles that of the outer depression in fig. 10 A, and offers the same distinction compared with the inner surface of the mandible of *Amblotherium*, shown in Pl. II, fig. 1 A, as has been pointed out in regard to that specimen. The mylohyoid groove is wide at its hinder half and straighter in its course than in *Amblotherium* or *Achyrodon*.

The preserved fore part of the base of the coronoid, and a neatly defined impression of the remainder, show a shallow emargination of the summit which may be due to fracture, as is doubtless the deeper notch there in the mandible (fig. 10 A, *c*). But the coincidence is noteworthy. If one could trust the part of the impression marked *b*, in fig. 13 A, as showing the position of the condyle, it would seem to be relatively higher, and divided by a shorter and more angular notch from the coronoid than in the type of *Peramus tenuirostris* (fig. 10 A, *b*). The anterior part of the inward production of the lower border of the depression on the inner side of the ascending ramus indicates the marsupial character, but is not preserved backwardly far enough to show any downward extension of an angular process, as at *a′* in figure 10 A.

The crowns of two molars are partially preserved, and the roots of two in advance are visible. A chief cone, and indications of smaller basal cusps, as in *m* 4, fig. 10 A, are plainly shown.

The end of the symphysis has been broken and displaced slightly upward, so that one cannot satisfactorily or with certainty conclude as to a difference, or the degree of difference, from the shape of that part in fig. 11 A. If the mandibular ramus (fig. 13, Pl. II) should exemplify more than a sexual inferiority of size of *Peramus tenuirostris*, it might bear the specific name *minor*. I do not recognise grounds for generic distinction.

§ XII. *Genus*—Stylodon, *Owen*, 1866.[1] Plate II, figs. 14—19; Plate III, figs. 1—4.

The present genus of Mesozoic Mammal was founded on a portion of lower jaw with teeth (Pl. II, fig. 15, nat. size, 15 A, magn. five diam.) submitted to the Author by his friend the Rev. Peter B. Brodie, M.A., F.G.S., by whom it had been obtained from the same locality and marly member of the Purbeck beds as that which became subsequently the scene of Mr. Beckles's explorations.

The results of the latter abundantly confirm the title of this, at one time, unique specimen, to the generic distinction assigned to it, and the later acquisitions instructively add to our knowledge of the dental and mandibular characters of *Stylodon*.

Species—Stylodon pusillus, *Owen*.[2] Plate II, figs. 15, 15 A, to 19, 19 A.

I may be permitted to quote part of my original account of the type-specimen of the present species before proceeding to the description of those discovered by Mr. Beckles.

"The part of the lower jaw is imbedded in a small block of the matrix, with the outer surface exposed: it includes the portion of the ascending ramus supporting the coronoid process (a film of which only remains in the depression of the matrix, mainly indicating its size and shape), and so much of the horizontal ramus as includes the alveoli of the nine posterior teeth, eight of which are *in situ*. The articular and angular processes, and the fore part of the ramus, have been broken away, and there is no indication, in the matrix, of the entire ramus having been imbedded therein; it may be inferred, therefore, that the mutilation took place prior to imbedding. Enough, however, has been preserved to demonstrate the class-characters of the animal to which the fossil belonged, and to enable us to add another genus and species to the small category of *Mammalia* of the Mesozoic period.

"The continuous unity of bone at the part of the mandible which would show most of the sutures in a lacertian jaw—the height, breadth and contour of the '*processus coronoideus*'—and the implantation of one at least of the teeth by two fangs in a double socket, concur in testifying to the warm-blooded, air-breathing, viviparous, and lactiferous class of the animal. The base of the coronoid process shows the raised boundary of the lower part of the depression for the insertion of a temporal muscle of mammalian proportions. The lower margin of the ascending ramus has a degree of thickness and flatness suggestive of Marsupial affinities; but the angle itself is broken off. As, however, the alternative is the almost equally low 'lissencephalous' sub-class, to which the present little Insectivore must be referred, if it be not 'lyencephalous,' it adds another to the prevalent testimony of the low condition of the Mesozoic mammalian life.

[1] στύλος, pillar; οδους, tooth. The 'Geological Magazine, or Monthly Journal of Geology,' &c. No. xxiii, May, 1866, vol. iii, p. 199, pl. x. figs. 1 and 2. [2] Ib. ib.

"The crowns of the teeth, encased in lustrous enamel, are long or high in proportion to their breadth and thickness. They manifest this proportion, indeed, in a higher degree than do the teeth of *Spalacotherium;* and, being rounded or cylindroid at the aspect exposed, have suggested to me the generic name *Stylodon*, signifying 'pillar-tooth.' The hindmost in place, supported apparently on a single columnar fang, which is partly protruded from the socket, and covered with a darker and duller cement, has a longish conical crown, with the fore part of the base rather more produced than the hind part: the crown of the next tooth is somewhat longer: that of the antepenultimate has a broader base, produced anteriorly into a minute angle, and slightly thickened behind, but not developed into a continuous cingulum. The apical half of the crown is broken off in the three teeth next in advance. Each has a small anterior basal 'talon,' and a single columnar root, so far as it is exposed; they are, likewise, severally smaller than the antepenultimate tooth. The seventh tooth, counting forward, is more abruptly smaller than the rest, with a simple conical crown, indicating only a feeble prominence of the fore part of the base. Then rises the crown of the largest tooth of the series, laniariform, subrecurved, or seeming to be so, from the convexity of the front border, and the minor concavity of the hind one, where the base is a little thickened and produced; this crown is supported on two divergent fangs. The convex surface of the jaw beneath these teeth is entire—shows no neurovascular outlets—the main anterior one has gone with the missing fore part of the ramus.

"Any attempt to determine the nature of the above-described eight teeth must be made on unsatisfactory and uncertain grounds. Guided by their shape and proportions, we might view the foremost as a 'canine,' the next four as 'premolars,' the last three as 'true molars,' and thus infer an example of placental diphyodont dentition. The objection to the two-fanged character of the canine would be met by the same mode of implantation of the canine of the common mole (*Talpa*), the proportion of which tooth to the succeeding premolar is very similar to that presented by *Stylodon.*

"But the proportion of the preserved dentigerous part of the present fossil to the part behind indicates a greater number and size of teeth in advance of the laniariform tooth than the three small incisors of *Talpa.* The closer similarity of the narrow columnar hinder molars to those in the Cape Mole (*Chrysochloris, Cuv.*), and the very probable addition of an eighth such molar to the seven in place behind the laniariform tooth of the fossil, warn us of the deceptive character of the analogy of the dentition of the common Mole. It is more likely that *Stylodon* like *Spalacotherium* and *Chrysochloris* (unique in this respect among existing *Insectivora*), exemplified that excess of number of teeth which, in *Marsupialia,* as in *Insectivora,* is seen in a single known existing genus (*Myrmecobius*), but was common in the similar small insectivorous pouched Mammals of the older Oolitic deposits. *Spalacotherium* had ten molar teeth on each side of the lower jaw, of which the last six had tricuspid crowns, with proportions and spacing similar to those in the Cape Mole."[1] The corresponding teeth of the present genus and species are in closer contact with each other, and are of more simple shape, and apparently more simple implantation.

The first example which I have selected from Mr. Beckles's series (Pl. II, fig. 17) shows the generic character of the molar teeth of *Stylodon;* and, if they appear to be a little further apart than in fig. 15, it is because more of the intervening matrix remains. Those who have experienced by how slight a touch of the finest needle-point the crown or part of the crown of a tooth flies off, in the attempt to develope these delicate fossils from their subpetrified marl-bed, will appreciate the reticence which practice begets of being content when enough has been exposed for comparison and determination, and of "letting well alone."

The alternative of the Cape Mole suggested in my original Memoir as preferable to that of the common Mole for homologizing the teeth in place in the type-jaw, and the probable nearer affinity of *Stylodon* to *Spalacotherium,* is confirmed by the fossil now under description. The two-rooted tooth with a canine-shaped and canine-proportioned crown proves to be the last of the premolar series (as definable by shape).

The instructive specimen, figured of the natural size in outline, and magnified three diam. in tint, is a left mandibular ramus, wanting the rising branch, but including the dental series, which may be formulised as—

$$i\,\frac{}{4-4},\ c\,\frac{}{1-1},p\,\frac{}{4-4},\ m\,\frac{}{7-7} = 32.$$

The front or first incisor (i 1), is procumbent, with a long and narrow spatulate crown. The second (i 2), with a narrower crown, lies parallel with the first. The third (i 3) is smaller, and more erect: the fourth (i 4) is also very small, and is nearer to the canine than to the third incisor. The canine (c), with a longish slender obtuse crown (perhaps not entire at the apex), slopes forward, but less so than do the incisors. The outer side of the root shows a longitudinal fissure, indicative of division.

The first premolar (p 1) is small, and near to but not touching the canine: the second (p 2) rises, at an interval equal to its own breadth, from the first, and is also small. The third premolar (p 3) shows a longish, subcompressed, subcurved, conical crown. The fourth (p 4) is a similar but a larger tooth. Each premolar has two roots, one before the other.

The true molar series begins, as in *Amblotherium,* by teeth of inferior size, as if they had continued backward a series of deciduous teeth which the larger premolars had displaced. The first molar (m 1) has a straight, vertical, smaller and more slender cone than p 4; it is also more convex antero-posteriorly, and with a cingulum extending into an anterior and a posterior basal cusp. The root, or outer root, supporting the girted crown, rises some way above the alveolus. These characters are repeated in the four

[1] 'Quart. Journ. Geological Society of London,' 1854, vol. x, p. 425.

succeeding molars, with slight but progressive increase of height, not of breadth, of crown. The length of the exposed part of the third molar (*m* 3) is equal to the entire depth of the ramus below the socket: the same may be said of the fourth (*m* 4) and fifth (*m* 5) molars; but the lower border of the jaw may not be fully exposed.

The crowns of the last two molars (*m* 6, *m* 7) are partly broken away; and those of the last two incisors and first two premolars have suffered mutilation; otherwise, the whole mandibular series of teeth of *Stylodon pusillus* is instructively displayed in the present specimen. In comparison with the mandible of *Amblotherium soricinum* (Pl. II, fig. 1) it well exemplifies the value of the dental characters showing generic distinction in these minute multidentate Marsupials of the Mesozoic period.

The next example supplies almost as much of the dental series of the upper jaw, as does the foregoing specimen of that of the lower jaw. The grounds for referring the specimen (Pl. II, figs. 14 and 14 A) to *Stylodon pusillus* will be given, as might be looked for, in some detail.

In the existing Insectivores which show teeth, or at least the molar series of teeth, resembling those of certain species of small Mammals represented by fossil jaws and teeth from the Purbeck marl-beds, the longest and largest lobe or cusp projects from the inner part of the crown in the upper molars, from the outer part in the lower ones. This is well shown in *Chrysochloris*,[1] in which the inside view of the upper teeth and the outside view of the lower teeth present the form or character of crown closely resembling the type of that which suggested the generic name *Stylodon*. Somewhat of the same character is seen in the Tenrecs (*Centetes*),[2] which more nearly resemble *Stylodon* in the proportions of the incisors and canine. In *Perameles*,[3] and *Didelphys*[4] also, the longest cusps of the true molars project from the inner half or side of the crown in the upper jaw, and the reverse in the lower jaw. The tendency to adhere to this reversing of position, as it seems, of upper and lower molars in respect to outer and inner side-configuration of crown is discernible in the teeth of *Sarcophilus ursinus*, Pl. II, fig. 3 *c*, and fig. 4 *c*.

Upon these considerations, and after close and repeated scrutiny of the teeth, which a successful application of the needle-point has exposed in one of Mr. Beckles' slabs, affording, at first sight, small promise of such result, I conclude them to belong to the upper jaw.

The apparent continuation of the jaw-bone (*a*, *b*, fig. 14 A) directly down, or vertically, from the alveolar margin of this specimen, at first suggested a mandibular character. But the cracks and fissures (ib. *a*, *a*) close to that margin, and the thinness of the osseous plate

[1] Fr. Cuvier, genre *Chrysoclore*, 'Annales du Muséum d'Histoire Naturelle,' tom. xii (1808), p. 49, pl. iii, figs. 1—5. Ib., 'Dents de Mammifères,' 8vo, 1825, p. 63, pl., no. 18. (The line-engraving in the original memoir is better than the lithograph in the subsequent work.)

[2] Ib., p. 46; and ib., p. 69, pl. no. 19.

[3] Ib., p. 71, pl. no. 23, A.

[4] Ib., p. 73, pl. no. 23, C.

itself, show it to be part of a bony palate, broken and bent up into its present position by posthumous pressure. The part (*b*), moreover, continued from the sockets of the three last molars, retains an inward curve or bend therefrom, suitable to its palatal character, and not in accordance with the disposition of either the inner or outer plate of the ramus of any mandible in the present series of small mammalian fossils.

With this determination the general curve of the molar series also accords: it inclines outward from the canine, and, after a straight course, bends inward at the end of the series, the hinder half of which is thus convex outwards or horizontally. Vertically the series presents, as in the upper molars of Marsupials and Insectivores, a slight sigmoid disposition.

Assuming then that we have—or rather are detecting—in the present specimen, the dentigerous part of the left upper jaw, it exposes the inner side of the teeth, and also the working surface of the last three molars (*m* 5, 6, 7). The teeth, *in sitú*, are the canine (*c*), and eleven of the premolar-molar series.

Of the incisors nothing can be said, satisfactorily or confidently, beyond the fact that there are, in the portion of crushed bone, *d*, anterior to the canine, feeble indications of their alveoli.

The canine (*c*) is a formidable tooth; its crown is more than twice the length of that of the longest molar; it is gently bent, as it descends, backward and a little inward, is strongly indented at the middle of the inner side of the base, the indent widening to the socket, as if indicative of a division, or disposition to divide, into two roots. A like indication was noted in the lower canine of *Stylodon pusillus*.

Close behind the canine projects the crown of a minute premolar (*p* 1), of a simple, subcylindrical, obtusely pointed form. After an interval there is an indication of a similar minute premolar (*p* 2). Then follows a premolar (*p* 3), having for its crown a broader based conical cusp with a minute tubercle before and behind: this tooth is not longer than the first, but is much broader from before backward; it is implanted by two roots. Immediately follows a much larger and longer premolar (*p* 4), the conical crown of which does not show the basal tubercles. The next tooth (*m* 1) presents the form of the exposed inner surface common to the rest of the molars; viz., that of a cylindrical column truncate atop: this terminates internally a crown which expands slightly as it extends outward; the inner cusp does not reach the level of the apex of the antecedent premolar, and the sudden loss of size in *m* 1 significantly recalls that character in the type mandible (Pl. II fig. 15). The second molar (*m* 2) in the upper jaw (fig. 14) is merely augmented in size: it shows more of the dark-coloured cement-covered base before the bright amber-coloured enamel begins. The following molar (*m* 3) is similar. The fourth of these molars (*m* 4) shows a slight outswelling of the enamelled base of the crown and the summit of the inner column is less worn, rising to an obtuse point. The fifth, sixth, and seventh molars (*m* 5, 6, 7) decrease progressively in length; they slightly expand to the outer side, which is divided by a mid-longitudinal cleft (fig. 14, B, *c c*) into two low cusps. The grinding surface sinks as it slightly expands from the produced sharp summit of the inner cusp, and is concave from within outwards: it is very smooth and polished. The series of grinding surfaces of these antero-posteriorly compressed tri-cuspidate molars describes lengthwise a moderate convexity downward or toward the mandible, which curve, with the horizontal outward bend of this part of the dental series, confirms the determination of these teeth, as belonging to the upper jaw.

The maxillary molars of *Stylodon* show most resemblance to those of *Chrysochloris*, but they are close together, and, indeed, obliquely overlap each other. Being broadest transversely, and extending from within slightly backward as well as outward, a small part of the hinder surface, as well as the narrow columnar side, of one tooth stands clear of the crown of the following tooth.

If, as is most probable, one of the minute premolars has dropped from the interspace between the first (*p* 1) and the next (*p* 2) in place, we may reckon five premolars according to shape, and seven molars by the same character, twelve in all, on each side the upper jaw, besides the canines and an unknown quantity of small incisors. The indication of premaxillaries (*a*) testifies to a greater extent of dentigerous jaw anterior to the canine than exists in the Cape Mole.

In the outline of the natural size, Pl. II, fig. 14 (and in fig. 14 A, magn. nearly four diam. in tint), I conclude, therefore, on the foregoing grounds, is represented a great part of the left upper jaw and dentition of *Stylodon pusillus*.

To the same genus and species I refer the left mandibular ramus, with five molars *in sitú*, opposed by portions of the crowns of the corresponding upper teeth (Pl. II, figs. 16 nat. size; 16 A, magn. 3 diam.). A few of the premolars are more or less perfectly preserved in the part of the mandible in advance of the lower molars.

The ascending ramus and the symphysial end of this mandible are broken off; the inner surface of the preserved part with teeth is exposed. The longitudinal groove on the inner side of the ramus is relatively wider than in most other genera of small Mesozoic Marsupials, showing that groove.

Fragmentary portions of the maxilla to which the portions of upper molars belonged are discernible in the matrix below the mandibular ramus, but too much crushed for working out to any purpose.

In the subject of fig. 18, Pl. II, we have acceptable confirmation of the dental characters of the lower jaw shown in figs. 15 and 17. It consists of the two rami of the mandible separated in such a way that the left presents an outside view, and the right turns its lower border to the surface of the slab; part of its outer surface has been exposed by removal of matrix.

It is evident that the skull was crushed, together with the jaw, prior to being imbedded in the lacustrine or fluviatile marl. Parts of the basioccipital and basisphenoid, showing their 'harmoniæ,' are recognisable, but I am unable to determine any other cranial element in the remaining mass of crushed fragments.

The lower border of the mandible, as shown in the left ramus, magn. 3 diam. in fig. 18 A, slopes from below forward and very gradually upward to the socket of the first or front incisor, as in the specimen, fig. 17, and in *Peramus*, fig. 11. The foremost tooth is preserved in both rami: it is the largest of the incisors; the crown is shaped like the bowl of a narrow spoon; it expands beyond the root, slightly bends upward and terminates in a rounded edge; it is moderately convex across, externally. Three teeth of smaller size and more slender crown, follow; they are implanted each by a single root, at intervals rather more than their own breadth, save the second, which is closer to the first incisor.

The fifth tooth by resumption of size of crown, though it be less broad than the first incisor, suggests a canine; but it seems to be implanted by two fangs. After an interval of rather more than the coronal breadth of the canine, there is a small simple-crowned premolar; after a shorter interval there is a second still smaller premolar. Then follows an alveolar tract, which may have accommodated four or five teeth of larger size. The molar series is resumed by six successive teeth, which terminate it. The exposed outer side of the crown in the three teeth where it is entire shows the character of the true lower molars of *Stylodon*, with the type-specimen of which (fig. 15) the present one agrees in size. It yields valuable accession to the evidence of the characters of the fore part of the mandibular dentition of the genus. The cement-covered outer or main fang of the largest molars rises a short distance above the alveolar, and swells into a low quasi-cingulum forming the base of the enamelled crown. The ultimate and last molars seem progressively to decrease in length in a degree not shown in the last two molars in place in the type specimen. Does this indicate an additional or eighth molar? There are two anterior outlets of the dental canal, the foremost of which opens beneath the interval between the canine and the anterior premolar.

In Pl. II, figure 19 gives the nat. size, and 19 A a view magn. 3 diam., of a portion of a left mandibular ramus, with the base of the ascending ramus, the last two molars, and the sockets with roots of the six antecedent teeth. This specimen is chiefly valuable as showing the outer part of the crown in the last two molars in place. The tooth rises some way above the socket, and then swells out to form the base of a long and narrow-pointed cusp or cone, which terminates, outwardly, the crown of the tooth; but this, as it extends inwards, expands in fore-and-aft diameter, and develops a minute inner basal cusp. Something of this kind is shown in the ante-penultimate molar of fig. 15 A, which tooth may have been rotated slightly from its natural position. The sockets of the six antecedent molars indicate teeth of the same relative size as those which are in place in the type specimen of *Stylodon pusillus*.

The proportion of the mandibular ramus preserved in the present fragment corresponds pretty closely with that of the type specimen; only the crowns of the molars anterior to the penultimate one are more or less broken away. The basal half of the crown of the long and large terminal premolar (*p* 4) shows its two roots one before the other. If the succeeding teeth have their root divided, the fangs must stand on the same transverse line, one on the inner side of the other. The fore part of the base of the coronoid projects, ridge-like, curving forward to subside upon the outer surface of the ramus, as in the type-jaw (fig. 15 A). The base of the ascending branch extends straight backward to a like degree, and there is a similar slight indent at or above the angle (*a*), dividing this from the ridge (*b*), which would end in the condyle.

The size is the same in both specimens.

The apparent slenderness and separation of the crowns of the molars (in the figure) is due so much to the degree of exposure of the specimen that I do not feel the ground safe for proposing specific distinction.

In Pl. III, fig. 2, nat. size (2 A, magn. 3 diam.), are shown the outer side of a portion of the left mandibular ramus of *Stylodon pusillus,* with the seven molars and part of the last premolar. This specimen gives another example of the mandibular molar characters of the present genus and species. I figure it because it shows better than in any of the foregoing specimens the angle at which the fore part of the coronoid process arises in this species. The last two molars progressively diminish in size; the crowns of the fourth and fifth are the highest.

The Becklesian collection, containing the counterpart slab with the impression of the above fossil, indicates its fragmentary state when imbedded in the fresh-water marl, and confirms the idea which was derived from inspection of the type-fossil.[1]

Another variety of *Stylodon pusillus* is exemplified in the portion of the left mandibular ramus, showing the outer side, with the last premolar and six following molar teeth *in sitû,* forming the subject of Pl. III, fig. 3, and fig. 3 A.

The second and sixth molars have longer crowns, for example, than in fig. 2. The generic and specific characters of the type-jaw (Pl. II, fig. 15) are, however, instructively repeated in the extent of the dentition here displayed.

There is a small outlet of the dental canal below the interval between the penultimate and last premolars and another foramen in advance.

Species 2.—STYLODON ROBUSTUS, *Owen.* Plate III, figs. 1, 1 A.

The present example (Pl. III, fig. 1, nat. size; 1 A, magn. 3 diam.) shows a *Stylodon* with a deeper and more robust character of jaw than the preceding specimens. It consists of a left mandibular ramus, mutilated at both ends, with ten of the molary series *in sitû,* one only wanting the crown; the outer side is exposed. The foremost

[1] 'Geol. Mag.,' loc. cit., p. 199.

tooth of this series is a minute premolar (*p* 1); the next (*p* 2) is a larger tooth, showing part of the two fangs above the socket, and the conical subcompressed crown rising rapidly or vertically to the apex of the fore part, and sloping more gradually backward. The third premolar (*p* 3) shows more equal fore and hind borders of the cone, with an indication of an anterior basal cusp. The crown of the fourth premolar is, as above noted, wanting; its base was larger than the third, and it probably showed the characteristic height of crown indicated by the dotted line in fig. 1 A of the last (fourth) premolar, as compared with the first true molar. The succeeding seven teeth exemplify the Stylodont type of true molars; but the hindmost is here preserved, showing a greater inferiority of height to the penultimate tooth than appears in the type specimen. We have here the signs of individual variation which may have been repeated in generations, as a zoological species.

Incertæ sedis [? *Leptocladus dubius*]. Plate III, figs. 4, 4 A.

After repeated scrutiny and comparison I decided to make the specimen about to be described the subject of a lithograph, the ultimate result impressing me with a belief in its having most claim to affinity with *Stylodon*. It is, however, with diffidence that I offer this remark; and the fossil is made known rather, or chiefly, as a guide for comparison with future discoveries of better specimens, which may prove the present to be indicative of a distinct genus and species.

Pl. III, figs. 4, and 4 A, magn. 3 diam., represents a left mandibular ramus, with the outer side exposed, wanting the ascending branch, with nine teeth in place, the socket of a canine, and two sockets of incisors. The lower contour is almost straight; the alveolar one slightly rises along the middle third, and sinks or is concave, but in a very feeble degree, both before and behind. The vertical extent of the ramus is the same behind and before the premolar-molar series. The symphysis curves rather abruptly from below the canine to the incisor-alveoli. The teeth, however, are too much mutilated to yield satisfactory generic characters of the present multidentate Marsupial.

The crown of the best preserved molar consists of one chief cone, which is high and sharp; a basal ridge or 'cingulum' swells into a minute prominence anteriorly, and extends with the base of the crown further back, to form a low hind cusp. The cingulum subsides at the middle of the outer convex part of the base of the main cone, and rises as it recedes therefrom, forward and backward, to form the accessory cusps. The above structure is more or less traceable in the last three teeth *in sitû* in the present specimens. There is space for one or two such molars between the hindmost and the rising base of the coronoid process.

The tooth anterior to the foremost of the three molars, by the inferior height of the chief cone in proportion to its breadth, suggests that it may be the last of the premolar series. The minute anterior cusp and the low backward production of the base of the main cone are well marked. Four teeth of like type precede the above premolar; they decrease in size, especially in basal fore-and-aft extent as they advance in position; but this decrease is most marked in the foremost. Each is implanted by two roots.

From the size of the socket the antero-posterior diameter of the canine must have exceeded that of the largest molar; its crown was probably of the usual proportional length. The incisors, which appear not to have exceeded three in number, were minute; they were close-set, and not divided by an interspace from the canine. All the other teeth stand a little apart, as in *Spalacotherium* and *Chrysochloris*. The intervals are certainly wider than in *Stylodon pusillus*.

The outer side of this minute slender jaw is unusually convex vertically. There are two anterior dental foramina, one (f') beneath the fourth, another (f) beneath the first, premolar.

If other discoveries should better demonstrate a generic type of teeth in a mandible with horizontal rami of the form and proportions here exhibited, perhaps the name *Leptocladus*[1] might be accepted for the genus here indicated. For the convenience of registration I have marked the fossil as *Leptocladus dubius*.

§ XIII. *Genus*—Bolodon,[2] *Owen*.

This genus is founded on characters of the maxillary teeth, as shown in two specimens (Pl. III, figs. 5 and 6).

Seeing the rarity of an upper jaw as compared with a lower jaw in the mammalian fossils from Mesozoic beds, one is disposed strongly to surmise that some of the many mandibles in the present series must belong to the same species or genus which has left the specimens about to be described.

But there are, amongst the few examples of upper jaw, maxillary teeth with patterns of crown which do permit their association with previously recognised mandibular teeth, as, for example, those of *Peralestes, Stylodon, Triconodon*.

I find, however, no mandibular ramus with teeth which exemplify the same kind or degree of conformity with the three remarkable ones, which have suggested the generic name signifying 'lump-tooth;' and I have, therefore, no alternative but to describe them as indicative of the genus and species, described in the present section.

Species 1.—Bolodon crassidens, *Ow.* Plate III, figs. 5, 5 a, 5 b.

In Pl. III, fig. 5 represents, of the natural size, and figs. 5, a and b, magnified 3 diam., the right maxillary, with the outer side exposed, showing the beginning of the zygoma (z), and part of the lower rim of the orbit (o). A fossa anterior to the maxillary process or

[1] λεπτὸς, slender; κλάδος, ramus.

[2] βῶλος, lump; ὀδοὺς, tooth.

root of the zygoma may include the antorbital foramen (*f*). The outer wall of the upper jaw in advance of this is remarkable for its height and verticality, and for the arched convexity which defines it above, the thick or broad hind part of which arch may be due in part to a nasal bone combined with the maxillary. A crack, fissure, or sutural 'harmonia' runs from the interspace between the second and third teeth in place some way upward where all trace of it is lost. The determination of the teeth depends on the demonstration of the character of this fissure which the present material does not afford. If it be a suture the two anterior teeth are in the premaxillary; if it be an accidental crack, the premaxillary may be wanting at the fore part of the specimen and the foremost tooth would be a canine. Under this doubt I shall merely indicate the six teeth in place, as they follow from before backward, by consecutive numerals, although the last four with complex crowns are 'molars,' by the character of shape.

The laniariform tooth (1), if a canine, is unusually large among the small Purbeck Mammals: the crown is robust, and terminates somewhat obtusely, retaining its thickness nearer to the apex than usual; in section it is a very full oval, much less compressed than in the canines of any other Mesozoic Mammal. The inner side is less convex across than the outer. The enamel there shows two or three low linear longitudinal risings. There is an indication of a rugous talon behind the base of the crown. This tooth is implanted by a single thick root.

The succeeding tooth (2) is of much less size; it is also implanted by one large root, which expands into a low stumpy bulging crown, consisting of one chief thick cone, with a small anterior and posterior ridge-shaped cusp. The enamel is rugous; it swells out beyond the smooth fang to form the base of the crown, without, however, defining a distinct cingulum. This tooth is contiguous to No. 1.

An interval of the breadth of the tooth (2) divides it from the next (3); the alveolar part of the jaw is there broken, or seems so, if the fissure be not sutural. The outer side of the crown of the tooth (2) developes a low thick stumpy cone (*a*) : the inner side divides into two similar cones. The outer cone (*a*) is the largest, the antero-internal one (*b*) the smallest, but the difference is slight. Of the two inner cones or tubercles, one is rather in advance of the outer cone, the other is on the same transverse line therewith. The enamel forming the low apex of each cusp or cone is rugous; it is smooth and polished where it covers the outer bulging convex base of the crown. The rugosity is due to ridges converging toward the apex.

The next tooth (4) in close contiguity with the last is of similar size and shape; but the antero-internal cusp (*b*) is rather larger. In both teeth a low ridge passes from the back part of the base of the external cusp (*a*) to that of the post-internal cusp (*c*) connecting them. The succeeding tooth (*s*) seems not quite to have 'come into place.' The external cusp is below the level of that of the antecedent tooth, and so are the just visible apices of the two internal cusps; it evidently has a crown of like size and character with that of the foregoing teeth; but fracture interferes with a satisfactory appreciation of the modifications of this molar. The longitudinal rugosity of the enamelled summits and the shining smoothness of the outer convex base of the crown are repeated.

The last tooth in place (6) is a larger one with some modification of the crown. This is not longer, vertically, but is more extended from before backward, than in the preceding teeth. This extension is due to a ridge or talon continued from the hind basal half of the main outer cone; the summit of which, as well as those of the two inner cones, have suffered fracture. The basal part projects outwardly with a polished coat of enamel; but the bulge is less than that in the antecedent teeth; and, instead of being continued into one cusp, it divides, after inclining inward, into two smaller cusps, with the rugous enamel. The hind lobe of the tooth is less prominent externally than the front one, and terminates in a notched enamel border.

There seems to be a socket of a smaller molar behind the above-described tooth, and the zygomatic process of the maxillary indicates that socket to terminate the molar series.

A portion of the delicate bony palate extending from the inner side of the alveolar tract of the maxillary is exposed in the marly matrix.

On the hypothesis that the crack is a suture defining the premaxillary, the tooth (1) would be an incisor of a proportion reaching that in *Diprotodonts,* and the next single-rooted tooth (2) would be a smaller incisor.

It is remarkable that the only other specimen with teeth of the Bolodont type should also be maxillary. It is represented in Pl. III, fig. 6, nat. size; 6 A, B, magn. 4 diam. The specimen is a crushed portion of upper jaw with three teeth of the right and two of the left molar series. The latter includes the tooth corresponding to the foremost of the right side and one in advance; the right series, accordingly, has two teeth posterior in position to those shown on the left side. By the obliquity with which the posthumous crushing force has pressed upon the fossil, the left teeth show their outer side, the right teeth their inner side. The bony palate is entire between these right and left teeth, and shows its median suture.

In the oblique view of the two molars of the left maxillary (fig. 6 A), the outer side, which is chiefly seen, shows one chief cone, the summits of the two inner cones also coming into view; the three molars of the right maxillary (fig. 6 B) show more directly the two main cones of the inner side; the summit of the main outer cone also coming into view in the second of these teeth.

The main outer cone answers to that marked *a* in the molars numbered 3, 4 in fig. 5, A and B; the two main inner cones in fig. 6 B, answer to those marked *b* and *c* in figs. 5, A and B.

But the teeth in the present specimen show some minor features, not so recognisable in the preceding one.

The outer main cone (*a*) in the second left tooth developes from the hind part of its base a talon or thick ridge (*e*) which inclines obliquely inward, and joins the hind part of the base of the hinder inner cone (*c*). A less thick ridge extends from the fore part of the outer lobe (*a*) from its base half way or more to its summit, and bounds the fore part of the crown, being continued to the base of the front inner lobe (*b*); this anterior talon or ridge (*d*) is less developed in the anterior than in the posterior of the two molars of the left side; the hind ridge or talon is also less developed, and it is to the diminution of the accessory parts (*d* and *e*) that the smaller size of the anterior of the two left molars is chiefly due. The two best preserved molars of the right maxillary are more equal in size and similar in character; they show the convex bulge of the inner surface of the two main inner cones. The third molar, which may be the hindmost, is not sufficiently entire for useful description, but the indication of the division of the inner wall of the crown into the two main cones is unmistakable.

The same characteristic sculpturing of the enamel which was noted in the preceding specimen is conspicuous in the best preserved teeth of the present, viz. the vertically ridged summits of the chief cones, the ridges being comparatively thick, few, and converging toward the apex. The sides of the main cones turned toward each other are shorter and less vertical than those forming the outer and inner surfaces of the crown. The inner side of the outer cone extends a short way between the outer sides of the two inner cones.

Again and again have I gone over all the mandibular specimens and fragments of lower jaws in quest of teeth approximating sufficiently in character with the well-marked upper molars above described, but in vain. Had there occurred any Purbeck mandibular specimen allied to the Oolitic *Stereognathus*, it might have suggested a relationship to the maxillary evidences of *Bolodon crassidens*.

Incertæ sedis. Plate III, figs. 14, 14 A, 14 B, 16 A, 16 B, 20.

The subject of fig. 14, Pl. III, is a portion of a right mandibular ramus, with parts of two molars (*a*); with the intervening sockets of, seemingly, the last premolar and the first and second molars, and with a mutilated premolar in advance of that (*b*) in place.

The chief value of this specimen is its demonstration of a broad triturating surface, such as might be produced by attrition against upper molars of the breadth of those in the preceding specimen. But the antero-posterior length of the best preserved molar (*a*) in the present mandible forbids a reference to *Bolodon*. The last molar, or what seems to be such (*c*), is about one third the size of the antecedent tooth (*a*), with a low one-lobed crown, the enamel of which is feebly wrinkled on its outside near the grinding surface. It may answer to the small tubercular in *Thylacoleo* and *Plagiaulax*. The premolar (*b*) has a low but sharp-pointed chief cone, thick, convex externally in proportion to its height; the hind cusp is well developed. The state of this specimen forbids me to hazard a generic or specific name, and I cannot certainly refer it to any of the well-characterised species.

The subject of fig. 16, nat. size, 16 A, magn. 3 diam., Pl. III, is a considerable portion of a left mandibular ramus, apparently showing the contour of the lower half of the ascending branch, with a few fractured molars *in sitú*. The symphysial end is broken away.

Fig. 20, Pl. III, shows the impression, with two small portions, of the left mandibular ramus. The anterior (ib., A) part of the bone contains the canine, the crown of which is long, strong, subrecurved, and rather obtuse at the apex; it is supported on a root of twice the length of the crown, which seems to bifurcate at its implanted end. The impression on the matrix shows the fine ridge which was moulded on the usual longitudinal linear groove of the inner side of the ramus. The impressions of the same side of the molar teeth indicate a middle principal pointed conical lobe, and anterior and posterior smaller, but similar lobes. Of these impressions six may be counted, leaving space for premolars between them and the canine. The hind portion of preserved bone is from the lower part of the ascending ramus.

§ XIV. *Genus*—TRICONODON, *Owen*, 1860.[1]

In the typo-dentate section of polyprotodont Marsupials a generic form is as well marked in the Purbeck series as is that typified by *Phascolotherium* in the Lower Oolitic stage.

But at the Purbeck period the principle of differentiation manifests itself in the present genus by the abrupt assumption of the definite and well-marked triconodont character of the molars (Pl. III, fig. 7, *m* 1, 2, 3) as contrasted with the premolars; and the molars, as defined by shape, are three in number, a reduction rare in the Marsupial order, and unique in association with the four antecedent premolars as, similarly, defined by shape of crown.

Species 1.—TRICONODON MORDAX, *Owen*.[2] Plate III, figs. 7, 7 A.

Pl. III, fig. 7, represents of the nat. size, and fig. 7 A, magn. 2 diam., the original specimen on which was founded the present genus and species.

The generic name relates to the form of the crown in the three last teeth (*m* 1, 2, 3), which is subcompressed, antero-posteriorly extended, and divided into three nearly equal cones in the same longitudinal line, the mid cone being very little larger or longer than the front and hind cones; there is no cingulum on the outer side of the crown, but I may add

[1] τρεῖς, three; κῶνος, cone; ὀδοὺς, tooth.

[2] 'Enc. Brit.,' vol. xvii, 1859, Art. "Palæontology," p. 161, fig. 86; 'Palæontology,' 8vo, 1860, p. 318, fig. 91.

to the original description that at the posterior margin of the posterior cone a rudimental talon is feebly marked off by a short vertical indent from the rest of the outer surface of that cone.

The first of these teeth (fig. 7 A, *m* 1) is very little less than the others; the fore ridge of the base of the coronoid (*c*) screens part of the last cone of the third molar (*m* 3) from view.

The last premolar (*p* 4) seems to have slipped some way from its socket, exposing its two roots, and bringing the base of its crown on a level with the apices of the cones of the succeeding molars. The crown of *p* 4 has a principal subcompressed cone, with a small and low anterior basal cusp, and a larger and higher posterior one. The two divisions of the socket of the premolar in advance (*p* 3) indicate a tooth of rather inferior size. The next premolar (*p* 2) is much less, but of like character; the main cone, however, is much reduced in proportion to the basal cusps. The indications of teeth anterior to *p* 2 are obscure; they show, however, the socket of a minute two-rooted anterior premolar (*p* 1), the apex of an emerging crown of a canine (*c*), and one, or perhaps two, of the sockets of the small incisors.

An outlet of the dental canal opens beneath the socket of *p* 1, midway between the upper and lower borders of that part of the jaw.

The symphysis rises rather abruptly from the lower border, sloping at an open angle therewith, more resembling that part in *Sarcophilus* than in *Thylacinus*, where it tapers forward more gradually.

The lower border of the ramus is nearly straight, very feebly wavy, from the convexity below the molars, which is repeated rather less feebly below the crotaphyte depression: it is obtuse, rounded, losing thickness as it recedes to beneath the rising branch. The crotaphyte depression is there bounded by a low ridge (*a'*), extending backward to the outer and under side of the condyle (*b*), as in *Thylacinus*, only more depressed, so as to cause the slight convexity of that part of the lower contour of the jaw. In advance of the crotaphyte depression a more shallow longitudinal one extends some way forward, just above the rounded lower border of the ramus.

The condyle (*b*) is large, convex both transversely and vertically, most extended in the latter direction; it projects from a level a little below the outlets of the alveoli. The notch between it and the coronoid process gives the condyle a subpedunculate character (this is better marked in the larger species of *Triconodon*). So much of the coronoid process as remains does not extend back so far as the hind part of the condyle, but the process might have done so when the apex was entire.

From the relation of the last molar (*m* 3) to the fore margin of the coronoid, and the degree of protrusion of the crown of the canine, this specimen may be concluded to have come from an individual not quite fully grown.

I am led to the same inference by the appearance of the less complete specimen figured, of the natural size, in Pl. III, fig. 8. This also consists of a left mandibular ramus with the outer side exposed, but wanting the hind half of the ascending branch and the fore part, if not the whole, of the symphysis. It shows well the three triconodont molars and the sockets of the anterior teeth as far as that of the first premolar. Beneath it is a 'foramen mentale,' and behind, under the second premolar, is another outlet of the dental canal; the inlet of this may be seen at the hind fractured part of the jaw. The anterior boundary of the outer crotaphyte depression is well marked; it is angular anteriorly, the corner just rounded off; the lower horizontal boundary projects as it recedes, recalling a character of the mandible of *Thylacinus.* The outer plate of the ramus falls sheer from the alveoli, not swelling out first, as the inner plate does. Two thirds down, the outer plate begins to swell out and curve to form the thick convex lower border of the ramus.

The bone is marked by fine longitudinal striæ. There is no trace of the longitudinal depression shown in fig. 7. The three molars occupy an alveolar tract slightly exceeding that in the type-specimen. Like it, I suspect the present jaw may have come from an animal not fully adult.

In the magnified view (3 diam.) of the crown of *m* 2 (fig. 8 A) the vertical indent is shown at the hind border of the hind cone, and a minute notch and prominence appears at the fore part of the base of the front cone, which the specimen (fig. 9 A) shows to be due to the beginning of the inner 'cingulum.'

Triconodon mordax (?). Plate III, figs. 9, 9 A, 10, 10 A.

The specimen, Pl. III, fig. 9, nat. size, 9 A, second molar, magn. 4 diam., is a part of a right mandibular ramus, with the three molars and the sockets of the four premolars, showing the inner surface. In exposing the triconodont molars the fore part of the first (*m* 1) flew off, leaving, however, a distinct impression of its two anterior cones.

The cingulum traversing the base of the inner side of the crown of *m* 2, and turning up to the fore margin of the first cone and the hind margin of the last, is here instructively displayed (fig. 9 A), as is also the continuation of the cingulum into a small hind basal cusp of the last molar (*m* 3). The cingulum thus limited to the inner side of the lower molars is here minutely tuberculate. The crown of the second premolar (*p* 2) shows a main median cone with the apex slightly recurved, and a fore and hind basal cusp, the latter being the larger.

The symphysis begins behind at the vertical line dropped from the interspace between the first and second premolars. The inner part of the lower border of the ramus is produced to form the lower boundary of the longitudinal groove extending forward from near the entry of the dental canal.

In size, especially in the extent of the three molars, this specimen shows a slight inferiority as compared with the type-jaw (Pl. III, fig. 7) and the subject of fig. 8. But both this difference of size and some slight modification of the shape of the cones, as viewed from the inner side (fig. 9 A) and outer side (fig. 9 A), may well come within the sexual and other variations of a species. The limitation of the cingulum to the inner surface of the base of the molars is generic. In subsequent specimens I shall show the reverse position of it in the upper molars of *Triconodon.*

The next specimen (Pl. III, fig. 10, nat. size, and 10 A, teeth, magn. 3 diam.) yields confirmatory evidence of the characters of *p* 4 and *m* 1, as shown in the type-specimen (fig. 7). It consists of a right mandibular ramus, with the outer side exposed, wanting part of the ascending branch, of which the form is indicated by a smooth impression on the matrix.

The alveolar tract includes the last premolar (*p* 4) and first true molar (*m* 1), *in sitû;* it shows the empty sockets of the second and third molars, and of a third and second premolar, each of which is two-rooted. The socket of the first premolar retains the base of the crown of that tooth (*p* 1); it is preceded by a larger socket of a single-rooted canine, and by the sockets of three small incisors.

The fore part of the depression for the insertion of the crotaphyte muscle is shown on the part of the ascending ramus preserved. The impression on the matrix shows that the angle of the jaw was inflected, in a way and degree from which may be inferred the marsupial nature of the species.

The true molar (fig. 10 A, *m* 1) consists of three principal lobes and a small posterior talon. Each lobe is a subcompressed sharp-pointed cusp; the mid one rather the largest and highest, but the apices of the three rise nearly to the same level. The 'talon' is also pointed, and ends about half way up the third lobe. The fore-and-aft extent of this tooth much exceeds either its height or breadth, the latter being the least dimension. No cingulum appears on the side of the tooth exposed. The crown is implanted by two roots.

The crown of the last premolar has one conical, subcompressed, pointed lobe, with a minute basal cusp in front and a larger one behind; the fore-and-aft extent of this premolar is nearly equal that of the succeeding three-coned molar. It is implanted by two roots. The size of the first premolar (*p* 1), as indicated by its base, is less than half that of the last (*p* 4). The canine must have had an antero-posterior breadth of base nearly equal to that of the last premolar. The incisors were the least of all the teeth. There was no break, or 'diastema,' in the dental series.

Along the outer side of the ramus near its lower border runs a linear fissure, but this may be accidental; above the back part of this fissure appears a shallow longitudinal depression, as in the type-jaw (fig. 7).

As compared with *Phascolotherium*[1] from Stonesfield Oolite, with the same dental

[1] 'History of British Fossil Mammals,' 8vo, 1846, p. 61, fig. 20.

formula, *Triconodon* differs in the close and unbroken array of the several teeth in the same ramus. The mandible is shorter in proportion to its depth; it maintains this depth more equably from the ascending ramus to the symphysis: the anterior contour bends up abruptly from the lower one, instead of the gradual rise and continuation forward to the end of the symphysis, as in all the known Stonesfield Mammals,[1] and as in the existing *Myrmecobius* (Pl. I, fig. 24).[2]

The chief value of the specimen (Pl. III, fig. 10, nat. size) lies in the repetition of the characters of the symphysial angle, and the almost straight course, or feeble undulation, of the lower border of the mandibular ramus, as in that of the type-jaw (fig. 7) of *Triconodon mordax*.

Triconodon (?). Plate III, figs. 15, 16, 20.

The subject of fig. 15, Pl. III, is part of a right mandibular ramus of a young Mammal allied to and perhaps of the genus last described. The main cone of a premolar (*p*) is rising into place. The tooth marked *m* 1, but which might be the last of the premolar series, has a low main cone, boldly convex externally, with a low anterior basal cusp, and a large posteriorly produced hind cusp, making the fore-and-aft length of the crown exceed its height. The foremost compressed cone of the succeeding molar and part of the succeeding cone of the same tooth are preserved. Near the fractured fore end of the ramus two or three outlets of the dental canal are discernible.

The inferiority of size, as compared with fig. 9 or with the type of *Triconodon mordax* (fig. 7), seems to be more than individual immaturity would account for, and I hesitate either to affirm or deny its specific identity.

The more mutilated ramus (Pl. III, fig. 16), of the same size as the preceding, and with a like straight contour of the lower border of the jaw, is figured and here noted with the view chiefly of calling attention to similar better preserved specimens, in the event of such being obtained, capable of throwing light upon the true nature of the subjects of figs. 15 and 16.

Fig. 20 is chiefly an impression of a similar sized ramus, with a well-preserved canine and impressions, which at the hind part of the molar series recall a Triconodont character.

Triconodon (?). Plate IV, figs. 5, 5 A.

The subject of Pl. IV, fig. 5, *a* and *b*, nat. size, and 5 A, magn. 3 diam., is a portion of a right maxillary bone, with the antepenultimate and penultimate molars, and

[1] Ib., figs. 15, 17, 19.
[2] Ib., fig. 18.

the socket of the last molar. A portion of the bony palate and the beginning of the zygomatic or malar process of the maxillary are preserved; the outer side is exposed.

The molars in place are worn down nearly to the cingulum, which extends along the outer side of the base of the crown; its division into the three compressed lobes is just traceable; the grooves on the inner side of the crown indicate the action of the lobes of the lower molars. In size the molars in the present specimen are rather less than those of the smaller sized example of *Triconodon mordax* (Pl. III, fig. 9).

TRICONODON, *sp. ind.* Plate IV, figs. 6, 6 A.

The subject of Pl. IV, fig. 6, nat. size, with the three molars magnified 3 diam. at A, is part of a right mandibular ramus, with the three molars and sockets of the premolars. The lower portion of the ramus, as well as the fore and hind ends, are mutilated, and the specimen is chiefly valuable as showing the characters of the inner side of the true molars.

There is a progressive increase in antero-posterior extent from the first (*m* 1) to the third (*m* 3) molars; the cones show an inclination backward, not observable in Pl. III, figs. 7, 8, and 9. Moreover, the cingulum is not tuberculate or crenate, as in Pl. III, figs. 9 and 11, and it extends into and developes a larger posterior basal prominence or talon in each molar.

The correspondence in general size or extent of the series of three molars is very close between the present specimens (Pl. IV, fig. 6) and the subject of Pl. III, fig. 9. But the above-defined differences in form and proportions lead me strongly to incline to see in the specimen here described the indication of a distinct species of *Triconodon.*

TRICONODON, *sp. ind.* Plate III, fig. 21.

The subject of Pl. III, fig. 21, is the fore part of a right mandibular ramus, with the first and fourth premolars, part of the first true molar, and the crushed socket of a canine, nat. size. The molar (*m* 1) has a compressed antero-posteriorly extended crown of the triconodont type, but with the mid cone only entire; the front one, as in fig. 12, was obviously lower, the hind one more nearly equal to the mid one. The last premolar consists of a main cone with a fore and hind basal talon, the apex of the cone rising higher than that of the mid cone of the contiguous molar. The small anterior premolar (*p* 1) is too mutilated for characterising. All the premolars and the molar were inserted, each by two fangs.

The teeth agree in size with those in *Triconodon ferox* (figs. 12 and 13). The ramus of the jaw beneath the first and second premolar is less deep and more convex externally than in that species. There are two anterior outlets of the dental canal, one beneath *p* 1, the other beneath the socket of *p* 2. The outer alveolar wall descends at once from the sockets to the outward swelling of the ramus, two thirds down toward the thick rounded lower border of this part of the mandible. The angle at which the symphysial end seems to rise from the lower border resembles that in *Triconodon mordax.*

The subject of Pl. IV, fig. 4, nat. size, is a portion of a left mandibular ramus, with the inner surface exposed, showing the symphysis and the broken bases of the third or fourth premolars. The faint linear groove along the inner part of the thick under border of the ramus does not answer to that called 'mylohyoid' in fig. 11, Pl. III; it may be a trace of the line of confluence of the osseous encasing of the primitive mandibular cartilage. But the mammalian unity of the bone is well exemplified in this portion of jaw.

The extent, shape, and the angle of the long axis of the symphysial surface with that of the horizontal ramus, are the same as in *Triconodon mordax* (Pl. III, figs. 7 and 10).

Species 2.—Triconodon ferox, *Ow.* Plate III, figs. 11, 12, 13, 17, 18, 19. Plate IV, fig. 1.

The size of the specimen about to be described might be deemed to represent that of the jaw of a full-grown *Triconodon mordax,* admitting the evidence of immaturity shown by the type-specimen (fig. 7). But although the jaw-bone would grow and bring into view the three main cones and hinder talon of the last molar clear of the coronoid process, yet the crowns of the teeth, once completed, do not grow. Now, the extent of the three molars *in sitú* in the subject of Pl. III, fig. 11, nat. size, exceeds that of the same teeth in fig. 7 by two millimeters or one line. The extent of the whole molary series in *Triconodon mordax* is nine lines, in the present jaw it is ten and a half lines.

Does this indicate a mere sexual superiority of size?

It is certain that the molars of the female *Thylacinus* are smaller than those of the male, concomitantly with her general inferiority of size. I should be unwilling, seeing the general conformity of the dentition in the present and preceding specimens, to refer the subject of fig. 11 to a distinct species, believing rather that it might represent a male of *Triconodon mordax,* were it not for the difference in the shape of the mandibular ramus itself, to which I shall next ask attention, the present specimen agreeing more closely in this respect with *Phascolotherium* than with *Triconodon mordax.*

There is, however, an important character in which the agreement with the smaller species of *Triconodon* is closer, and which may be a generic feature.

Among existing mammals with a dentition for animal food certain marsupials, *e. g. Thylacinus, Sarcophilus,* have the articular condyle of the mandible on as low a level as the alveolar tract. This character is repeated in the *Phascolotherium* of the Stonesfield

Oolite.[1] But in the present jaw, as in the type-specimen, the condyle projects backward below the level of the alveolar apertures, and the lower border of the ascending ramus, which it terminates behind, does not curve up to the condyle so much as in *Phascolotherium.*

It represents, in position, the angle of the jaw; but on the inner side, in the present specimen, is a fractured surface (fig. 11 B, *a*), indicative of a part projecting inward, and which would be the true homologue of the inflected angle of the Marsupial jaw. The articular surface of so much of the condyle as is preserved is smoothly convex, both transversely and vertically.

A deep notch, rounded at the bottom, but narrower than in *Phascolotherium,* and also narrower and deeper than in figs. 7 and 10, divides the condyle from the large, lofty, and antero-posteriorly broad, coronoid plate. The depth of the notch gives a pedunculate character to the low-placed condyle in a greater degree than in *Triconodon mordax.*

The exposed (inner) surface of the coronoid (*e*) is flat, with a shallow depression at its fore and inner part, where it passes into the horizontal ramus. Below this depression is the narrow canal, leading from a few lines in advance of the peduncle of the condyle, and sinking, as the 'dental canal,' into the substance of the ramus at a vertical line dropped from a little behind the last molar tooth.

A very feeble and rather broad longitudinal impression (*g*) is continued from the entry of the dental canal forward along the inner side of the ramus, as far as below the last premolar. This condition of the mylohyoid groove repeats that in *Myrmecobius.* The lower border of the ramus describes one uninterrupted gentle curve, convex downward from the condyle to the fore end, as in *Phascolotherium.* The symphysis follows, with a low slope upward and forward, carrying on and terminating the fore part of the curve. This is markedly different from the contour of the symphysial or fore part of the mandible in the two specimens of *Triconodon mordax,* in which that part of the jaw is preserved (figs. 7 and 10).

The inner alveolar plate projects a little from the sockets before sinking into the inner surface of the ramus. The whole molar series, four premolars, and three true molars are in place, with the base of the canine.

The shape of the jaw, with the same extent of the three molars, in the subject of Pl. III, fig. 12, nat. size, leads me to refer it to the same species (*Triconodon ferox*), as fig. 11. It consists of a left mandibular ramus, inner side exposed, with the ascending branch in part shown by an impression, and with the symphysial end crushed and mutilated.

The portion of the bone preserved contains the last three molars, with the fore ends of the upper and lower ridges of the coronoid or those bounding the pterygoid depression.

The first molar is rather smaller than the second, and its mid cusp, being entire, shows

[1] Pl. I, fig. 26; and 'Brit. Fossil Mammals,' p. 61, fig. 20, *a*.

it to rise a little higher than the first and third cusp of the same tooth. In the second molar the apex of the mid cusp is broken off, and in the third molar both this and the hind cusp are wanting. Some traces of sockets are visible anterior to the molar series.

The impression of the angle and lower margin of the ascending ramus shows them to have been slightly inflected. The ramus has a slight general curve, convex downward, from the hind to the fore part, as in the type *Triconodon ferox*. The lower border of the mandible is moderately thick and rounded.

The subject of Pl. III, fig. 13, nat. size, is the hinder half of a left mandibular ramus, outer side exposed, with the three molars and last premolar.

The coronoid process is preserved. In its height, breadth, and backward curve it resembles that in *Phascolotherium*, which is like that in most zoophagous Marsupials. Unfortunately the lower border of the ascending ramus with the angle is broken off. The transverse rounding of the thick lower border of the preserved part of the horizontal ramus is rather oblique, descending from the outer toward the inner surface.

In this portion of jaw the mid cusp is entire in the third molar, showing the three cusps to be of equal height. The last premolar (*p* 4) is represented by its main cone and small hind basal cusp; the front one, probably present in the entire tooth, has been broken off. The cone, which constitutes the chief part of the crown of the premolar, is subcompressed, pointed, rising higher than the level of the summits of the cones of the succeeding molars. A fine groove indents the outer side close to the front border of the cone. The first molar, mutilated in the present specimen, shows the same degree of inferiority to the second molar as in the right ramus (fig. 11), where it is entire.

Although the depth of the ramus below the last molar is markedly greater than in fig. 11, the three molars are not larger nor do they occupy a greater longitudinal extent. I conclude, therefore, that the subjects of figs. 12 and 13 exemplify a larger and stronger individual of *Triconodon ferox*.

The fragment of the right mandibular ramus (Pl. III, fig. 19), with the last molar and a portion of the penultimate molar *in sitû*, shows well some of the characters of the outer surface of the last molar in *Triconodon ferox*.

The hind lobe of *m* 3 (fig. 19 A) has a shallow oblique depression, marking off a low basal talon. The outer and fore part of the base of the front lobe is similarly marked by an oblique cleft defining a low cingulum, beginning at the fore part of that lobe. Its non-extension along the base of the tooth to the hind talon shows the aspect presented to be the outer one.

There is a slight vertical notch at the hind part of the last cone of the penultimate molar (*m* 2), marking off a better developed basal talon than in *m* 3. This talon or ridge terminates posteriorly the inner basal cingulum.

The lobes or cones of the homologous teeth are higher and sharper than in *Triconodon* *mordax*. In size this third molar somewhat exceeds that in the last-described specimen of *Triconodon ferox*, but not so much as to justify a reference to a distinct species.

The following exemplifications of the generic characters of upper or maxillary teeth of *Triconodon* seem, from their size, to have been afforded by *Tr. ferox* rather than by *Tr. mordax*.

The subject of Pl. III, fig. 18, nat. size, fig. 18 A, magn. 3 diam., and B working surface of teeth, magn. 3 diam., is a portion of a left maxilla, with the last two premolars and the first two molars.

The molars show much wear. A cingulum extends along the outer side of the base of each; it is impressed by many small vertical grooves or notches, and is thickest as it curves toward the summit of the anterior and the posterior lobes at the two ends of the tooth. The three lobes incline inward toward their summits; but these have been much worn down. The posterior fang of the second molar (*m* 2) is exposed at the hinder fracture. The main cone of the last premolar (*p* 4) has its apex worn away, not broken off; but this extends beyond the level of the working surface of *m* 1 and *m* 2. There is a hind basal cusp, as well as a basal ridge, or 'cingulum' which ends behind in a slight projection beyond the 'talon' of *p* 4. The penultimate premolar (*p* 3) has a slightly retroverted main cone with a front and hind basal talon, the latter being most prominent. The alveolus and two roots of the second premolar (*p* 2) are included in this fragment of upper jaw, showing a decrease of size corresponding to that of the homotypal teeth of the mandible.

A portion of the bony palate is preserved (*a*, fig. 18), extending inward from the alveoli of *p* 1, *p* 2: this thin, inferiorly concave, bony plate is entire to its fractured margin. There is a depression or smooth groove (*o*) in the maxillary bone, a short way above the sockets of *p* 2; it may indicate the position of an antorbital canal outlet.

In Pl. III, fig. 17 represents of the nat. size, and fig. 17 A magn. 3 diam., a portion of a right maxilla, with the last two premolars, the first molar and the fore part of the second molar, *in sitú*, the inner side being exposed with a contiguous portion of the bony palate. The teeth agree in size with those in the maxillary specimen of the opposite side last described.

The penultimate premolar (*p* 3), in like manner, shows a chief cone, with an anterior and a posterior basal cup, each of the latter being girt by a ridge which almost subsides at the prominent mid-part of the main cone; the hind basal cusp is the largest. The last premolar (*p* 4), with increase of size shows plainly the continuation of the cingulum, with a tubercular character, from below the fore and hind talons, across the base of the main cone, with a narrow median interruption, where the main cone seems to be longitudinally impressed. The posterior basal cusp is relatively larger than in *p* 3. The apex of the main cone extends beyond the summit of the contiguous molar cones. In the anterior molar the foremost of the three cones or divisions of the crown is less than either of the other two cones. The cingulum is more interrupted and more feebly developed than in *p* 4, or than along the outer side of the crown of *m* 1 (see fig. 18 B, *m* 1); it crosses obliquely the fore part of the front cone; it also appears on part of the base of the mid cone, and on the fore part of that of the hind cone, but feebly. The cones are low, and worn; the transverse breadth of these upper molars is greater than in their lower homotypes, yet the characteristic extension of the tooth in the antero-posterior direction concurs, with the trifid crown, in proclaiming the genus to which the present and preceding portions of upper jaw are referable.

The tendency to turn, as it were, the outer side of the upper molars to the inner side in the lower molars is exemplified in the partial development of the cingulum, as shown in fig. 17A compared with its integrity in fig. 18 B.

Confirmation of the ascription of fig. 17 to *Triconodon ferox* is afforded by the subjects of figures 1, 1A, B, C, Pl. IV. Figure 1 gives the natural size of portions of an upper maxillary of a right mandibular ramus (fig. 1 B, magn. 2 diam.), with the inner surface exposed, and a similar anterior portion of the left mandibular ramus (fig. 1 C, magn. 2 diam.), with the outer side exposed, of the same skull.

A portion of the bony palate projecting from the matrix is crushed down below its level, so as to obscure the inner surface of some of the teeth. The crown of the molar (fig. 1 A, magn. 4 times) shows the thickness of the cingulum traversing the outer side of its base, characteristic of the upper molars of *Triconodon*. A more interrupted growth of 'cingulum' on the inner side increases the transverse basal breadth. The inferior height of the anterior cone indicates this to be the first molar (*m* 1). Of the premolars two are preserved, showing a principal cone, a hind smaller one, and the additional basal cusp due to the further extension backwards of the cingulum, as in *p* 4, fig. 17, Pl. III.

The portion of right mandibular ramus, in contact with its maxilla (Pl. IV, fig. 1 B), is mainly instructive in showing a second incisor (*i* 2) in place; it is the tooth in advance of that shown in fig. 7, Pl. III; it is smaller in size but similar in shape to the third incisor (*i* 3).

The canine (*c*) has the usual laniary shape, slightly recurved; the apex is wanting, it appears to be worn down; there is a longitudinal basal indent at the inner side of the crown here exposed. The first premolar and its socket are crushed out of view; the crown of the second premolar (*p* 2) is in place, showing the chief cone with a short subvertical fore margin, a long sloping hind margin, provided with a basal cusp, which extends the cingulum. The latter feature is more strongly marked along the inner side of the base of the third premolar (*p* 3); its fore end, as it circumscribes that part of the base of the main cone, simulates a small basal talon; the hind end similarly projects beyond the true basal cusp or talon at that part of the main cone. The two-chambered alveolus of the last premolar indicates the usual progressive increase of size. Part of a similar socket, with the hind root and portion of the crown of the first molar (*m* 1), is definable; it is followed by the first and second cones of *m* 2. The basal cingulum is shown in both teeth.

In the fore part of the left ramus, showing the outer surface (Pl. IV, fig. 1 C), the characters of that side of the crown of the canine are seen; it is more convex than the inner side, and has not the longitudinal basal depression. The anterior outlet of the dental canal is beneath the alveolus of the first premolar. Part of the crown of the second (*p* 2) is preserved. The third (*p*) shows the height of the main cone, which wants the apex and the right ramus. The last premolar and the first true molar (*m* 1) are represented by the basal parts of the crown. The interruption or partial development of the cingulum is here noticeable. The mandibular rami in the present specimen show the convex lower outline and the gradual curve upward to the incisive alveoli, which appears to be characteristic of *Triconodon ferox*, or at least to differentiate it from *Triconodon mordax*.

Species 3.—TRICONODON OCCISOR. Plate IV, figs. 2, 2 A, 2 B.

I next enter upon the description of the partially dislocated rami of the same mandible (Pl. IV, fig. 2, nat. size; A and B, teeth magn. 2 diam.), showing the formal characters of the mandible in *Triconodon mordax*, but belonging to an animal too superior in size to be referable to that species; from which also the present more decidedly and instructively differs in a minor relative size of the first molar (*m* 1) as compared with the other two molars.

At first sight the left ramus (fig. 2, *l*) seems identical, answering as it does, in both size and shape, with the type of the genus (fig. 7, Pl. III). But if the first two molars be compared in the two specimens, those of the present show a marked increase of antero-posterior extent, notwithstanding the smaller proportion of *m* 1 to *m* 2. This differential character comes out well in the figures of each mandible which are magnified in the same degree in Pl. IV, fig. 2 B, and Pl. III, fig. 7 A respectively. Furthermore, although some signs of immaturity are recognisable in the type of *Triconodon mordax*, the mandible, here compared, of *Triconodon occisor* is of a still younger individual; only half of the last molar (*m* 3) has advanced into view beyond the base of the coronoid, and not more than two thirds of the crown of the canine (*c*) and of that of the last premolar (*p* 4) have risen above the socket.

The fully grown animal of the present species would equal in size that of *Triconodon ferox*, but the shape of the mandible and the proportions of the molars forbid a reference of the present specimen to that species.

I cannot, with a recognition of the above defined characters, withdraw from the undesirable duty of signifying them by adding another specific name to the present well-marked genus.

I give my original notes on the type specimen of *Tr. occisor.*

"Both rami, somewhat mutilated, of the same mandible, the left (*l*) showing the outer side, the right (*r*) (good for molars) the inner side; and the latter more complete, having a fore-and-aft extent of coronoid process preserved for nine lines behind the last molar. Part of the inflected ridge or angle (*a*) is shown. In advance and above this is the entry of the dental canal (*d*), the condyle itself is broken away. The longitudinal linear groove is seen to terminate near the symphysis. The thicker inner alveolar plate is here well contrasted with the thinner outer wall of the sockets in *l*. The minutely tubercular ridge along the base of the inner side of the crown is well shown in the first molar" (*m* 1, fig. 2 B); "also the vertical groove close to the anterior border of each cone (most clearly shown in the first and second cones). The hind basal notch or talon comes well out on the outer side of the left *m* 1 and *m* 2" (fig. 2 A, Pl. IV).

"The last molar is not quite in place, its hindmost cone has not emerged or come forward from its alveolus, where it is exposed in the right ramus" (fig. 2, *r*, and 2 B, *m* 3). "The last premolar" (*p* 4, fig. 2 A) "has not risen into place; its apex is on a level with the base of the first cone of *m* 1. The third premolar" (*p* 3, fig. 2 B) "is in place in the right ramus, and shows the basal ridge along its inner side, together with the large posterior talon; the anterior talon is feebly indicated.

"Both anterior and posterior talons are more conspicuous and more equal in the second premolar" (fig. 2 B, *p* 2), "which is much smaller than the third, chiefly through the minor development of the main cone, which is less acute than that of *p* 3. The first premolar (*p* 1) has a still smaller main cone with an anterior and a posterior cusp. The premolars, like the molars, are inserted each by two roots."

So much of the crown of the canine as has risen into place shows a less recurved shape than in *Triconodon ferox.* The anterior border of the jaw rises at an open angle with the lower one to the incisive alveoli, as in *Triconodon mordax.* It does not ascend or curve gradually up as in *Triconodon ferox.*

Species 4.—Triconodon major, *Ow.* Plate IV, fig. 3.

In a block of stone, from the part of the Middle Purbeck marked 'Feather,' in fig. 4, p. 22, the stone being similar in character with that containing the Swanage Crocodile (*Goniopholis*), Turtles (*Pleurosternon*, &c.) and Fish (*Microdus*, &c.), and which the masons were sawing up, their attention was caught by the appearance of a fossil in the line of section. The process was stopped, and the portion of stone with the fossil cut out. It was purchased for the British Museum, and, after careful development of the fossil, the part of a right mandibular ramus was exposed, which is represented, of the natural size, in Pl. IV, figure 3.

The preserved molar (*m* 2) is of the Triconodont type; but the size of the specimen is fully one third larger than the largest of the previously described species of *Triconodon*. The animal to which it belonged would probably be of the size of the 'Native Cat' of Australia (*Dasyurus Maugei*, Geoffroy). I estimate the length of the lower jaw of *Triconodon major*, when entire, according to the analogy of *Triconodon ferox* (Pl. III, figs. 7 and 8), to have been two inches and a half, and the jaw attains that length in the male of the spotted species of Dasyure above cited.

The tooth preserved, which lacks only the apex of the anterior cone, answers to the second of the three molars in *Tr. ferox* (Pl. III, fig. 12). It shows the usual absence of continuous cingulum along the outer side of the base of the crown. There is no trace of anterior or posterior talon. The coronal clefts seem to be rather less deep than in the smaller species. The socket and remnant of the first molar shows it to have been, as in *Tr. ferox*, smaller in proportion to the second molar than it is in *Tr. mordax*. The last premolar (*p* 4) shows the same relative antero-posterior extent of crown as in the smaller species: the two fangs supporting the base of the crown are partially exposed, but the rest of the tooth is broken off. The socket for the two fangs of the penultimate premolar (*p* 3) is preserved, anterior to which the jaw is broken off, exposing the anterior root of that tooth and the cavity of the ramus (fig. 3 *a*).

The two-celled socket of the molar following the one in place indicates a tooth of equal size; and the position of the outer buttress-like beginning of the fore part of the coronoid process shows *m* 3 to have been the last. The stone-saw has removed an extent of two lines between the beginning of the coronoid and the rest of the rising branch. This gives a basal fore-and-aft breadth of the coronoid of eight lines; the apex or upper half of the process is wanting. A similar notch between the hind border of the process and the condyle, as in Pl. III, figs. 6 and 10, gives the same pedunculate character to the upper part of the condyle; the joint projects at a lower level than the alveolar outlets. From its lower end a ridge (*a*) projects outward, but in a less degree than in *Dasyurus*, defining below the crotaphyte fossa.

The fractured fore part of the jaw exposes the anterior cell or division of the socket of the third premolar, filled with matrix, and the cavity of the ramus itself similarly occupied. The bone has suffered a longitudinal fracture towards its hind part.

§ XV. *Genus*—Triacanthodon,[1] *Owen.*

Species 1.—Triacanthodon serrula,[2] *Ow.* Plate IV, figs. 7, 7 A, 8, 8 A.

This genus and species are exemplified in two slabs, counterparts of the same split block of Purbeck Shale, with the left mandibular ramus of a young individual.

One portion or slab (Pl. IV, fig. 7, nat. size, and 7A, magn. 2 diam.) includes the ascending ramus, the last molar tooth in its formative cell, and an impression of the rest of the bone and teeth; the other portion (fig. 8, nat. size, and 8A, magn. 2 diam.) includes the part of the ramus and teeth anterior to the penultimate molar, and the impression of the hinder part of the jaw with those of the last two molars. The portion of the ramus including the penultimate molar, which intervened between the fractures in figs. 7 and 8, had been lost before the specimen came into my hands; it is well represented, however, by the impressions of its outer and inner surfaces in the counterpart slabs.

The fore part of the ramus in fig. 8 shows the outer surface, the hind part in the opposite slab (fig. 7) shows the inner surface, of the mandible.

In the fore part of the jaw the outer incisor (fig. 8A, *i* 3) is preserved; it is small, conical, thick, outwardly convex, with a sub-obtuse apex; there is a feeble indication of two shallow longitudinal linear impressions bounding a middle tract of the outer convexity, near the base of the crown. The canine (ib. *c*) is long, large in proportion to the incisor, strong, sub-recurved, sharp-pointed, with a longitudinal indent near the basal part of the outer side of the crown, indicative of a tendency to division of the implanted root. The canine follows the incisor without any diastema. The concave line of the hind border of the crown is arrested three fourths of the way toward the base by a slight hinder projection—a *quasi* feeble 'talon.'

A very short interval divides the canine from the first premolar (*p* 1). This is small, two-rooted, sub-compressed, with a hind cusp almost equalling the main cone, and with a small anterior basal cusp; the whole crown is low in proportion to its fore-and-aft extent.

The second premolar (*p* 2), similar in form to, but somewhat larger than, the first, has a more elevated main or mid cone; the front cusp or talon is rather more developed than in *p* 1.

The third premolar (*p* 3) shows a markedly larger size, especially in the relative height and breadth of the main cone. The anterior basal cusp is low; the posterior cusp

[1] τρεῖς, three; ἄκανθα, spine; ὀδοὺς, tooth.

[2] *Serrula*, little saw, suggested by the row of denticles formed by the five three-spined teeth.

is higher, and it is followed by a minute basal 'talon,' probably the termination of an internal 'cingulum.'

This tooth is followed by *p* 4 or *d* 4, approaching the Triconodont or true molar type; but with the basal cusps, especially the front ones, better developed than in any of the succeeding true molars. The mid cone is also relatively higher in proportion to the first and third cones; but the whole crown is lower in proportion to its fore-and-aft extent than in the succeeding molars. The apex of the mid cone reaches only to half the height of the main cone of the antecedent premolars. The crown is entire; no main cone is worn or broken away. If it be the homologue of *p* 4 in *Triconodon* it shows widely different proportions and form. The superiority of the middle to the fore and hind cusps favours its reference to the premolar series; unless, indeed, it may belong to the deciduous series; the symbol of *d* 4, in fig. 8A, is to be taken suggestively in reference to the alternative above proposed. I have not felt justified to hazard this unique and brittle evidence by burrowing after a possible hidden germ of a successional tooth. Behind *p* 4 or *d* 4 is a tooth (*m* 1) of the more usual Triconodont or Triacanthodont type, the anterior and posterior cones, especially the latter, rising more nearly to equality with the mid cone: there is neither fore nor hind talon. The crown of this tooth stands at a higher level than that of the preceding, but rises not quite to a level with the apex of *p* 3.

The next tooth (*m* 2), of the same type as *m* 1, slightly exceeds it in size; it is equally devoid of trace of 'cingulum' on the outer side here exposed. A minute tubercular prominence at the fore part of the base may be the anterior end of an inner 'cingulum:' there is no trace of hinder talon. The next two molars (*m* 3, *m* 4) are indicated by impressions of their crowns in the present slab, that of the hindmost (*m* 4) being wholly within the impression of the coronoid process. It is preserved in the opposite slab, with that process (fig. 7 A, *m* 4). The penultimate molar, with the supporting part of the jaw, as before stated, has been lost.

Before quitting the survey of the slab (fig. 8), I may note that the outer wall of the socket of the canine is prominent, and that in the depression between it and the less prominent alveolus of the succeeding premolar the foremost and largest of three outlets of the dental canal opens. These three foramina are in the same longitudinal line, midway between the upper and lower borders of the ramus, pretty closely following each other. The outer surface of the bone is finely punctate and longitudinally striate. The outer alveolar border is serrate through the low angular processes rising into the intervals of the teeth and their fangs; the wall sinks at once from the alveolar outlets a short way, then slightly swells outward before inbending to the thick lower border of the ramus, making the lower half convex vertically. The symphysial contour forms, as in *Triconodon mordax*, an open angle with the lower border of the ramus; but this is continued in an uninterrupted gentle curve to the condyle (*b*).

In the opposite slab (fig. 7) the crown of the last molar (*m* 4) is exposed, incompletely developed, in a formative alveolus at the fore part of the base of the coronoid process; the calcified summits indicate a conformable character with the antecedent molars. In *Macropus* and most diphyodont Placentals the hidden and incomplete condition of the last molar would imply, or be coincident with, a like condition of the last premolar.

The coronoid process (fig. 7 A, *e*) is subrhomboidal, is broad, high, reclinate; its apex is continued backward to the same vertical line as that touched by the hind part of the condyle which projects below the level of the alveolar outlets. The condyle (*b*) is pedunculate at its upper part through the oblique deep notch between it and the coronoid. It shows well the carnivorous mammalian convexity, the lower part of which is continued into the lower border of the ascending ramus. This border is inflected, and part of it is retained in the grooved impression left on the slab (fig. 8 A, at *a′*). The inflected border, representing the 'angle of the jaw,' bounds the shallow longitudinal channel leading to the entry of the dental canal.

FIG. 5.

Hind part of mandible of *Thylacinus* ($\frac{2}{3}$ natural size).

The Thylacine (fig. 5), amongst known living zoophagous Marsupials, offers the nearest approach to the indications of predatory nature given by the lower jaw and teeth of *Triacanthodon*. But these indications are exaggerated in the concentrated carnivorous character of those parts in the genus next to be described.

§ XVI. *Genus*—Plagiaulax, *Falconer*, 1857.[1]

Species 1.—Plagiaulax minor, *Falconer*.[2] Plate III, figs. 9, 9 a, 9 b.

This species is represented by the dentigerous portion of the right mandibular ramus with the teeth *in sitû* (Pl. IV, fig. 9, nat. size; 9 a, magn. 3 diam.; b, molars magn. 6 diam.). The lower border of the hind part with the ascending ramus is broken away.

The teeth are the incisor (*i*), four premolars (*p* 4—2), and two molars (*m* 1, 2). The incisor is long, large, laniariform, more rounded or convex externally than in the larger species (see Pl. IV, fig. 11, a, *i*); the anterior end is broken off, but the impression left on the matrix shows it to have been pointed, and also indicates a shallow longitudinal groove on the inner side of the tooth, nearer the fore than the hind border (*a i'*). The length of the exposed part of the tooth or 'crown' equals the fore-and-aft extent of the entire premolar series. The direction of the crown is upward and forward, at an angle of 120° with the alveolar line of the succeeding teeth: the convexity of the antero-inferior border and a slight concavity of the postero-superior border give the appearance of a curve in the same direction.

The first premolar abuts against the fore part of the second. It rises at a distance from the incisor equal to the breadth of the base of that tooth. It is minute, with a crown longer or higher than its fore-and-aft breadth. Slightly bulging at its base, above the single root, it becomes flat externally with the summit obliquely truncate.

The crown of the second premolar (*p* 2), larger and more compressed, swells out rather more abruptly above the fang, from which protuberance the crown expands and flattens as it rises, and again contracts to abut upon the fore margin of the next tooth. The apex of the crown of *p* 2 is marked by three fine short ridges directed from before upward and backward; below these the enamel is smooth and flat to the bulging base. The height of the crown is greater than its fore-and-aft breadth, the extreme of which is about half way to the angular summit; this shape is due to a truncation in the same direction as in the first molar, viz. from above downward and forward, which gives to the crown a rhomboidal figure.

The third premolar (*p* 3) attains greater breadth in proportion to its height, though the latter dimension of the crown still predominates: the thickness of

[1] "An abbreviation for 'Plagiaulacodon,' from πλάγιος, oblique, and αὖλαξ, groove, having reference to the diagonal grooving of the premolars,' see 'Description of Two Species of the Fossil Mammalian Genus Plagiaulax from Purbeck;' by Hugh Falconer, M.D., F.R.S., F.G.S., in 'Quarterly Journal of the Geological Society of London,' vol. xiii, p. 261.

[2] Ib., p. 264, and p. 281, fig. 15.

the crown is but little increased. The rhomboidal form prevails; the upper angle being in contact with the upper and anterior angle of the more quadrate crown of the last and largest premolar, and the trenchant border slopes therefrom downward and forward to that of *p* 2. The lower angle of the rhomboid is formed by the smooth shining bulge of enamel above the fang, or the chief anterior fang. Above that the surface expands and flattens, with the slightest degree of concavity lengthwise, and the feeblest indication of a ridge along the hind border. Two, or at most three, oblique ridges mark the trenchant summit of the crown, whence they run a short way downward and forward.

In the last premolar (*p* 4), with a slight increase of height of crown, the antero-posterior diameter prevails without increase of thickness. The anterior root, above which is the enamelled swelling, is more plainly a subordinate support, instead of being the chief or the sole one. The outer surface of the crown rises more directly from the posterior insertion as a flattened tract. A feeble vertical ridge holds the same distance from the anterior thickened border of the crown as does that which, in the preceding premolar, marks the posterior border. The flattened part of the crown behind the short vertical rising in *p* 4, thus seems to be a superadded part of the tooth, and may indicate the tooth, so symbolised, to be a carnassial true molar; but the test of development cannot, with present evidence, be applied. The oblique ridges, six or seven in number, continued downward and forward from the serrations of the trenchant margin, are limited to the upper half of the crown. The hind part is lower than the fore part; the serrate border sloping from before downward and backward; that border of the four closely contiguous premolars describes an unbroken convex curve, like the edge of a circular saw. The four trenchant teeth constitute two thirds of the molary series.

The first tubercular molar (*m* 1) has an oblong crown, with the long diameter from before backward. Its vertical diameter is less than half that of the fore part of the antecedent tooth. The grinding surface (Pl. IV, fig. 9 B, *m* 1) is divided by an antero-posterior depression into an outer and an inner division, the inner wall rising highest; this presents three obtuse cones, the foremost being smallest, and the other two further apart. The outer division is cleft into three more equal, smaller, and lower tubercles. Below these the outer surface of the crown is not impressed or indented, but presents a smooth moderate convexity from before backward. The three pairs of peripheral tubercles in this minute lower molar recall the character of those of *Stereognathus* (Pl. I, fig. 29), though the resemblance is not so close as to the lower molar (Pl. I, figs. 6–12) of *Microlestes*.

The last molar (*m* 2) loses in antero-posterior and vertical extent; its middle depressed surface is broader, and is bounded by narrow ridge-like low walls of enamel, with feeble indications of a tubercular character, the inner and fore angle being most elevated. In both molars the height of the crown is inconsiderable compared with the other dimensions.

The outer and fore root of the coronoid process projects external to the alveolus of the last molar, and shows the fractured surface, and the most prominent part of the outer surface of the horizontal ramus is thence continued in a gentle curve below the alveoli of the premolars, forward, to the upper part of the socket of the incisor; the prominence is not well defined, but it gives a vertical bulge or convexity to the outer side of the jaw.

The alveolar border rises in well-marked angles into the interspaces of the premolars, or of their roots.

The crown or exposed part of the incisor formed, when entire, two sixths of the total extent of the dental series; the premolars two fifths; the molars one fifth.

Fig. 6.

Mandible and teeth, nat. size. *Plagiaulax minor.*

Fig. 9, Pl. IV, gives the natural size of the specimen. If the ascending ramus of the jaw be restored after the type of that of the larger species of *Plagiaulax* (ib. fig. 10), the length of the lower jaw, including the incisor, would be seven and a half lines, as in the woodcut, fig. 6.

Species 2.—Plagiaulax Becklesii, *Falconer*.[1] Plate IV, figs. 10, 10 a, 10 b, 11, 11 a.

The type of this species is preserved in the counterpart slabs of a split block of Purbeck shale, of which one contains the hind half of the right mandibular ramus, with the impression of part of the fore half (Pl. IV, fig. 10, nat. size; 10 a, magn. 3 diam.); the other contains the fore half of the same ramus with the teeth and the impression of the major part of the rest of the bone (ib. fig. 11, nat. size; 11 a magn. 3 diam.). The inner side is exposed of the hind half, the outer side of the fore half.

The fore half contains the incisor (fig. 11 a, *i*) and three premolars (ib. *p* 2, 3, 4); the hind half shows the shallow sockets of two small molars (fig. 10 a, *m* 1, *m* 2).

The condyle of the jaw (figs. 10 *c*, 10 b) is unusually large, especially in the vertical direction. It extends to the lower border of the ramus, the angle—almost a right one—being formed by their meeting or intersection at *a*. A narrow tract of fracture indicates the homologue of the angular process to have been thence directly inflected as a thin plate, the base of attachment of which was continued forward below the pterygoid depression, to the entry of the dental canal (*d*).

The condyle (*c*) is convex transversely and vertically, the articular surface curving from before backward, downward, and again slightly forward, to the extent of nearly a half circle: its breadth rapidly increases from the upper end to one third down, then gradually decreases to near the angle. The smooth articular surface is best marked upon (and was, perhaps, confined to) the upper broader part of the condyle, the lower boundary, as in *Thylacinus*, not being defined. The narrowing is chiefly from the inner side; so that the outer contour of this vertical condyle (fig. 10 b, *o*) is uniformly

[1] Op. cit., pp. 262, 278, 279, figs. 1—5, 7—14.

convex; the inner contour (ib. *i*) is convex at the upper half, concave at the lower one; the inner border is sharply defined, as in *Thylacinus*. The representative of the angular process of the jaw in other Mammals is here directly and abruptly inflected inward, at the level of the lower end of the condyle, as a horizontal ridge (*a*, *a'*), which extends forward from the inner side of the lower margin of the ramus to the entry of the dental canal (*d*), in front of which the ridge curves and rises vertically with some subsidence and blunting to the back part of the molar socket (*m* 2), which is partly within, and is below the anterior part of the base of the coronoid process (*b*). The inflected part of the lower border of the ramus is not much produced, but is most so near the angle, where the margin, broken off from the slab under scrutiny, is preserved in that containing the fore part of the ramus with the teeth (fig. 11). The line of the inflected lower border of the jaw runs nearly straight from the terminal condyle to beneath the dental canal.

From the upper end of the condyle the hind margin of the rising branch ('ramus ascendens,' 'perpendicular portion or ramus,' Anthropotomy) dips down before curving forward and upward to rise almost vertically, or with a slight backward curve, to the summit of the coronoid process (*b*). The concave curve from the condyle is deep and bold, giving a pedunculate character to the joint, at least at its upper part. The inner margin of the condyle is produced beyond the level of the inner surface of the rising ramus, circumscribing that surface behind, as does the ridge anterior to the dental canal in front. The apex of the coronoid process, if it were entire, would probably not extend further back in relation to the condyle than in *Thylacinus*, fig. 5.

From the summit of the coronoid the anterior margin of that process curves with, at first, a bold convexity, subsiding near the base to change into the gentle concave line by which the process commences, anteriorly, on the outside of the hind socket or hind part of the socket of the last molar tooth.

The tract of line forming the inner surface of the broad (antero-posteriorly extended) and high coronoid, with that of the 'ramus ascendens' below, is almost flat on the inner side of the jaw here exposed. It is vertically concave through the production of the inner part of the lower border, near that border, and is very feebly convex in the same direction along the base of the coronoid; in the fore-and-aft direction the flatness of the relatively extensive tract of the inner surface of this part of the mandible is less affected. The inner alveolar wall of the last socket makes an obtuse projection (below *m* 2, in fig. 10 A), and it is thicker than the outer alveolar wall. In the horizontal plane the inner border of the socket describes a more convex curve than does the outer border. The entire border is obtuse; the socket is a full longitudinal irregular ellipse, and less deep than its length, recalling the shallow bed in which rests the hind tubercular of *Thylacoleo* and *Felis*. A part of the socket of the anterior molar (*m* 1) is preserved, in front of which is the impression, in slab, fig. 10, of the large premolar (*p* 4).

The fore part of the ramus with the teeth is almost as deep as it is long, the depth or height of the ramus increasing from the incisive alveolus to the hind fractured part. A prominence (fig. 11 A, *b*) a little below the hind part of the socket of the last premolar leads backward to the broken origin of the outer part of the anterior border of the base of the coronoid process, and a feebler bulge or vertical convexity of the line extends forward below the premolar alveoli to near the outlet of the socket of the incisor. The concavity (*a*), deepest at the back part of this portion of jaw, gradually shallows and contracts to end below the alveolus of *p* 2. The second vertical convexity (*c*) of the outer surface of the ramus, forming the lower boundary of the concavity (*a*) is continued into the thick rounded under border of the jaw.

The ramus loses depth as it advances and terminates anteriorly in the socket of the large subcompressed laniariform incisor (fig. 11, *i*). The crown of this formidable tooth is directed upward at an angle of 110° with the line of the premolar alveoli; the tooth as it advances contracts or loses fore-and-aft breadth, and is slightly curved upward to its pointed extremity. The transverse breadth, which is small, is maintained nearly to the apex. The outer side of the basal third shows a shallow medial longitudinal impression, contracting to lose itself in the uniform subconvex level of the rest of the outer surface. This depression recalls that at the corresponding part of the base of the canine in *Triacanthodon* (*p*, Pl. IV, fig. 8 A, *c*). The anterior border of the incisor is blunt to near the apex; the posterior border shows a narrow flat tract with sharp margins; the entire crown is invested by enamel. It is implanted, as far as the socket is exposed, by a single cement-clad root, which slightly contracts as it sinks into the bone.

The incisor is relatively as long as in *Plagiaulax minor* (Pl. IV, fig. 9), but is broader antero-posteriorly, less convex, and less uniformly so externally, more recurved toward the apex; in other words, more fitted for piercing as might become a larger and stronger species.

The three compressed lamelliform premolars progressively increase in height and, in a greater degree, in fore-and-aft extent, as they recede in position. The crowns of the three teeth (*p* 2, 3, 4) are in very close contact, and are so coadjusted as to give to their trenchant borders a continuous convex outline, acting as one great carnassial.

The first premolar (fig. 11 A, *p* 2) is the least. It arises about twice its own breadth from the outlet of the incisive alveolus, leaving a distance of that extent between it and the incisor. The height of the crown is twice its breadth. The fore part of the base swells into a smooth convexity. The contracting summit bends slightly back and abuts against the middle of the fore part of the second premolar. The outer side of the upper part of the crown of the premolar (*p* 2) shows an oblique ridge. It appears to be implanted by two fangs, an alveolar process rising to their interspace.

The second premolar (*p* 3) is implanted by a large anterior and a small posterior fang. The outer side of the anterior root swells out at the base of the crown into a smooth convex protuberance. The outer alveolar wall rises in an angular form between this and the more inwardly inserted small hind root. The crown, narrow transversely, expands from before backward, and then contracts to a subconvex trenchant border. Of this the cutting power is enhanced by a fine serration at the hind half, formed by four fine points of enamel, from which, ridges extend obliquely forward and downward, leaving intervening parallel narrow grooves. The height of the crown of the second premolar is rather more than its fore-and-aft breadth.

In the last premolar (*p* 4) the increase of size is considerable, as in *Pl. minor.* The two roots are nearly equal, the hind one exceeding. Both swell out slightly before they coalesce and expand into the crown, but the anterior protuberance is most marked. The fore-and-aft extent of this trenchant tooth exceeds its height. The serrate margin is moderately convex. It is formed by eight enamelled points, from each of which a ridge extends obliquely downward and forward, parallel with the course of the four in the antecedent tooth, and to the same extent down the crown; but both ridges and grooves are more strongly marked in the present premolar. The outer surface of the crown is flat, and slopes at once to the trenchant edge, unbroken save by the oblique ridges on its upper half. The hindmost of these is feeble, and runs below that from the hindmost denticle forming the posterior angle of the crown. There is no trace of the short vertical rising noted in *p* 4 of *Plagiaulax minor.*

As each specimen is delineated, or outlined, of the natural size, admeasurements are not given in the text. Dividing the length, in a straight line, of the present mandibular ramus, from the apex of the incisor to the back part of the condyle, into nine parts, five of these include the dentition and four the ascending ramus behind the last molar. Of the five parts, including the dentition, a little over four fifths are occupied by the incisor and premolars, and the rest by the two molars. The teeth occupying the four fifths of the dentary tract are expressly and very effectively modified for piercing and cutting: those lodged in the hind fifth of the alveolar tract we may infer, by analogy of other specimens, to have been two small and low tubercular molars adapted for pounding.

The piercing, holding, and tearing power is limited to one large sub-erect, sub-recurved, laniariform tooth, which by position in the jaw is technically an incisor. The cutting or dividing function is allotted to three teeth, so proportioned and coadjusted as to act as one large carnassial, working by a sub-convexly curved, trenchant, and finely serrate edge, as a shear-blade on a tooth, or aggregate of teeth, of probably like carnassial form or character in the upper jaw. The strengthening oblique ridges and resultant serration of the cutting edge seem well adapted to the division of the tough and dry integument of Saurians.

The position, shape, direction, and relative size of the condyle, with the size, shape, and duration of the coronoid process, indicate the power and line or direction of work of the mandible, which by the analogy of the Thylacine (fig. 5) and Ursine Dasyure (fig. 20) I conclude to have been the work mainly of biting and cutting, with a little crushing or pounding of the divided substances before their final deglutition. The comparisons, however, with the jaws and teeth of other mammalian species will be deferred till the descriptions of the specimens of *Plagiaulax* are completed.

PLAGIAULAX BECKLESII (?).[1] Plate IV, figs. 12, 12 A, 12 B.

The specimen (Pl. IV, fig. 12, nat. size, 12 A, magn. 3 diam., B, grinding surface of molars, magn. 3 diam.) referred to this species[1] is a fragment of the right mandibular ramus with the beginning of the fore part of the base of the coronoid process (fig. 12 A, *c*): it includes two tubercular molars *in sitû*, with the inner side exposed, and the impression of the obliquely ridged trenchant crown of a premolar (ib. *p* 4) in relative superiority of size to the tuberculars corresponding with that indicated by the tooth in place (*p* 4) and the molar alveoli in the preceding specimen (ib. fig. 10 A). To the species represented by that specimen I should refer, without doubt, the present fragment, but that the distance from the hind margin of the last premolar to the back of the socket of the hind molar is relatively greater in the present specimen; yet not to such a degree as to forbid the reference, with some indication of doubt, of the present specimen to the *Plagiaulax Becklesii.* Accepting this determination, we can complete herewith the description of the mandibular dentition of that species.

The penultimate molar (fig. 12 A and B, *m* 1) presents a low oblong crown, the fore-and-aft extent exceeding by one fourth the transverse diameter. The outer half is worn lower than the inner half of the grinding surface, and the outer side of the higher inner border is worn vertically smooth to a shallow groove, traversing the working surface from before backward, and dividing the inner from the outer part of that surface.

The inner surface, swelling out above the two roots of the tooth, presents a low obtuse conical rising anteriorly, with an anterior basal low ridge. The posterior half of the inner side of the crown is lower, and presents two small risings, divided by a shallow longitudinal indent. The outer and lower worn-down side of the crown shows two or three feeble risings.

In the last molar (ib. *m* 2) the inner half of the crown is higher than the outer one, toward which it also presents a smooth, straight, sheer, or vertically worn, surface. But it is on a lower level than *m* 1, the enamel being detached or broken away, which gives the appearance of the tooth having been worn down more nearly to the fangs than is the penultimate molar. This, however, is the result of accident. Sufficient of the inner half of the molar remains to show the vertical surface presented to the lower outer half; and such surface, indicative of vertical abrasion by an upper molar, would be, probably, as high as in the penultimate molar (*m* 1), had the enamel of the inner half of the crown been preserved in *m* 2. The outer half of the crown retains its enamel covering; has a convex outline from before backward, with an almost flat, slightly concave, working surface. The outer and fore part of the base of the coronoid is external to the posterior two thirds of the last molar.

[1] By Dr. Falconer, loc. cit., p. 279, figs. 7—10.

Small as is this fragment, some useful inferences may be drawn from it. Firstly, that the two molars *in sitû* were small, not to say minute, in relation to the entire mandible; and occupied not much greater extent—if any—of the dental series than do the alveolar indications of such molars in the former specimen (fig. 10 A). Secondly, that the line of action in which they worked upon the upper molars was more vertical than horizontal; could hardly have been transverse, seeing the sheer wall by which the inner half of the crown rises above the outer half. The two molars are plainly of the character of the tuberculars terminating the carnassial series of flesh-feeders, adapted for pounding and squeezing out the juice of imperfectly divided animal tissues; not fitted, for the rotatory grinding actions by which vegetable substances are reduced, with salivary admixture, to a pulp; but taking that share in the dividing work which the larger of the two small mandibular molars does in *Thylacoleo carnifex*.

PLAGIAULAX BECKLESII, *Falconer*. Plate IV, figs. 13 *a*, A, 13 *b*, B.

This species is, again, represented by the fore part of the right mandibular ramus with the implanted base of the broken incisor (*i*), part of the first (*p* 2), the second (*p* 3), and the fore part of the third (*p* 4) premolars. The inner side of the specimen is represented in Pl. IV, fig. 13, nat. size, 13 B, magn. three diam.: the outer side of the specimen is represented in fig. 13 *a*, nat. size, 13 A, magn. three diam. In both figures the parts wanting, but preserved in the preceding specimens, are restored in outline.

The symphysial surface (fig. 13 B, *s*, *r*), extends upward and forward at an angle of 147° with the lower line of the mandible (*r*, *a*). It is indented behind, the part (*s*) above the entering notch suddenly expanding. A linear groove extends from the notch forward across the symphysial surface, dividing the upper broad from the lower narrower part of the articular surface. The inner surface of the ramus is slightly swollen behind the upper part of the symphysis by the corresponding wall of the long socket of the laniariform front tooth (*i*), and the vertical convexity of that swelling changes to a concavity as the inner surface descends to the thick rounded lower margin.

The crown of the second premolar (*p* 3) swells out on the inner side (fig. 13 A) above the roots, with a concavity or notch, which divides the swollen base into two smooth protuberances, the anterior being the most prominent. Above this the inner surface is flat to the trenchant margin, not defining a cingulum. The flat inner surface of *p* 3 is traversed by four linear ridges extending from above downward and forward, each ridge being continued from the summit of the low projection, the succession of which gives a fine serrate character to the trenchant border of the tooth.

The ramus has been fractured across the third premolar (*p* 4), showing the length of the implanted fang (fig. 13 B); the degree of outswelling of the base of the crown both externally and internally, and the proportion of the transverse basal breadth to the height of the crown. In this section the tooth is spear-shaped.

Externally as well as internally the lower swollen border of the crown is notched, indicative of the division of the root, and the part in front of the notch is more prominent than the one behind; it is also lower placed. The outer side of the crown (fig. 13 A, *p* 4) is flat from the base to the cutting edge, and no indent marks the base of the crown as a cingulum.

The small anterior premolar (*p* 2) repeats the character of the fore part of the succeeding premolars, in the smooth enamelled tuberosity by which the crown rises from the root. The narrow crown slopes backward, and is applied like a buttress against the fore part of the next premolar.

The grooves are limited to the upper half of the outer surface of the crown of *p* 3 (fig. 13 A), but descend a little lower on the inner surface (fig. 13 B). The anterior denticle of the serrate cutting edge bounds the foremost short groove; the second ridge commencing below the first denticle runs along a greater proportion of the cutting edge before terminating in the second denticle. The third ridge beginning near the fore margin of the crown extends obliquely upward and backward to the third denticle near the hind part of the cutting edge. The fourth ridge terminates in the hind angle of that edge. The groove below the fourth ridge is completed by a fifth, parallel with the others, and terminating a little below the hinder angle of the crown.

In the third or last premolar (*p* 4) four grooves on the upper half of the outer surface have directions nearly parallel with those of *p* 3. The foremost denticle at the anterior angle of the crown bounds the first short groove. The four succeeding ridges all begin at or close to the anterior margin of the crown.

The accentuation of the outer surface of the fore part of the mandibular ramus is well shown in this fragment. A low ridge (*t*, fig. 13 A), one fourth of the depth of the ramus from the alveolar margins, bounds above a shallow depression at the middle third of that surface which narrows to a point forward beneath the fore part of the first premolar (*p* 2). Anterior to this point, or angular end of the depression, is a single well-defined circular outlet of the dental canal (*d*).

The incisor is subcompressed. The section of the base of the exserted crown is a long ellipse with the anterior and posterior rounded ends similar in breadth; but the inner medial side is rather flatter than the outer one.

PLAGIAULAX BECKLESII (?). Plate IV, figs. 15, 15 A.

To this species I refer, with doubt, a specimen of part of the crown of the incisor, a small part of the anterior premolar (*p* 2), the penultimate (*p* 3) and major part of the last premolar (*p* 4) apparently of the left side, imbedded in their natural relative positions in a portion of the Purbeck shale, with the outer surface exposed (Pl. IV, fig. 15, nat. size. 15 A, magn. 3 diam.).

The enamel of the apical half of the crown of the incisor, here preserved, shows a fine longitudinally wrinkled character. The section or fracture of the crown indicates its inner side to have had a shallow longitudinal groove. The basal part of the crown has left a partial impression indicating the diastema between it and the premolars not to have been so long as at first sight appears.

Part of the root of the small anterior premolar (*p* 2) is preserved. The penultimate premolar (*p* 3) shows the usual four oblique ridges on the upper part of the crown. Six ridges are discernible on the corresponding part of that of the broader last premolar (*p* 4). The width of the interspace of the two diverging roots of this tooth, and the transverse breadth of the base of the crown, are well shown in this specimen. It has belonged to an animal quite as large as the type of *Plagiaulax Becklesii*, and it most probably belongs to that species. This specimen does not appear to have come under the notice of Dr. Falconer.

Species 3.—Plagiaulax Falconeri, *Owen*. Plate IV, figs. 16 and 16 a.

This species is represented by the fore part of the right mandibular ramus, with the incisor and premolars, showing their outer surface; followed by the impression of two smaller molars, and part of the ascending ramus (Pl. IV, fig. 16, nat. size, 16 a, magn. 3 diam.). The preserved part of the jaw is rather less deep than in *Plagiaulax Becklesii;* the incisor is less broad in proportion to its length, especially at the base; it is also more convex on the outer side, and devoid of the longitudinal channel there (fig. 16 a, *i*); but it is similar in length, position, curvature, and laniary character. The longitudinal ridge or prominence (*t*, fig. 16 a) of the ramus (answering to *t* in fig. 13 a) is here situated half way between the alveolar outlets of the premolars and the lower border of the ramus; it is further from that border in *Pl. Becklesii* (fig. 11, *a*, *b*), and is less definitely marked; the longitudinal channel below is less prolonged anteriorly. A single outlet of the dental canal opens at a line dropped from the middle of the diastema between the incisor and premolars.

The first premolar (*p* 2, fig. 16 a) is larger than in *Pl. Becklesii;* its crown developès the smooth protuberance above the fang, before flattening and expanding; at two thirds toward the apex it contracts thereto. The apex shows one short ridge dividing two grooves; it rises to the anterior angle of the crown of the succeeding premolar; the form of the crown is rhomboidal. The upper and posterior border is in contact with the anterior border of the next tooth. The upper and anterior border slopes forward and downward from the apex; the two lower borders converge, as they descend, to the basal protuberance. The height of the crown is one third more than its fore-and-aft breadth. The small hind root is visible at its base.

The second premolar (*p* 3) has a subquadrate crown; but the outer enamelled surface is rhomboidal; the lower apex being formed by the basal protuberance. The upper and posterior border is applied to the next tooth (*p* 4), the anterior angle of which is reached by the apex of the present tooth. The upper and anterior border of the rhomb forms the free trenchant part of the crown and slopes down to the angle of the antecedent tooth (*p* 2). This border presents four dentations, from which as many ridges are continued downward and forward, but subside before they reach the middle broadest part of the crown. The beginning of the posterior root is shown. This tooth is less than its homologue in *Pl. Becklesii* (fig. 11 A, *p* 3).

The last molar (fig. 16 A, *p* 4) presents the usual subquadrate form, with the hinder root the largest. Eight denticles arm the trenchant border, from which the ridges traverse in the usual oblique course the upper half of the crown. There is a slight protuberance above each root, the rest of the crown being flat. A minute short vertical ridge is on the fore half of the crown, below the oblique ridges; and a similar short vertical ridge may be discerned near the hind part of the penultimate molar (*p* 3), recalling the structure seen in *Plagiaulax minor;* and of which there is no trace in *Pl. Becklesii.* An impression of the bituberculate inner wall of the crown of a small molar (*m* 1) is visible on the matrix behind the last premolar; it is followed by the impression and also part of the inner wall of a second molar (*m* 2). This appears to be more even in character than the first; it is not developed into two tubercles so large and well marked; it is of the same, generically, small size. Beyond the last molar rises the impression of part of the beginning of the coronoid process (*b*).

Dividing the dental series of this specimen from the tip of the incisor to the back part of the last molar into fifteen parts, the incisor occupies five parts, the premolars five parts, the diastema two parts, and the molars (*m* 1 and 2) three parts.

If the only differences between the present specimen and the type of *Plagiaulax Becklesii* had been in the less robust mandible and more slender incisor, such characters might have been interpreted as sexual; but the difference of the configuration of the outer surface of the jaw, and more especially in the proportions of the premolars, point to a derivative stage which would support a distinct specific entry in Zoological Catalogues. It is instructive to discern in the differences supporting a *Plagiaulax Falconeri* evidence of an intermediate position between *Pl. Becklesii* and *Pl. minor.* In size the present species, which I dedicate, as of right, to the Founder of this most singular and interesting genus, is the same or but very little inferior to the type of *Pl. Becklesii.*

The specimen (fig. 16) does not appear to have come under the notice of Dr. FALCONER.

PLAGIAULAX MEDIUS, *Owen.* (Cut, fig. 7, p. 86, and fig. 12, p. 90, magn. 4 diam., after FALCONER.)

The subject of fig. 14, p. 289, of FALCONER'S 'Original Memoir' (loc. cit.), I have failed to find after rigorous and reiterated search in the series of specimens of the Becklesian Collection transmitted to me for description. It was not in that portion including the subjects of all the other illustrations of his 'Memoir,' marked as 'returned' by the author. The foregoing specimen (Pl. IV, fig. 16), not described by FALCONER, comes the nearest to it, and at first I suspected that it might be such original from which the ascending ramus and condyle had been accidentally broken away. But FALCONER describes his specimen as "Fig. 1, *Plagiaulax Becklesii.* The left ramus of the lower jaw, nearly perfect, showing the outer surface, magnified 4 diameters," (loc. cit., p. 280[1]). But the subject of my Pl. IV, fig. 16, is clearly the fore part of the right ramus of the lower jaw; it differs also in the proportion of the premolars, in the relative depth of the ramus supporting them, and more decidedly in the shape, size, and direction of the incisor.

Dr. FALCONER refers the specimen, fig. 14, p. 280, of his original Memoir, tom. cit. and fig. 1, Pl. XXXIV, of the undercited work, to his *Plagiaulax Becklesii,* and it will be observed, in the copy of that figure, in Cut 12, p. 90, that the premolar (*p* 2) bears the same proportion to *p* 3 as in the type of *Plagiaulax Becklesii,* Pl. IV, figs. 11, 11 A.

The mandibular ramus with the incisor of *Plagiaulax minor,* restored according to the analogy of *Plagiaulax Becklesii,* is, as we have seen, $7\frac{1}{2}$ lines in length (fig. 6, p. 76). The original of the fig. 14, p. 280, of FALCONER's 'Memoir,' magn. 4 diam., must have been 8 lines in length (fig. 7); it is nevertheless referred to *Plagiaulax Becklesii* (Pl. IV, figs. 10—14), which is 14 lines in length (fig. 8).

Trusting, as we may confidently do, to the accuracy of FALCONER's figure, it will be seen that this differs not only, notably, in size from the type of the species to which that minute and careful Observer refers it, but in the size of the premolar teeth. The series of three in the type of *Plagiaulax Becklesii* (fig. 8) has a longitudinal extent of 3 lines, but in *Plagiaulax medius* (fig. 7) of $2\frac{1}{4}$ lines. The shorter incisor (ib., *i*), tapering from the exposed part of the base to the apex, might be interpreted as a stage in the development and protrusion of the tooth; and this probably led Dr. FALCONER to suggest that "the specimen would seem to have belonged to a young individual of *Pl. Becklesii.*"[2]

FIG. 7.

Plagiaulax medius. The subject of Falconer's *Plagiaulax Becklesii,* fig. 14, loc. cit., reversed and reduced to the nat. size.

FIG. 8.

The type of *Plagiaulax Becklesii,* F. Nat. size.

But the crowns of the premolars are fully formed and in place, that of the anterior one (*p* 2) appearing to have been worn. Nothing that is known of the change of the dentition of the *Marsupialia* would support the inference that the premolars in fig. 7 were of the deciduous series, destined to be displaced by permanent ones of the size of those

[1] See also 'Palæontological Memoirs and Notes of the late HUGH FALCONER, A.M., M.D., &c.,' 8vo., 1868, vol. ii, p. 417, pl. xxxiv, fig. 1.

[2] Loc. cit., p. 271, and 'Palæontological Memoirs, &c.,' 1868, vol. ii, p. 421.

in *Plagiaulax Becklesii*, fig. 8. Repeated researches have failed to bring to light any other instance of a vertically replacing tooth ('dent de remplacement,' Cuv.), save that 'premolar,' by development as well as by shape, which displaces the second or the first and second of the primary or deciduous molar series in the *Poephaga*.[1]

This premolar (*p* 4, figs. 13, 14, p. 92), which assumes an antero-posteriorly extended trenchant and vertically ridged character in *Hypsiprymnidæ*, may be the homologue of *p* 4 in *Plagiaulax*, but the proof from developmental character is wanting. I deem it most unlikely that any of the premolars in fig. 7, p. 86 should be destined to be displaced and replaced by a vertical successor of larger size and similar character. There then remains the possibility, assuming the trenchant, serrate, ridged teeth in *Plagiaulax medius* to be permanent or non-deciduous primary ones, that they belonged to a female *Plagiaulax Becklesii*, in which the incisor was not fully risen into place. The difference in the shape of the coronoid process (*c*) may depend upon some marginal defect of that plate in the small and delicate fossil.[2] The condyle (*c*) may likewise have lost so much of its prominence as would have brought it to the vertical parallel of the angle of the jaw (*a*), as in fig. 8 and Pl. IV, fig. 10.

If the parts as figured by Dr. FALCONER were natural, they would indicate, with difference of size, a difference of shape of jaw, which, as compared with that of the type *Plagiaulax Becklesii*, should be interpreted as specific. They undoubtedly show the same low position of the condyle, viz. depressed below the level of the molar alveoli—lower, indeed, than in the type-specimen (fig. 8, p. 86). The figure also shows the wide emargination between the base of the coronoid (*c*) and the condyle (*b*), like that which is seen in the mandible of *Thylacinus* (fig. 5, p. 74), and to which the term 'neck' or 'peduncle' of the condyle is sometimes applied.

From the seemingly more distinct and prominent angle (fig. 7, *a*) a ridge is continued forward and upward, bounding below the external crotaphyte hollow, at a higher level than the inverted angle and lower margin of the jaw bounds the internal or pterygoid hollow in *Plagiaulax Becklesii* (Pl. IV, fig. 10).[3]

In the well-preserved 'ascending ramus' of the jaw of *Plagiaulax Becklesii* (Pl. IV, fig. 10, 10 A) there is no trace of a solution of continuity effecting a communication between the external and internal crotaphyte depressions near the entry of the dental canal, as

[1] Owen's "Fossil Marsupialia from the Caves of Wellington Valley," May 8, 1838, in Mitchell's 'Three Expeditions into the Interior of Eastern Australia,' 8vo, vol. ii, p. 360, pl. 30. 'Classification of the Marsupialia,' 'Proceedings of the Geological Society of London,' Jan. 8th, 1839.

[2] Dr. Falconer, who describes this fossil, in a P.S. to his original paper, as "a fifth specimen of *Plagiaulax*" received since that paper was written, states, "The true molars, if present, are concealed by the flap formed by the anterior margin of the coronoid process. This part of the jaw has been slightly crushed."—Loc. cit. (1857), p. 271, op. cit. (1868), p. 421.

[3] "The base of the coronoid is occupied by a deep depression bounded on the lower side by a raised ridge, which sweeps round from the inferior part of the condyle, to be continued into the anterior margin of the coronoid process."—Falconer, loc. cit., 1857, p. 271, tom. cit., 1868, p. 421.

in the poephagous and rhizophagous Marsupials. Dr. FALCONER states, "So far as can be seen" (in fig. 7) "the depression would seem to be more limited" than in *Hypsiprymnus,* where the "crotaphyte depression terminates in an excavation common to it and the dentary canal."[1]

I conclude, therefore, that, in this 'fifth specimen,' as in the type of *Plagiaulax Becklesii,* the ascending plate or 'ramus' is entire, as in *Dasyurus* and *Thylacinus,* with a like carnivorous character of coronoid and condyle.

§ XVII.—TAXONOMIC DEDUCTIONS.

In the non-production of an angular process of the mandible downward and backward below a condyle low-placed as in *Plagiaulax,* in the inflection of the part corresponding to the angular process in placental *Carnivora* and its continuation with a similarly inflected lower border of the 'ascending ramus,' with a corresponding outwardly produced ridge deepening and bounding below the outer crotaphyte depression, I see, with Dr. FALCONER, characters of the mandible of *Plagiaulax* which "are clearly marsupial."[2]

In this ancient extinct marsupial genus the mandibular dentition is :—

$$i\ \frac{}{1-1},\ c\ \frac{}{0-0},\ p\ \frac{}{4-4},\ \text{or}\ \frac{}{3-3},\ m\ \frac{}{2-2}, = \frac{}{14 \text{ or } 12.}$$

In this formula the 'premolars' are defined by 'shape.'

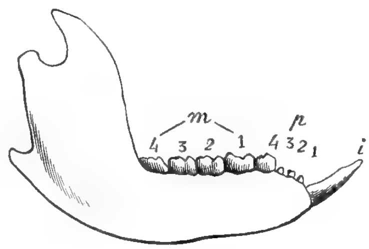
Now, the *Marsupialia* show two leading modifications of the anterior mandibular teeth: in one, several pairs of incisors intervene between the right and left canines; in the other, one pair of incisors of large size are present, and no canines. The first condition characterises the 'polyprotodont section,' the second the 'diprotodont section.'[3] The existing representatives of the latter group of pouched Mammals are confined to the Australasian area. Some of the former group are American.

In both sections there are modifications of dentition, digestive organs, and limb-structures, which in an interesting degree run parallel with each other; the arboreal diprotodont Phalangers and Petaurists, *e. g.*, with the Opossums and Phascogales; the saltatory Bandicoots and Choeropods with the Potoroos and Kangaroos: the gradatory carnivorous Polyprotodonts have no known existing Diprotodont correlatives. *Plagiaulax* belongs to the diprotodont section of *Marsupialia,* and the next step is to determine, so far as the mandible and mandibular dentition may support a deduction, to which of the minor groups or families of that section it shows the nearest affinity.

[1] Loc. cit., p. 271, and tom. cit., p. 421.
[2] Loc. cit., p. 271, and tom. cit., p. 421.
[3] OWEN 'Anatomy of Vertebrates,' vol. iii, p. 293.

No existing Diprotodont offers the mandibular formula of *Plagiaulax*. In the Phalangers a subtrenchant tooth (fig. 9, *p* 4), in contact with the true or tubercular molars, and with a crown reaching to the same level, is reckoned as the last or hindmost premolar, and as the homologue of the similarly developed and situated tooth in *Phascolarctos* and in most '*Poephaga*.'[1] I view the last and largest of the premolars of *Plagiaulax* as the homologue of this tooth, and symbolise it as *p* 4.

Fig. 9.



Mandible and mandibular teeth. *Phalangista Cookii.*

In *Phalangista Cookii* (fig. 9) three small teeth intervene between the last premolar (*p* 4) and the incisor (*i*). Two of them are held to be *p* 3 and *p* 2—the homologues of those so symbolised in *Plagiaulax Becklesii* (fig. 8). With respect to the anterior small tooth, it may be questioned whether it be the homologue of *p* 1, in *Plagiaulax minor*, or the rudiment of a lower canine. At any rate, as regards number of mandibular teeth between the incisor and the true molars, it is only in the Carpophagous family of Diprotodonts that species are known corresponding with the species of *Plagiaulax*. In *Petaurus* (*Belideus*) *flaviventer* four denticles intervene between the functional premolar and the incisor.[2]

Some zoologists have founded subgeneric divisions, with names, on the difference in number of the small premolars, and would, on like grounds, place in distinct genera *Plagiaulax Becklesii* and *Plagiaulax minor*. A better ground for such distinction is afforded, among existing *Carpophaga*, by the small volant species, *Petaurus* (*Acrobata*) *pygmæus*, in which the true or tuberculate molars are reduced to three on each side of both jaws; whilst between these and the incisor in the lower jaw are interposed four teeth; add thereto the shape of the last premolar, which has exchanged the trenchant for the acuminate character. Mere form, however, of one or more premolars is not enough to determine the reference to, or the removal from, such a group as *Carpophaga* of a species proved by more important characters to belong to that group or to one of like value in the diprotodont series.

In some *Poephaga*, for example, the tooth answering to *p* 4 in *Plagiaulax* resembles it in size and trenchant shape, being also grooved; yet the *Poephaga* depart further than do most *Carpophaga*, in having no tooth interposed between *p* 4 and the large procumbent incisor of the lower jaw.

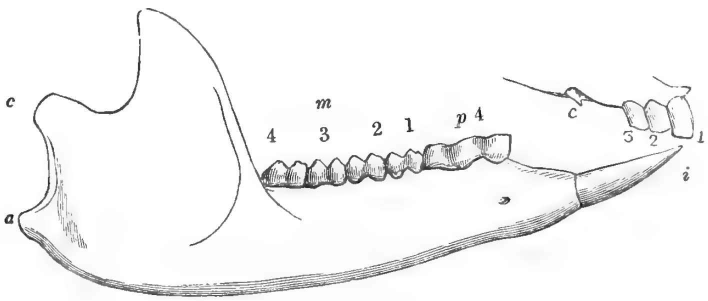
The *Hypsiprymnidæ* or Rat-Kangaroos, with a ridged and trenchant *p* 4, have it followed by four molars with massive triturating crowns. Of these the first three have "a

[1] This term, applied in 1839 to the diprotodont family including *Hypsiprymnus, Macropus,* and their subgenera, is preferable to the subsequently propounded one, *Macropoda,* of Van der Hoeven; because the latter is equally applicable in its descriptive sense to the long-legged saltatory Polyprotodonts. See *Owen,* Classification of the Marsupialia, in 'Transactions of the Zoological Society of London,' 4to, vol. ii, p. 315.

[2] See Art. *Marsupialia,* 'Cyclopædia of Anatomy,' vol. iii, 1841, p. 264, fig. 89.

quadrate form, presenting four equidistant blunt tubercles, which are joined in pairs by transverse ridges, but with these ridges less elevated than the points of the tubercles: there

FIG. 10.

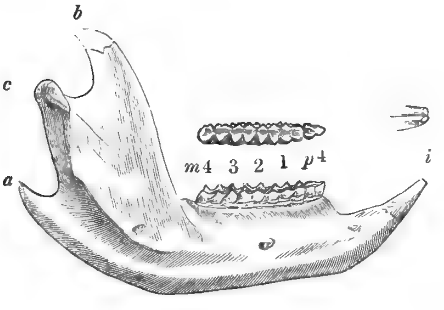


Mandible and teeth, *Dendrolagus dorcocephalus* (nat. size).

is a slight trace of the band of the tooth ('cingulum' of my "Odontography") "on the front and back part of each molar, as in *Macropus*. The hindermost molar is generally small, almost round."[1]

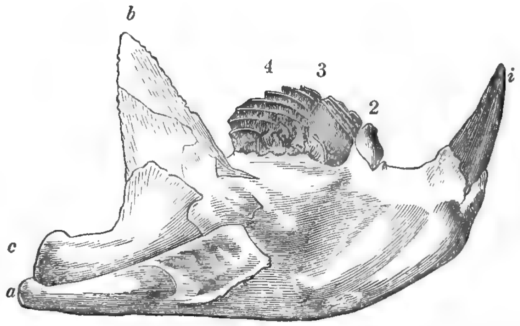
In those vegetable-eating Marsupials the molar teeth adapted to such diet are never fewer and commonly more in number than in the most typical placental *Herbivora*. In relation, apparently, with the drier and tougher vegetable fibres of Australia, the premolar is trenchant, and in the smaller *Poephaga* is strengthened by vertical grooves and ridges. In one of the New Guinea Tree-Kangaroos (*Dendrolagus dorcocephalus*, fig. 10) this trenchant tooth is proportionally larger than in the Australian Potoroos and Bettongs, but the light-giving teeth—the true molars—are conformable with the macropode type.[2]

FIG. 11.



Mandible and mandibular teeth, ½ nat. size, *Phascolarctos fuscus*.

FIG. 12.



Mandible and mandibular teeth, *Plagiaulax* (*medius*, mihi) *Becklesii*, Falc., magn. 4 diam. (after Falconer).[3] Reversed.

A greater contrast in the Diprotodont series is seen in the mandible and mandibular teeth of the Koala (*Phascolarctos*, fig. 11) and *Plagiaulax*, fig. 12.

[1] WATERHOUSE, "A Natural History of the Mammalia (*Marsupialia*)," 8vo, 1845, p. 194.

[2] Ib., p. 182, pl. 10, figs. 5, 5 *a*.

[3] 'Quarterly Journal of the Geol. Soc.,' vol. xiii (1857), p. 280, fig. 14; also 'Palæontographical Memoirs, &c.,' vol. ii, p. 416, pl. 34, fig. 1.

The premolar (fig. 11, *p* 4) is reduced in size, and begins to assume the triturating structure and breadth. In the true molars the four lobes have each the shape of a three-sided pyramid, with the inner side of the inner pair of lobes undulated or indented in a manner recalling the ruminant type of grinders.

The lower incisors in *Phascolarctos* and *Hypsiprymnus* show, as in Rodents, an abraded surface (fig. 11, *i*) indicative of habitual and long continued gnawing actions. The mandible, by its lofty condyle (ib. *c*), its short, narrow, recurved coronoid (*b*), and the low relative position in which the inflected angle (*a*) is produced, concurs with the herbivorous type of dentition in all *Carpophaga* and *Poephaga*.

In *Halmaturus* the mandibular incisor is procumbent; its long pointed crown is depressed, rather expanded or spatulate, with an outer trenchant edge, the inner side more or less flattened by pressure against its fellow, and the upper side showing, for some extent behind the point, the plane of attrition produced by action against the three opposing incisors of the premaxillary. The trenchant premolar, though relatively larger and more compressed than in *Macropus,* especially in such large extinct Wallabees as *Halmaturus Atlas,* forms but a small part, one ninth, of the dental series. It is followed by four molars with large cubical bilophodont crowns, with superadded longitudinal and transverse ridges. Each molar averages three fourths of the fore-and-aft extent of the trenchant premolar.[1]

In *Hypsiprymnus* the long pointed incisor (fig. 14, *i*) is likewise procumbent, but is trihedral. The outer side is convex across, the inner and the upper sides are narrower and are flat, but are not divided by so sharp an angle as that which bounds the outer facet. The upper surface of the incisor shows a plane of attrition from action upon the upper incisors for one third of the extent from its apex, and the enamel is wanting on this surface. The trenchant premolar (ib. *p* 4) has a low crown with a straight cutting subserrate edge. The outer and inner sides meet at a much less acute angle than in *Plagiaulax*. The inner side shows five or six vertical ridges, the first and last being broad. The outer side is worn smooth in old individuals. This tooth forms one seventh of the longitudinal extent of the entire dental series. It is succeeded by four molars (*m* 1—4) with large cubical massive crowns, the grinding surface of which, characterised as described by Waterhouse,[2] become, by age, worn down to a flattened, more or less irregular, triturating surface, exemplifying the habitual horizontal, rotatory, or alternate crushing action of the mandible upon the upper jaw.

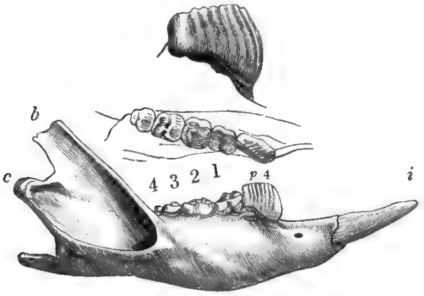
There is but little variation in the rise from horizontality of the lower incisor in the known Potoroos (fig. 14) and Bettongs (fig. 13); in none is the upper contour of the exserted part of the tooth (*i*) raised above the parallel of the alveolar border of the lower molars.

In a skull of the Brush-tailed Bettong (*Bettongia penicillata,* fig. 13) now before me, the scalpriform character of abrasion of the upper surface of the pointed ends of the

[1] 'Odontography,' pl. 101, fig. 3. [2] Op. cit., p. 194.

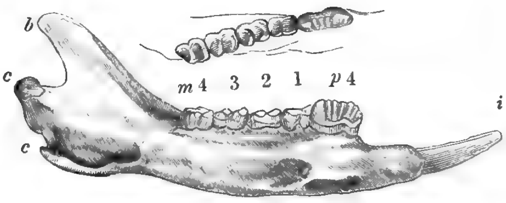
incisors extends half way toward their base. The ridges and grooved trenchant premolars

FIG. 13.



Bettongia penicillata (Gould), mandible and teeth, outer side, nat. size.

FIG. 14.



Hypsiprymnus minor, mandible and teeth, inner side, nat. size.

occupy rather more than one sixth of the dental series. They are followed by four molars resembling those of *Hypsiprymnus,* and equally adapted for vegetable diet.

"The premolar in *H. Gilbertii* is but little longer than the foremost true molar, whilst in *H. murinus* it is equal in length to the first true molar tooth added to that of the second."—*Waterhouse*, op. cit., p. 230.

In all Marsupial *Poephaga* the mandible presents corresponding modifications for the movements required in the cropping and mastication of vegetable food. The major part of the condyle is horizontal; and extended transversely, flattened, or with a feeble convexity from before backward, which is its least diameter (Pl. IV, fig. 10, c). The condyle (figs. 13, 14, *c*) is raised above the level of the grinding teeth, about equidistant from the inflected angle below (ib. *a*) and the summit of the coronoid process above. This process (ib. *b*) is relatively narrow, short, and much inclined backward. The vertical line from its summit to the condyle is less than half the same diameter of that part of the ramus. A wide vacuity at the fore and outer part of the 'ascending branch' receives the dentary canal from the inner surface, and is continued forward into the substance of the horizontal ramus.

In the absence of this external vacuity or perforation, and in the presence of every character of jaw and teeth showing adaptation for animal diet, *Plagiaulax* (fig. 12) differs from the Potoroos (*Hypsiprymnus*), Kangaroos (*Macropus*), and every other known recent or extinct form of poephagous *Marsupialia.*

We should have no ground for surprise if, in the long ages since the diprotodont condition was first manifested, forms now exemplifying it had departed too far from the primitive type to be zoologically associated therewith more nearly than as Marsupials with lower incisors limited to a single pair. If we ask :—where is the living Marsupial that retains the typical number of premolars with a reduction of the true molars to two and of the incisor to one, on each side of the lower jaw?—the answer is 'Nowhere.'

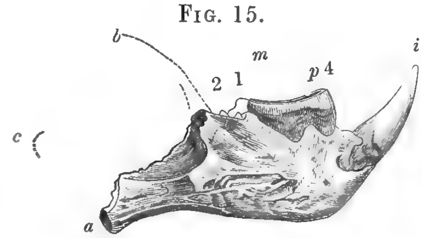
In the case of the *Amphitherium* or of the *Spalacotherium*, &c., with the excessive number of molars, Mr. Waterhouse's discovery of *Myrmecobius* indicated the Marsupial still retaining that anomalous character of dentition which the small Mesozoic quadrupeds manifested in a land geographically now that of England.

So, with regard to the *Plagiaulax* with its defective molar formula, we must also travel to the antipodean continent of *Myrmecobius* to find the forms most nearly allied, in dentition, to the Purbeck genus. But even there they are no longer amongst the existing Marsupials.

The incisors of *Thylacoleo* (fig. 15, *i*) in size, position, direction, and shape closely resemble those in *Plagiaulax*, much more closely than does the lower incisor of any poephagous, carpophagous, or rhizophagous species of Marsupial: the crown is completely sheathed by enamel. But the laniary modifications are exaggerated or carried further out in *Thylacoleo;* the tooth is more compressed, its hinder trenchant edge is finely serrate, as in *Machairodus;* the crown is slightly recurved, as in *Plagiaulax Becklesii* and *Pl. Falconeri;* and the outer surface shows a very shallow and wide longitudinal depression at its basal half.

The last premolar (*p* 4) is trenchant, and occupies two fifths of the longitudinal extent of the dental series; it is preceded by three small and early shed premolars; it is followed, as in *Plagiaulax*, by two small, tubercular molars (*m* 1 and 2), which, together, are limited to one sixth of the dental series. The first of these, again, indicates the more strictly carnivorous character of *Thylacoleo* by the elevation and compression of the fore part of the crown, detracting in the same degree from its triturating power and character. The second lower molar is low, tubercular, one third the size of the first molar, implanted by one short thick root. We know that the two small teeth succeeding the carnassial in the lower jaw were opposed to a single transversely extended tubercular molar above, in *Thylacoleo*.

Fig. 15.



Thylacoleo carnifex, mandible and teeth, ¼th nat. size.

The large carnassial premolar in *Thylacoleo* (fig. 15, *p* 4) forms the same proportion of the dental series as do the close-set three or four trenchant premolars in *Plagiaulax*. The antero-posteriorly extended crown of the Thylacoleo's premolar has the enamel at the basal part of the inner surface vertically and finely undulated, one cannot say grooved or ridged. The worn margin demonstrates the trenchant or shear-blade mode of working upon the similarly shaped and developed upper carnassial. The smooth even surface slopes obliquely down the outer side of the lower and the inner side of the upper carnassial in *Thylacoleo*, showing the same relation of these teeth to one another transversely, as in the Lion and other Felines.

In *Thylacoleo* the outer wall of the mandibular ramus bulges out, as in *Plagiaulax*, below the socket of the premolar. The outer crotaphyte depression is entire and imperforate. The dentary canal begins at a corresponding part of the inner or pterygoid depression From the continuation backward and slightly downward of the lower border of the outer crotaphyte depression, and from the concomitant extent of the fractured base of the coronoid process in the least mutilated mandible of *Thylacoleo,* which has yet reached me (fig. 15), I infer a breadth and general development of the coronoid process, and a position of the condyle corresponding, more or less, with those characteristic of *Plagiaulax, Sarcophilus,* and *Thylacynus.*

The dentition of the upper as well as of the lower jaw of *Thylacoleo* being ascertained, its formula gives:—

$$i\,\frac{2-2}{1-1},\ c\,\frac{1-1}{0-0},\ p\,\frac{4-4}{3-3},\ m\,\frac{1-1}{2-2};=28.$$

Thus, so far as the dentition of *Plagiaulax* is known, it more closely resembles that of *Thylacoleo* than of any other Marsupial.

From the characteristic reduction in size and number of the molar teeth, I have associated them as members of a 'paucidentate' family or Section of *Diprotodonts.*

In this section may be discerned an interesting illustration of the Law or Tendency from the General to the Particular as species approach the present time in geological position.

The extinct pouched Carnivore of the Neozoic period has the functional or carnassial premolars reduced to a single tooth on each side of the lower jaw; the extinct pouched Carnivore of the Mesozoic period retained, in one species, three premolars of the carnassial type, in another species four—the normal number—on each side of the lower jaw.

The parallel runs very close with that which the placental *Carnivora* show within the limits of Tertiary time; as when, *e.g.*, we compare the Miocene *Hyænodon* and its three lower carnassials with the modern *Hyæna,* where they are reduced to one; or when we compare the Miocene *Amphycyon* with its three upper tuberculars with the modern *Ursus,* where they are reduced to two.

The alleged 'well-ascertained' conclusion as to the herbivorous nature of *Plagiaulax* allowed only the contrast with the rich and well-adapted series of grinding teeth in the *Poephaga* and placental *Herbivores* to be thought of, and blinded the Objector to the suggestive instance of ancient adhesion to type[1] which the carnassials of *Plagiaulax,* viewed as a Carnivore, force upon the attention.

Because certain saltatory vegetable-feeding Marsupials have one trenchant and vertically ridged mandibular premolar, occupying a small proportion of the entire molary series, it is not admissible that three or four trenchant and obliquely ridged mandibular premolars, forming a large proportion of the entire molary series, afford adequate grounds for concluding the limbs to be 'macropodal,' and the beast to be herbivorous and a "Marsupial form of Rodent."[2]

A life's experience in the labour of restoring, from fragmentary evidences, an extinct

[1] **Falconer, 'Quarterly Journal of the Geol. Soc.,' vol. xiii, p. 276; also, 'Palæontographical Memoirs, &c.,' vol. ii, pp. 421, 427.**

[2] **Ib., ib., vol. xviii, p. 349, and 'Pal. Mem.,' vol. ii, p. 425.**

species has left me under the conviction that what has been above submitted to Palæontologists in the attempt to determine the affinities of *Plagiaulax* is near the truth: and that having the lower jaw and its entire dentition to work from, the Palæontologist ought to be able to indicate, approximatively, its place in the Natural System.

I should not have presumed so far if my material had been a solitary premolar; supposing even that the last and largest of the series had been the sole indication of what we now know as *Plagiaulax*.

If it had resembled a premolar of a Rat-kangaroo as much as it differs from one; if its crushing edge had been straight and vertically notched, instead of being curved and obliquely notched, or 'serrate;' if its ridges had been vertical instead of oblique; no inference as to the number and kind of teeth with which such premolar had been associated, in the otherwise unknown Oolitic beast could be safely or scientifically drawn; still less could the Palæontologist be justified in jumping at the conclusion that the old user of this solitary evidence of its dental tools had been a saltatory herbivore! If one desired to have it believed that a Macropodal or Poephagous Marsupial had existed in Triassic or Oolitic antiquity, he might indeed substitute for scientific reasoning confidence of assertion.[1]

With a fossil premolar as like that of *Hypsiprymnus* as the last premolar of *Plagiaulax* is unlike,—I will not insult the common sense of Zootomists by citing the microlestian denticle (Pl. I, fig. 16) as a parallel case,—the competent Palæontologist viewing such premolar would call to mind instances where similar premolars are associated, in the Mammalian class, with very different molars, canines, and incisors. A premolar does a part, but not the whole, nor commonly the main work, of the preparation of the food for deglutition and digestion, &c. A premolar may show, as in *Hypsiprymnus* and *Plagiaulax*, an admirably fitting instrument for dividing by cutting or by sawing. But such a fossil instrument cannot, by itself, teach the nature of the substances to the division of which it was applied by the living animal; still less can it justify a conclusion as to the kind of locomotion with which the beast carried itself to its food or prey.

The great master and founder of Palæontology has been held by some to have hazarded over much in estimating the amount of inference that could be drawn from a solitary fossil tooth. But this at least all subsequent experience has confirmed, that he selected the class of teeth which best justifies his axiom. I proceed, next, to consider the physiological deductions which may be drawn from our knowledge of these light-giving elements in the dentition of *Plagiaulax*.

[1] Thus, Mr. Boyd Dawkins affirms:—"The presence of the *Macropoda* (Van der H. = *Poëphaga*, Owen) is proved by the discovery of the Kangaroo-rat allies: namely, in the Purbeck beds, of the *Plagiaulax*, the true affinities of which have been so amply demonstrated by Dr. Falconer ('Quart. Journ. Geol. Soc.,' vol. xiii, p. 261; vol. xviii, p. 348); in the Rhætic bone-bed, of the *Microlestes* of Frome and Diegerloch, closely allied, according to Professor Owen, to *Plagiaulax* ('Palæont.,' p. 303); and, lastly, in the strata below the bone-bed, by the discovery of the *Hypsiprymnopsis Rhæticus* of the Watchet shore." 'Quarterly Journal of the Geological Society of London,' vol. xx (1864), p. 412.

§ XVIII. Physiological Deductions.

From the shape of a tooth may be inferred its work; a pointed one to pierce, a trenchant one to cut, a broad knobbed or ridged crown to bruise. But the kind of substances to be pierced, cut, or ground demands other considerations than that of mere shape to determine. The chief of these is the kind of teeth with which the piercers, the cutters, or the pounders may be respectively associated, more especially the first two. If the Palæontologist has no other part of the skeleton than a jaw with teeth to work from, the guiding principle of correlation is correspondingly limited in its applicability. Cuvier's choice of tooth or class of teeth as being of highest correlative value, or as throwing most light on the food and habits of an unknown and extinct Mammal, still commends itself to my experience as the best.

Guided by his rule,[1] my first attention was paid to the molar teeth of *Plagiaulax*. These are too few, too small, and occupy too short a space in the dental series to perform the effective kind and amount of mastication required for the preparatory act of digestion of vegetable substances.

Known only as they exist in the lower jaw, the analogy of *Thylacoleo* teaches that they would not be in greater, were more likely to be in less number, in the upper jaw; accordingly, the inference of their functional relations to food may be legitimately drawn.

Every known instance of a like condition of tubercular molars points to the modifications of the rest of the dental series for predatory life and animal diet. And this, as regards the mandibular dentition of *Plagiaulax*, we have seen to be the case in every species and variety.

A pair of teeth, placed favorably at the fore part of the jaw, manifest the length, strength, sub-compressed, sub-recurved, pointed form of the laniaries of the Carnivore, and suggest the application to seizing, piercing, lacerating, slaying. The major part of the alveolar tract is occupied by teeth of the trenchant carnassial or shear-blade type.

There are few instances in which the sagacity of Cuvier in directing primary attention to the 'dents molaires' is better exemplified than by the small extinct Mesozoic Marsupial under consideration.

The Musk-deer has a pair of canines almost as formidable for lethal purposes as the upper ones of *Machairodus*. The Gorilla has canines in shape and proportion like those of the ordinary large Carnivora; the Baboon adds to them the secondary feline characters of longitudinal grooves and the trenchant ridge; but the tyro taking these teeth only for his guide or basis of physiological reasoning would be led astray.

The light-giving teeth in each case, by their massive cubical crowns, complex configuration and structures, number, and large proportion contributed by them to the

[1] "La première chose à faire dans l'étude d'un animal fossile est de reconnoître la forme de ces dents molaires; on determine par la s'il est carnivore ou herbivore."—Cuvier, 'Recherches sur les Ossemens fossiles,' 4to (1822), tom. iii, p. 1.

dental series, bespeak plainly the secondary or subsidiary function of the associated long and large laniaries, as weapons, viz. of defence or of sexual combat.

The true molars tell a similar story in every species of carpophagous and poephagous Marsupial. Detached lower incisors of the Kangaroos are long, pointed, and sharp-edged; in the Bettongs and Potoroos their tapering ends begin to manifest scalpriform modifications.

The procumbent, in many Kangaroos almost horizontal, position of these teeth warns against the conclusion that they were made to pierce as weapons, offensive or defensive: closely looked to and compared with true laniaries, such as those in *Potamogale* (figs. 16, 24) *Thylacoleo* (figs. 15, 18), and *Plagiaulax* (fig. 12), characters of shape and structure, besides those of direction or position, are discerned in the incisors of Poephagans (figs. 10, 13, 14) which relate to other ends than stabbing and tearing; to uses which require opposing teeth of a different character and in greater number than in paucidentate Marsupials.

The premolars of *Plagiaulax* are plainly made to cut; the strengthening of the blade by enamel-ridges, and the serration of the cutting edge, due to their oblique course, suggest an occasional application to tougher tissues than merely muscular. In the trenchant and vertically grooved premolars of Potoroos and Bettongs the margin is notched, but it has not the true serrate character which the oblique and unequally bordered dentations give to the cutting edge of the carnassials of *Plagiaulax*. The three or four such premolars in this genus combine their oblique serrate margins into a curved line like that of part of a circular saw; the notched edge of the single premolar in *Hypsiprymnus* is straight.

The many and large molar teeth and procumbent sub-scalpriform incisors associated with the trenchant premolars of Potoroos and Bettongs, show the kind of substances these were destined to cut. We know it to be tough, dry vegetable substances, such as the coarse grasses of the *Xanthorrhœa*, the tegument of the Cycadeous *Macrozamia*, root-fibres, &c.

The few and small molar teeth and suberect laniariform incisors associated with the serrate premolars of *Plagiaulax* show that they operated upon animal tissues; the evidence of the many and varied kinds of small Saurians coexisting with *Plagiaulax* significantly indicate the tough integument which such modified carnassials would be well fashioned to divide.

Trenchant premolars need not the ridged and serrate structure "for chopping up fruits or succulent vegetables;"[1] the very perfection and strength given to the carnassials of the little saurivore indicate the nature of the nutritive substances they operated on, and the needlessness of supplemental pounding or masticating teeth in greater number or of greater size than *Plagiaulax* possessed. Roots and grass "chopped up" by the premolars of

[1] Flower, Prof. Wm. Henry, F.R.S., "On the Affinities and probable Habits of the Extinct Australian Marsupial, *Thylacoleo carnifex*, Owen," in 'Quarterly Journal of the Geological Society of London,' vol. xxiv (1868), p. 318.

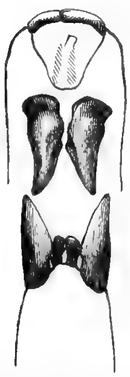
Rat-kangaroos would hardly, in that state of division, be fit for swallowing; accordingly we find a provision of not less than sixteen square and broad-crowned, ridged, and tuberculate grinders, superadded to the trenchant teeth, in order to pound up the chopped roots and grass, and to well blend those dry vegetable cuttings with abundant salivary secretion, in order to prepare a bolus fit for deglutition and subsequent digestion.

§ XIX. Objections to the Carnivority of *Plagiaulax* examined.

The procumbent pair of lower incisors in *Poephaga* oppose the upper surface, not the end of the tooth, to three pairs of upper incisors, of which the foremost is longest. By the analogy of *Thylacoleo* the suberect pointed pair of lower incisors in *Plagiaulax* would be crossed by a correspondingly developed and deflected pair of laniariform incisors; and, if these were followed by others in the premaxillary bones, they would probably be rudimental and limited, as in *Thylacoleo*, to a single pair.

The functional incisors in both jaws would act as in *Thylacoleo*, the lower ones like a pair of bayonets, cemented side by side, with the muscular forces of both mandibular rami concentrated on the thrust. A like advantage in lethal stabbing power is gained by the same "collateral arrangement in the axis"[1] of the perforating stroke, in many of the Ferines ("Carnassiers") of the Cuvierian system. It is interesting to note, however, that these instances occur in the orders ('*Insectivores, Marsupiaux*') which I have proposed to place, through cerebral characters, on lower steps in the Mammalian series; the lissencephalous and lyencephalous conditions of brain seeming to me of greater taxonomic value than the "possession of claws and of three kinds of teeth."[2] With lower intelligence the power of the killing teeth is heightened; and a like relation is not unfrequently exemplified.

Fig. 16.



Front view of upper and lower incisive laniaries, *Potamogale velox*; twice nat. size.[3]

Observation of the habits and actions of the lissencephalous Otter (*Potamogale*, Du Chaillu), with approximate or "collateral" laniaries (fig. 16), shows them to be as efficient, to say the least, in the capture and slaughter of its prey, as are the divaricate laniaries in the gyrencephalous Otter (*Lutra*). The Hedgehog

[1] Falconer, "On the disputed Affinity of the Mammalian Genus *Plagiaulax* from the Purbeck Beds," in 'Quarterly Journal of the Geological Society,' vol. xviii (1862), p. 352; also, "Palæontological Memoirs," vol. ii, p. 435.

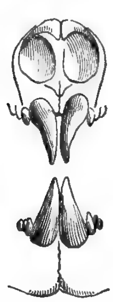
[2] "Les Carnassiers forment une réunion considérable et variée de quadrupèdes onguiculés, qui possèdent les trois sortes de dents." Cuvier, 'Regne Animal,' tom. i, ed. 1829, p. 110. But see, Owen, "On the Characters, Principles of Division, and Primary Groups of the Class *Mammalia*," in 'Proceedings of the Linnean Society,' Feb., 1857; also, "Anatomy of Vertebrates," 8vo, vol. ii, p. 296.

[3] I am indebted for the drawing from which cut fig. 16 was taken to Prof. Allman, F.R.S., of the University of Edinburgh, where the unique skeleton of that rare genus is preserved.

(*Erinaceus*) adds young Rabbits to its miscellaneous and lower animal diet, and kills them as effectually by its approximate laniaries as does the Stoat by its divaricate ones. Breeders of poultry will hardly be prepared to endorse the epithet "mild" applied by Prof. FLOWER to "the ferocity and destructive power" of the Rat as compared with the Ferret;[1] if the application of their respective lethal weapons upon defenceless birds be the subject for consideration. No doubt, in combat, the Terrier or the Ferret gets the better of the carnivorous rodent. We may admit that *Triconodon mordax*, the contemporary of the *Plagiaulax minor*, might have overcome and devoured that little predatory Diprotodont; but this would afford no ground for denying the power of the latter to pierce and slay, by means of its approximate laniaries, the comparatively defenceless *Saurilli, Macellodi, Nuthetes*,[2] and other diminutive lacertines.

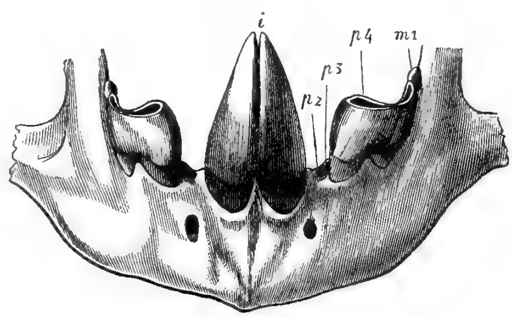
In the *Insectivora*, as in the *Marsupialia*, there are two local conditions of the teeth which are adapted "to pierce, retain, and kill." In some, *e.g. Gymnura, Dasyurus*, the laniaries answer, in position, to the canines of gyrencephalous *Carnivora*, and 'are held well apart through the interposition of a line of incisors:' in others, *e.g. Potamogale* (fig. 16), *Solenodon, Erinaceus, Scalops, Urotrichus* (fig. 17), *Plagiaulax, Thylacoleo* (fig. 18), the laniaries are approximate, or are separated at their base by only a single pair of minute incisors (fig. 16).

FIG. 17.



Front view of upper and lower laniaries, *Urotrichus talpoïdes*, magn.

FIG. 18.



Front view of lower incisive laniaries, ½ nat. size, *Thylacoleo carnifex*.

The transference of the laniary form and function from the canines to the incisors, the development of the latter locally characterised teeth into lethal weapons, is the rule in the lissencephalous members of CUVIER's 'Carnassiers.' Whether, however, the laniaries, which "are kept well apart" in *Moschus*, as in *Felis*, or which are approximate in *Plagiaulax* as in the many predaceous species above cited, be really used to pierce, hold, and kill other animals for food, cannot be determined in an extinct species "by a facile observation of mere form,"[3] but by the laws of physiological correlation. Referring to the molars of

[1] 'Quarterly Journal of the Geological Society,' vol. xxiv (1868), p. 318.

[2] OWEN, 'Quarterly Journal of the Geological Society,' vol. x (1854), p. 420.

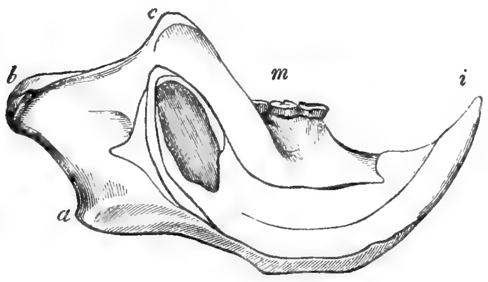
[3] FALCONER, 'Quarterly Journal,' &c., p. 358, 'Palæontological Memoirs,' p. 441.

Moschus, we should be justified, if we knew that animal solely by its petrified jaws and dentition, in concluding that its canines, notwithstanding their formidable development and their position as "held well apart," with "the points of penetration doubled, the dilacerating and killing powers multiplied," [1] were, nevertheless, not used for predaceous ends, but merely as weapons of sexual combat and defence. Similarly, a reference to the molars of *Plagiaulax* and *Thylacoleo* teaches that the approximate laniaries, "placed collaterally in the axis of the jaws, one on each side, above and below,"[2] were related to carnivorous habits.

As beautiful as they are true are the laws of correlation rightly discerned. With the carnivorous type of dentition of *Plagiaulax* are associated the characters of the carnivorous type of mandible (fig. 12). With the herbivorous teeth of *Hypsiprymnus* go the high-placed condyle, the small sloping coronoid, and the extension of jaw below the condyle for adequate implantation of the pterygoid muscles chiefly concerned in the working of molars framed for grinding vegetable substances (figs. 13 and 14).

In my memoir on the Aye-aye I had to note that the mandibular condyle was "sessile, narrow, rather long, convex both across and lengthwise, and placed on the level of the grinding teeth," and I remarked that "the sessile condyle contrasts strongly with the pedunculate one, especially in the small extinct ferines (*Plagiaulax* and *Triconodon*) of the Purbeck beds, a concomitant difference being shown in the dentition; trenchant teeth, grooved as in the lower carnassials of *Thylacoleo,* take the place of the flat-crowned molars of *Cheiromys*."[3]

Fig. 19.



Cheiromys: mandible and teeth, the incisor exposed: nat. size.

Prior to this discovery no such low position of the mandibular condyle was known, "in any herbivorous or mixed-feeding Mammal," supposing the Aye-aye to be such.

De Blainville had stated that the condyle was "nearly at the posterior extremity of the entire jaw,"[4] and he might have affirmed it to be quite there; but of its relative position to the alveolar series neither the text gave information, nor did the figure of the skull with the co-articulated mandible permit of a certain conclusion on that point. Dr. Falconer reproducing the same view of the detached mandibular ramus of *Cheiromys* which I had given in pl. 20, figs. 7, 8, of my memoir (see fig. 19), omits any notice of that figure. He cites only the work which I published the year before I received the unique

[1] Falconer, 'Quarterly Journal,' &c., p. 352, 'Palæontological Memoirs,' p. 435.

[2] Ib., ib., p. 352; ib., p. 435.

[3] 'Transactions of the Zoological Society of London,' vol. v, pt. 2, 4to, 1863 (read January 14 and 28, 1862), pp. 50, 81.

[4] "Presque à l'extremité postérieure de toute la mâchoire," 'Ostéographie, Mémoire sur l'Aye-aye,' p. 19.

specimen of Aye-aye, and then turns upon me the weapon with which I had furnished him.[1] "The author of 'Palæontology' states that it is a "character unknown among any herbivorous or mixed-feeding animal." "I again refer my reader," pursues Dr. FALCONER, "to the figure (fig. 20) of the lower jaw of the Aye-aye. In it the articular surface of the condyle, although directed subvertically, or at the most diagonally, is wholly below the grinding plane of the molars. It looks still more depressed in *Plagiaulax Becklesii;* but this is, in part, owing to the inflected margin of the angle being broken off in the fossil, while it is entire and salient in the recent form, thus elevating the condyle above the lower plane of the ramus, and leading to an appearance of a greater amount of difference than exists in nature."[2]

I will presently refer to the grounds assigned for concluding *Cheiromys* to be a herbivorous or mixed-feeding genus; and, referring to the description of the mandible in *Plagiaulax Becklesii* (p. 77) for the evidence of non-extension of the angle beyond the lower end of the condyle in that species, I will now offer a few remarks bearing upon the relative value of the molar teeth, and the position of the condyle of the mandible in the interpretation of the habits and food of an extinct Mammal.

Position of condyle relates to the force with which the mandible is worked, shape and pedunculation of the condyle to the direction of the working force.

The flattened or less convex articular surface favours the rotatory movements; the more convex, especially transversely extended, and pedunculate or subpedunculate condyle indicates the ginglymoid articulation with greater extent of divarication or wider gape, and more habitual movements in one plane, or limited more or less thereto. The rotatory grinding movements of the mandible are commonly associated with a high position of the condyle and vegetable diet; the vertical biting movements are commonly associated with a low position of the condyle and animal diet. But the advantage of a long lever afforded by a lofty coronoid process and low-placed condyle may co-relate with powerful biting and gnawing actions, as in the working of the maximised scalpriform teeth of *Cheiromys*.

These instruments are wielded by the powerful and favorably formed jaw with a force which enables the Aye-aye to rapidly erode or gouge away the hardest timber. To infer it to be a vegetable-feeder from the scalpriform teeth, and the associated low condyle, and other mandibular modifications, is to assume the ligneous fibre to be gnawed by the animal for food. But, were the species extinct, the molar teeth would teach that this could not be; few, small, flat-crowned, or tuberculate, they plainly point to operations on nutritive substances from the animal kingdom.

A captive Aye-aye, it is true, endured a regimen of rice for two months before it died. And this fact is cited to prove it to be a herbivore![3]

[1] 'Memoir on Aye-aye,' op. cit., pl. xx, figs. 7, 9; 'Palæontological Memoirs,' vol. ii, pl. 34, fig. 13.

[2] 'Quarterly Journal of the Geol. Soc.,' vol. xviii (1862), p. 361; also, 'Palæontological Memoirs and Notes,' 8vo, 1868, vol. ii, pp. 445, 446.

[3] "One of the live specimens procured by Sonnerat lived in captivity two months fed on boiled rice.

But were the maximised chisel-teeth, with a low-placed mandibular condyle and biting power of jaw, needed to divide the stems of rice or the stalks of dates or of bananas?

SONNERAT, besides specifying the compulsory food on which his captive Aye-aye perished, describes the long, slender, naked, middle digit, and states: "Il s'en sert pour tirer des trous des arbres les vers qui sont sa nourriture."[1] I understand this to mean that larvæ ('vers') are its natural or staple food. The affirmation may have been made from SONNERAT's observations on *Cheiromys* in a state of nature, or on the reports of natives of Madagascar, or on both authorities.

Dr. SANDWITH adds to his account of the substances on which he fed his Aye-aye a detailed statement of observations of its power of detecting, exposing, and extracting the xylophagous larvæ, which it eagerly devoured, confirmatory in an important and instructive degree of SONNERAT's statement of its food in a state of nature:[1] nor is other testimony to the same fact wanting.[2] And to the acquisition of such animal food the dental and mandibular machinery of *Cheiromys* are as perfectly adapted as was the same machinery in *Plagiaulax* to the different kinds of animal food which that extinct Marsupial captured and fed upon.

The large front teeth in *Cheiromys* are curved in segments of circles (fig. 19, *i*), the depth of the tooth exceeding the breadth; the working surface is elongated, in breadth equalling that of the base of the tooth, with a front convex enamelled border, forming the apex of the gouging tool.

With what molars are these scalpriform teeth associated? Few, small, tubercular (fig. 19, *m*): fitted for squeezing the soft animal nutriment out of the tegumentary covering of a caterpillar; not adapted for trituratory mastication of such vegetable food as calls for the more complex and massive molars of the Kangaroos, Potoroos, and Koalas, or of the xylophagous Voles and Beavers.

In another part of the polemical paper advocating the macropodal affinities of *Plagiaulax*, the angular process of the jaw as a salient apophysis is stated to be wanting in that genus, and an argument for its herbivority is based upon the assertion that "this process is a very constant character of the carnivorous jaw," and that "it is well developed in the minute insectivorous *Myrmecobius*."[3]

To this I reply, that the angular process is not present in *Stenorhynchus* and some

The species of *Hypsiprymnus* are strictly vegetable-feeders." FALCONER, 'Quarterly Journal of the Geological Society,' vol. xviii (1862), p. 364; 'Palæontological Memoirs,' 8vo, 1868, vol. ii, p. 449. "Dr. SANDWITH fed his captive Aye-aye upon bananas and dates." Ib., ib., p. 450. By parity of reasoning the Kite (Home, "Lectures on Comp. Anat.," 4to, vol. i, p. 271) and Sea-gull (OWEN, "Physiol. Catalogue of Mus. Coll. Surgeons," 2nd ed., 8vo, p. 151) might be cited as herbivorous. This and the passage on the rice-feeding were read to the Zool. Soc., Jan. 14th, 1862.

[1] "Voyage aux Indes Orientales," &c., Paris, 4to, 1782, and Ed. 8vo, 1806, vol. iv, p. 122.

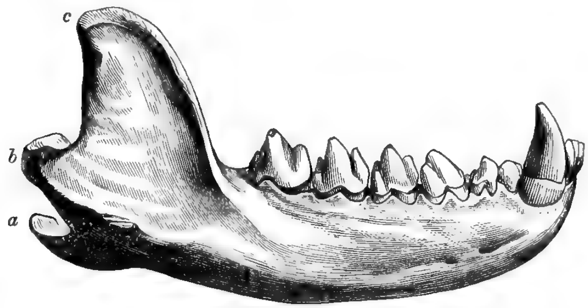
[2] OWEN, "On the Aye-aye," 4to, 1863, p. 25.

[3] FALCONER, 'Quart. Journ. Geol. Soc.,' vol. xviii, p. 363; 'Palæont. Memoirs,' p. 448.

other Seals; nor is it peculiar to the mandible of *Carnivora* even "as a salient process;" and, furthermore, as such, it is not wanting in *Plagiaulax;* only, it is directed inward immediately below the condyle in that Marsupial, not, as in *Myrmecobius* from a part of the jaw continued downward below the condyle.

The differences which the *Marsupialia* present in the position, form, and degree of inflection of the angle of the jaw are noted in the works cited below.[1] "The condyle of the jaw is nearer the plane of the inferior margin of the ramus in the Thylacine, (fig. 5,

FIG. 20.



Mandible and teeth, *Dasyurus ursinus.*

p. 74) and Dasyure (fig. 20), than in the Opossums; and, consequently, when the inflected angle is broken off, the curve of the line continued from the condyle along the lower margin of the jaw is least; in this particular again the Phascolothere resembles the Thylacine."[2] The *Plagiaulax* repeats this characteristic of the most carnivorous members of its order, but with still less degree of curvature.

One other proposition seems of sufficient weight, in relation to the scientific standing of the Objectors to my conclusions as to the habits and affinities of *Plagiaulax,* to call for notice; although its very suggestion betrays a sense of the insecurity of the grounds on which the herbivorous and saltatory nature of *Plagiaulax* has been contended for.

The species of this genus are affirmed to have been animals too small, too feeble, to have preyed upon others, especially when much larger than themselves.

Whoever has witnessed the well-known zoological phenomenon of the pertinaceous pursuit and fatal attack of a Hare by the diminutive Weasel would pause, however, before venturing on such ground.

Dr. FALCONER,[3] selecting for his example the most diminutive of the species of *Plagiaulax,* remarks:—"The entire length of the specimen, including the six molars and premolars, together with the procumbent incisor (according to the metrical line *e*), does not exceed ·4 of an inch, of which the six cheek-teeth united make only about two and

[1] 'Geological Transactions,' 2nd series, vol. vi, p. 50; 'Zoological Transactions,' vol. ii, p. 392; 'Cyclopædia of Anatomy,' Art. *Marsupialia,* vol. iii, p. 275.

[2] 'Hist. of British Fossil Mammals,' 8vo, 1840, p. 65.

[3] FALCONER, opera cit., pp. 363 and 448.

a half lines (·25 inch). I ask any zoologist or comparative anatomist to look at it, and say whether the dental apparatus of this extremely minute creature is competent to perform the duties required of a predaceous carnivore.

"Magnitude in this case is an important ingredient, as it necessarily involves measure of force. Could *P. minor* have preyed on small Mammals and Lizards? Is it not more probable that this pigmy form was itself an object of prey in the Purbeck Fauna?"[1]

To this I reply that the original, now before me, of "fig. 15, *Plagiaulax minor*, of the 'Quarterly Journal of the Geological Society of London' for August, 1857 (vol. xiii, p. 281)," reproduced in the subsequent polemical paper of Dr. FALCONER, in 'Quarterly Journal,' &c., for June, 1862 (vol. xviii, p. 367), and copied in pl. 34, fig. 2, of the Posthumous Work 'Palæontological Memoirs' (p. 416), shows two molars and four premolars; the incisor is neither chisel-shaped nor procumbent; but rises with a slight curve to its pointed apex at an angle of 120° with the line of the molar alveoli (fig. 21). The length of the dental series from the apex of the laniariform incisor to the hind part of the second molar is seven sixteenths of an inch, precisely the length of the dental series in *Urotrichus talpoïdes*—a transitional Shrew five inches long, from the snout to the tip of the tail, with a skull one inch in length, and a pair of lower pointed incisors (fig. 17) upcurved at the same angle as in *Pl. minor*, but relatively less and shorter (fig. 22, A).

FIG. 21.

Mandible and teeth, nat. size, *Plagiaulax minor.*

I am not cognizant of any grounds afforded by Zoology which forbid the supposition that a Mammal of five inches in length, with the carnivorous type of dentition of *Plagiaulax*, may have been able to capture and kill the diminutive species of Lizard (*Saurillus*,[2] &c.) abundantly associated with *Plagiaulax* in the Purbeck shales. Comparative anatomy suggests that the modifications of the dentition of *Plagiaulax minor*, as compared with the similarly sized Shrew (*Urotrichus*), would give the Purbeck Marsupial both the disposition and power to attack and prey upon animals of a larger size and higher organization than worms and insects. But the question of the carnivority of the genus *Plagiaulax*, if weighed by 'magnitude as a measure of force,' is not fully or fairly tested by the exclusive example of the most diminutive species.

In *Plagiaulax Falconeri* (Pl. IV, fig. 16) the extent of the dental series, lower jaw, is nine sixteenths of an inch: in *Plagiaulax Becklesii* (ib., figs. 10, 11, 12, and fig. 8, p. 86), it is ten sixteenths of an inch.

The entire length of the mandible in this species, inclusive of the incisor, in a straight line, is one inch three sixteenths; the depth of the ramus at the back part of the large carnassial is five sixteenths of an inch.

In the Weasel (*Mustela vulgaris*, fig. 22, c) the extent of the dental series, lower jaw, is eight sixteenths of an inch; the entire length of the mandible, inclusive of the

[1] FALCONER, op. cit. Ib., p. 363; ib., p. 448.

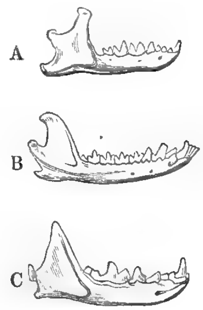
[2] OWEN, 'Quarterly Journal of the Geological Society,' No. 40, 1854, p. 420.

incisors, in a straight line, is thirteen sixteenths of an inch; the depth of the ramus at the back part of the large carnassial is two sixteenths of an inch.

In the Opossum, *Didelphys dorsigera* (fig. 22, B), the extent of the mandibular dentition is ten sixteenths of an inch.

With the greater relative depth and consequent strength of the jaw of *Plagiaulax* (fig. 23), a greater size and strength of both laniary (*i*) and carnassial teeth (*p*) are concomitant. The condyle (*b*), which is on the level of the dental series in the Weasel, and above it in the Opossum, is below that level in *Plagiaulax*. Every modification of the small Marsupial by which it departs from the little bloodthirsty placental is in the direction of greater carnivority.

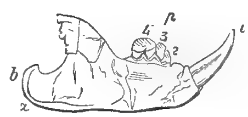
FIG. 22.



Mandible and teeth; A, *Urotrichus talpoïdes*; B, *Didelphys dorsigera*; C, *Mustela vulgaris*; nat. size.

In *Phascogale penicillata* the extent of the dental series, lower jaw, is fourteen sixteenths of an inch. It has four true molar teeth, relatively smaller laniaries, and still smaller sectorial premolars; the mandibular condyle is raised a little above the dental line; the carnivorous adaptation of both jaw and teeth is less marked than in the Purbeck Marsupial. But what is the testimony in regard to the habits of the existing pouched carnivore no bigger than a rat?

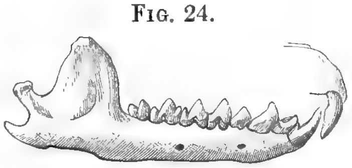
FIG. 23.



Mandible and teeth, *Plagiaulax Becklesii*; nat. size.

GOULD, who would be the last to repeat testimony to which zoology and comparative anatomy ran counter, writes:—" *Phascogale penicillata,* small as it is comparatively, is charged with killing fowls and other birds."[1] I can bear personal testimony, and that to my own loss, of the attack and slaughter of nearly full-grown Shang-hai pullets by *Mus decumanus*. Comparative anatomy lends more aid to the credibility of the predatorial power of the carnivorous Marsupial than of the equally small Rodent; but that both of them do attack and destroy animals more than twice their own size and weight is a zoological fact.

FIG. 24.



Mandible and teeth with upper laniary incisor, *Potamogale velox*; nat. size.

Though magnitude may be, in one sense, a measure of force, it by no means necessarily involves, or teaches, the application of such force, and consequently is anything but ' an important ingredient ' in the question of the carnivority of *Mus, Mustela, Phascogale,* and *Plagiaülax*.

But whatever bears on the interpretation of the singular dentition of the small 'paucidentate' Marsupial logically applies to the larger one. There I admit the superiority of Mr. KREFFT, Prof. FLOWER and Mr. BOYD DAWKINS, over Dr. FALCONER, at least in consistency.

Mr. KREFFT gives drawings of sections of the " lower incisor of *Thylacoleo, Nototherium,*

[1] 'Mammals of Australia,' folio, Introduction, p. 18.

Diprotodon, Thylacinus, and *Sarcophilus;*" also of the "upper incisor and lower incisor of *Felis tigris;*" showing the relative size of the teeth in these animals, and, he asserts, "proving sufficiently that the *Thylacoleo* was far inferior in strength to a modern Tiger, and no match for ponderous Diprotodons and Nototheriums."[1]

If the carnassial tooth were selected instead of an incisor, it would show, on the above basis, that *Thylacoleo* was "far superior in strength and carnivority to the modern tigers and lions." But I would submit that the relative size of a single tooth, if even the objector were able to recognise the homologous one in other Mammals, is not a decisive or sufficient test in the present question. It is evident that Mr. Krefft's figures 7 and 8 are sections of the canine, not the incisor, of the Tiger. But if the canine of the *Hippopotamus* were exemplified by a similar section, it would be no element, or a very deceptive one, in concluding as to the strength or carnivority of Behemoth. The canines of *Moschus* and other like instances will at once suggest themselves to the competent comparative anatomist.[2]

To the vague and rhetorical assertion of the 'gigantic Nototheres,' &c., being "many times as large as the *Thylacoleo,*" I will oppose a few matters of fact and mensuration. The length of the skull of the largest species of *Nototherium* (*N. Mitchelli*) is one foot six inches:[3] the length of the skull of *Thylacoleo carnifex* is nine inches eight lines; were the occipital ridge and spine entire in the specimen measured, it might be set down at ten inches. It will be within the bounds of accuracy to say that the Notothere was twice as large as the Thylacoleo. The skull of the *Diprotodon* is three feet in length: it is, however, large in proportion to the trunk and limbs: bulk for bulk, it was probably not much, if at all, larger in comparison with the *Thylacoleo,* than is the Giraffe in proportion to its destroyer the Lion. The disproportion between the Wolverene (*Gulo luscus*) and its prey, the Reindeer, must be greater than that which the dimensions of the known fossils of *Thylacoleo* and *Diprotodon* suggest. The length of a Lion's skull before me is one foot; that of the skull of a South African Giraffe is two feet two inches.

If we next compare, not a single tooth, merely, but the whole lethal dental weapons of *Thylacoleo* and *Felis tigris,* we get the following results. The length from the fore part of the laniary to the hind part of the carnassial, upper jaw, is in *Thylacoleo* four inches two lines; in *Felis tigris,* three inches seven lines; in *Felis spelæa,* four inches; in the lower jaw the same measurement in *Thylacoleo carnifex* gives four inches three lines.

[1] "On the Dentition of *Thylacoleo carnifex*" (Ow.): in the 'Annals and Magazine of Natural History,' 3rd series, vol. xviii, 1866, p. 148.

[2] Prof. Flower, F.R.S., however, lends his sanction to Mr. Krefft's objection, and rejects the hypothesis "that *Thylacoleo* was the destroyer of the gigantic herbivorous Marsupials (many times as large as itself) with which its remains are found associated, the Diprotodons and the Nototheres." 'Quarterly Journal of the Geological Society,' vol. xxiv (1868), p. 318.

[3] Owen, "On some Outline Drawings and Photographs of the Skull of *Nototherium,*" 'Quarterly Journal of the Geological Society of London,' vol. xv, p. 173, pl. vii (1858).

The proportions are reversed in Felines; but the difference affords no reasonable ground for inferring such inferiority of strength or destructive power as to support the inference that *Thylacoleo* was incapable of playing the same part in relation to Nototheres and Diprotodons as the Lion now performs in relation to Buffaloes and Giraffes.

The remains of the large extinct *Herbivora* of the Pleistocene period in Britain, which have been found in the limestone caves of Weston-super-Mare, Torquay, Pickering, &c., are held to have been, in most cases, parts of animals which have fallen a prey to the contemporary *Carnivora* now also extinct.

The caves of the limestone district of Wellington Valley, Australia, reveal phenomena of extinct animal life closely analogous. I infer that the fossils, always more fragmentary than those from the tranquil fresh-water deposits, of the Diprotodons, Nototheres, large Kangaroos and Wombats, surpassing in size any existing species, were remains of animals which had fallen a prey to contemporary *Carnivora.* Now, no species bearing such proportion to the *Diprotodon* and *Nototherium,* as the spelæan Lion, Bear and Hyæna, bore to the Mammoths, Rhinoceroses, primigenial Oxen, huge Deer, &c., in Europe, has hitherto been detected in Australian bone-caves, save the *Thylacoleo carnifex.* To its associated carnivorous cave-fossils, the Thylacine, or the Dasyure (*Sarcophilus*), the objection of defective strength and bulk might be specious; but, as applied to the *Thalacoleo,* it is simply absurd.

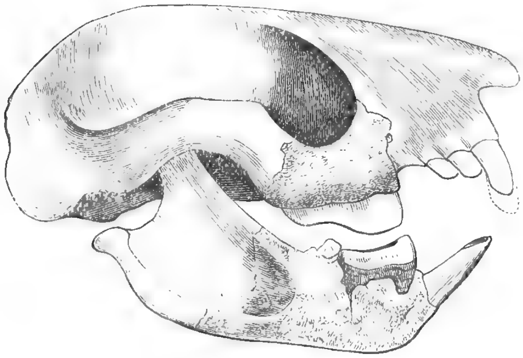
A comparison of fig. 15, p. 93, with fig. 12, p. 90, will show, by the obvious similarity of their subjects, that a refutation of the asserted herbivority of *Thylacoleo* is associated with the grounds of the interpretation submitted, in the present Monograph, of the *Plagiaulax* as a marsupial Carnivore allied to the later, larger, and more specialised carnivorous *Thylacoleo.*

In the main the descriptions or definitions of the characters of the fossil remains of *Plagiaulax* by my antagonists and myself are the same: the chief difference herein is, that I interpret the fractured surface of the angle of the jaw in a specimen of *Plagiaulax Becklesii* (Pl. IV, fig. 10, *a*) as indicative of that part having been bent inward immediately below the neck of the condyle as in *Sarcophilus* (fig. 20, *a*) and *Thylacinus* (fig. 5, *a*); whilst Dr. Falconer contends that the part broken away descended below the condyle as in the mandible of the Aye-aye (fig. 19, *a*). To elucidate this discrepancy as to matter of fact, I have reproduced, in fig. 12, p. 90, the magnified view of the mandible of *Plagiaulax* given by Falconer (loc. cit.), of a specimen which I have not seen, and hold it to be confirmatory of my deductions from the specimens (Pl. IV, figs. 9—15) which I have carefully scrutinised.

So likewise with regard to *Thylacoleo,* I interpret the evidences of the fossil mandible (fig. 15) as indicative of an agreement with *Plagiaulax,* and with existing Marsupial *Carnivora,* in the form and proportions of the coronoid process, and the indication of the low position of the condyle and its proximity to the inflected angle of the jaw.

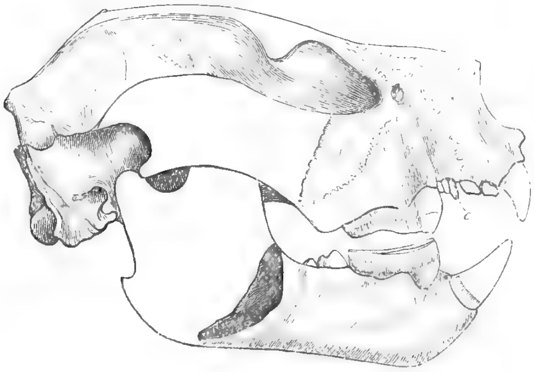
Messrs. KREFFT (fig. 25) and FLOWER (fig. 26) restore the mandible of *Thylacoleo*, in regard to these light-giving structures, according to the analogies of the carpophagous

FIG. 25.



Restoration of the skull and teeth of *Thylacoleo*, by Mr. Krefft, on the herbivorous hypothesis ('Ann. and Mag. of Nat. Hist.,' 1866, pl. xi).

FIG. 26.



Restoration of the skull of *Thylacoleo*, by Professor Flower, on the herbivorous hypothesis ('Quart. Journ. Geol. Soc.,' 1868, vol. xxiv, fig. 1, p. 312).

Phalangers and Koalas, and the poephagous Potoroos. But this restoration is shown by the specimen before me (fig. 15) to be erroneous. The dentition of the upper jaw restored on the same analogies is proved by the specimen figured in my last Memoir on *Thylacoleo*, communicated to the Royal Society, to be equally unfortunate.

The labours of Dr. FALCONER are worthy of highest praise; but loyalty to our common science compels me to say that he fell into his mistake as to *Plagiaulax* by neglecting its fundamental principle. (See Note, p. 96.)

Observing a general community of trenchant character, with grooves and ridges, between the premolar in certain *Poephaga* and one of the premolars of *Plagiaulax*, Dr. FALCONER jumped at the conclusion that the *Plagiaulax* was an herbivorous or 'Rodent' Marsupial like the Kangaroo-rat (*Hypsiprymnus*).

The one-and-twenty pages of the 'Quarterly Journal of the Geological Society,' and the forty-three pages of the posthumous volume of his 'Palæontological Memoirs,' devoted to a defence of this conclusion, have nevertheless seemed 'masterly' to some,[1] 'amply demonstrative' to others.[2] Something, therefore, needs to be said, by way of warning to beginners in Palæontology and in vindication of the noble science itself.

A few words, first, as to the extent to which affinity or conformity of organization, involving proportions and structure of limbs, resultant specialities of locomotion, habits, and food, may be predicated or inferred from the occurrence of secondary characters, such as grooves and ridges, in homologous teeth, not being molars. Certain *Quadrumana* have

[1] Prof. FLOWER, &c., op. cit., p. 307.

[2] Mr. BOYD DAWKINS, as quoted at p. 95.

long and large laniariform canines, longitudinally grooved,[1] sharp-pointed, with 'a trenchant posterior margin.'

In the *Carnivora* these characters distinguish the canines of Felines from those of other families and genera of the order. The correspondence in the number and direction (verticality) of the grooves on the crown of the sharp-pointed posteriorly trenchant canines, as well as in the number of those teeth, in the genera of *Quadrumana,* cited below, and in the genus *Felis,* is much closer than in the grooved trenchant premolars of *Plagiaulax* and *Hypsiprymnus.*

Now, suppose that our knowledge of the genus *Felis* was founded upon fossil remains of the mandible and mandibular dentition, from Mesozoic deposits. A Palæontologist detecting the correspondence of the fossil canine in the vertical grooves and trenchant hinder border, superadded to the common characters of a laniary tooth, with the canines of the existing Monkeys and Baboons, might infer that a Mammal had existed at the Mesozoic period with quadrumanous modification of limbs, scansorial habits and frugivorous diet.

Dr. FALCONER has drawn the parallel inference from the correspondence, such as it is, in the grooved and trenchant premolar teeth of *Plagiaulax* with those of *Hypsiprymnus,* namely, that there existed, at a Mesozoic period, a Marsupial with the saltatorial modification of limbs, leaping mode of progression, and herbivorous diet.

Mr. BOYD DAWKINS, therefore, draws the same conclusion, though with a much lower degree of likeness, in the assumed ridged and trenchant premolars, in regard to his "*Hypsiprymnopsis Rhæticus* of the Watchet Shore."[2]

The alleged "ample demonstration by Dr. FALCONER of the alliance of *Plagiaulax* to the Kangaroo-rats" is of the same kind and degree as that by which a Feline might be demonstrated to be a Baboon-ally.

The proof of the insufficiency of the ground afforded by the similarity of canine teeth is of the same kind as that by which I believe myself to have demonstrated the insufficiency of the ground afforded by the similarity of premolar teeth held to be 'amply demonstrative' of *Plagiaulax* being a 'Kangaroo-rat ally.'

The alleged correspondence of premolars is more than counterbalanced by the concomitant difference in the series of true molars presented by *Plagiaulax* and *Hypsiprymnus.* To the inference from the fossil jaw of *Felis* with canines having not only the same

[1] Owen's 'Odontography;' canines of *Hapale* (p. 439): canines of *Cebus,* — "those above being marked by the deep anterior groove: there is also a second longitudinal groove on the inner side of the crown near its posterior margin" (p. 440): in *Cynocephalus,* besides the grooves, the "trenchant posterior margin" of the long, pointed canine, is specified (p. 442): in *Papio maimon* "the anterior longitudinal groove of the canine is very deep, the posterior margin very sharp" (p. 316) The same character of canines is pointed out in *Papio porcarius* in the 'Catalogue of the Osteology in the Museum of the Royal College of Surgeons,' vol. ii (1853), p. 734, No. 4723. See also 'Anatomy of Vertebrates,' vol. iii, p. 316.

[2] Quarterly Journal of the Geological Society of London,' vol. xx (1864), p. 412.

peculiarity of grooving, but the grooves in the same direction, with some slight difference of position, and associated with the same trenchant hind border of the canine, that, therefore, it must be the jaw of a frugivorous or mixed-feeding Quadrumanous animal, I must have objected, as a disciple of CUVIER, and a believer in his 'Law of Correlation,' that the grooved and trenchant canines were associated in the Mesozoic fossil with large carnassial and small and few tubercular molars; whereas in the existing QUADRUMANA the grooved and trenchant canines are associated with several and large tubercular molars.

Similarly, the grooved and trenchant premolars of *Plagiaulax* are associated, in that Mesozoic fossil, with large laniaries and few and small tubercular molars; whereas in the existing "*Macropoda* (Van der H. = *Poephaga*, Owen)" the grooved and trenchant premolars are associated with many and large tubercular molars, besides being dissociated from large laniaries.

To me, therefore, the affinity of *Plagiaulax* to *Hypsiprymnus*, and the concomitant assumption of the saltatorial and herbivorous character of the small extinct Mesozoic Marsupial, are not demonstrated in any degree; the demonstration of the carnivority of *Plagiaulax* appears to be much more ample.

Referring to the page quoted by Mr. BOYD DAWKINS as proof of my opinion of the close alliance of *Microlestes* to *Plagiaulax*, I find the following:—"Amongst existing Mammals some of the small molars of the marsupial and insectivorous *Myrmecobius* of Australia offer the nearest resemblance to these fossil teeth, but a still closer one is presented by the small tubercular molars of the extinct Mammal called *Plagiaulax*." ('Palæontology,' 1st ed., p. 302; 2nd ed, p. 339.)

Now, here is no affirmation of alliance, close or loose, between *Microlestes* and *Plagiaulux*, but simply a statement of a resemblance between certain of their teeth. To be able to affirm of a 'close alliance' between *Plagiaulax* and *Microlestes*, the Palæontologist must know, not only the degree of resemblance between certain of their teeth, but also that between the rest of their dental system.

One must first learn in what numbers the small tubercular teeth of *Microlestes* were present in its jaws, and next with what other kind of teeth they may have been associated.

If my inferences be just and the conclusions they support be honoured by acceptance in Palæontology, it will not imply that my opponents had "fallen into errors of observation and description"[1] so much as it will "expose the fallacious train of reasoning which had led them astray;"[2] for which they "have no excuse to plead on the score of haste or want of due consideration."[3] Should *Plagiaulax* be permitted to rest, after the facts and reasonings on the fossil evidences at my command, in the paucidentate section of diprotodont Marsupials, with *Thylacoleo*, amongst the predaceous feeders on flesh, and

[1] Falconer, opp. citt., pp. 350, 433.
[2] Ib., ib. [3] Ib., ib.

not with *Hypsiprymnus* amongst the harmless saltatorial Herbivora, it will only be further proof of the worth and truth of the principle which Cuvier laid down as our guide in such dark routes in Palæontology.

§ XX. CONCLUSION.

The number of Mammalian species discovered in deposits of Mesozoic antiquity supports the inference of progressive advance. These early, if not initial, forms of the class are referable, on more or less demonstrative evidence, to the lyencephalous subclass; to that in which the brain has received least addition to its avian and reptilian status. Where the marsupial character is least clear in these little fragmentary fossils, the alternative from the plainer evidence is to the lissencephalous subclass. And it may well be, since, amongst the *Lissencephala,* the modern Insectivores show the first steps in the development or extension of the hippocampal commissure, entitling it to be called 'corpus callosum,' or 'supra-ventricular cross-band,' that intermediate steps in this cerebral progress may have been made by some of these Mesozoic Mammals, in which the marsupial characteristics are least differentiated from the modern Insectivorous types.

To the objection of the 'Uniformitarian,' that the fossil record of Mesozoic Mammalogy is too imperfect for inference, we may ask,—when he would be pleased to admit the evidence to be sufficient to affect belief or judgment? Is any class of fossils from any geological formation so extensively known as to justify the assumption that nothing exceptional or contradictory to conclusions therefrom may not ultimately turn up? Can the Zoologist demonstrate that he knows all the existing species of any one genus, order, or class? Does any misgiving of the imperfection of the records of living species warrant the suppression of the instinctive tendency to generalise from the facts at hand? Or, on the other hand, give liberty to guess or theorise without or against such facts?

In the present Monograph I submit evidence from three distinct and probably, as to time, very remote stages of that grand geological group of deposits, called 'Mesozoic.' There is a highly suggestive concurrence in the evidence, as at present derived, from Rhætic, Lower Oolitic and Upper Oolitic periods. To my mind it has a significance; and I believe its meaning and teaching to be against the uniformitarian assumption, and in favour of "orderly succession and progression due to Natural Law or Secondary Cause."[1]

Mesozoic Mammalian life is, without exception, on this evidence, low, insignificant in size and power, adapted for insect-food, for preying upon small lizards, or on the smaller and weaker members of their own low mammalian grade.

[1] Owen, 'On the Nature of Limbs,' 8vo, 1849, p. 86.

An easy show of a superior philosophy may be made by a profession of cautious expectancy, an assumption of due power of restraint, of reticence of reasoning, of self-denying abstinence from inference. Bulky Mammals, we may be reminded, are less numerous than dwarf kinds, so the chances of discovery of their remains are fewer; gyrencephalous Ungulates and Carnivores may still be found at Stonesfield, or Durdlestone, or elsewhere. And, if not, "In what circumstances is the *Phascolotherium* more embryonic, or of a more generalised type, than the modern Opossum?" asks Prof. HUXLEY, in his character of Advocate for the Uniformitarian view.[1]

There is not, to be sure, much of the old Marsupial left to enable the competent and equal observer to answer this question; but, if a clear reply be given by but half its jaw, we may infer that the whole animal would have been consistent in its ampler testimony.

Place the mandibular ramus and teeth of a *Didelphys* by the side of that of *Phascolotherium* (as in the specimen in the British Museum), and the more generalised type is conspicuous in the absence of the differentiation of the seven molars in the Oolitic fossil, which differentiation characterises the homologous teeth in the modern Opossum. The canine of the Phascolothere shows but a slight superiority of size over the antecedent teeth, which are of like shape to it, and are divided from each other by similar intervals. In the modern Opossum the canine is marked by greater relative size and difference of shape from the close-set group of small incisors anterior thereto. The seven molars of *Phascolotherium* show gradational differences of size, while that of shape is limited to slight simplification of the two smallest, which are the first and last of the seven teeth. In *Didelphys* the last four molars are abruptly and markedly differentiated both by size and complexity of structure, from the three preceding ones; so that zoologists distinguish the four as "true molars" from the three which are their "false molars." *Phascolotherium* shows no such grounds of distinction.

Only a physical defect of vision could fail to discern these "circumstances" by which the Oolitic Marsupial exemplifies the "more generalised type."

When hazarded assumptions and vague suppositions become facts, right reason will draw the proper deductions. In the meanwhile, on the basis gained by the results of the present research, the mind ponders on the prospect commanded over the Mesozoic earth.

We see, at every level and distance within such range, nothing moving of Mammalian life, save the low and the small; rat-like, shrew-like, forms of the most stupid and unintelligent order of sucklers. The results of Neozoic palæontology sometimes move one to exclaim, in regard to Mammals, "there were giants in those days!" but, descending to earlier periods, we find only dwarfs.

Amongst these initial forms of *Marsupialia* we may see in *Amphitherium* the prototype

[1] Speaking for Mr. Leonhard Horner, P.G.S., 'Quarterly Journal of the Geological Society of London,' vol. xviii (1862), pl. li.

of *Myrmecobius; Stylodon* has its analogue in *Chrysocloris; Peralestes* has culminated in *Sarcophilus; Triconodon* in *Thylacinus; Plagiaulax* is to *Thylacoleo* what the Weasel is to the Lion. But derivative change has not advanced to the long-limbed saltatory herbivorous type of Marsupial; nor has any evidence yet been had of a Mesozoic predecessor of the climbing Koala, the volant Petaurist, or the burrowing Wombat.

The American Mesozoic Marsupial (fig. 3, p. 20) exemplified the vegetative repetition of many molars, significant of the same low comparatively unspecialised grade of Mammal, evidence of which has been less sparingly, not to say more abundantly, got from European deposits of corresponding geological age.

The Marsupial type, through the operation, as I still believe, of some foreordained natural law or secondary cause, has, in America, "progressed to, and been succeeded by"[1] the more specialised form of *Didelphys;* in which, with reduction of molars to the present type number, there has been a specialisation of some as "premolars," of others as "true molars," strongly marked and carried to a degree far beyond anything which either figures or descriptions allow us to infer in the diminutive many-molared *Dromatherium sylvestre.*

The derivative descendants of the ancient American primeval forms of *Marsupialia* are reduced to that one genus or family called properly "Opossums" (*Didelphys* or *Didelphidæ*), now split up into such insignificant groups as *Philander, Hemiurus, Microdelphys, Thylamys, Chironectes,* &c., all having essentially the same modification and specialisation of Marsupial dentition as in *Didelphys* proper.

It is remarkable and perplexing in the endeavour to conjecture out the operation of the derivative law, to note, that the Mesozoic Marsupials of Europe, whose low, comparatively non-differentiated condition has been sufficiently exemplified and dwelt upon, have been also succeeded and finally represented in Europe by differentiated carnivorous Climbers (*Didelphidæ*); but on this continent they did not survive to enter the latter half of the Neozoic period. Our latest European fossil Marsupial is a Miocene Opossum.

Does the present rich and varied condition of Marsupial life in Australasia exemplify the changes which lyencephalous mammalian organization in Mesozoic America and Europe may have undergone or ramified into during the vast periods of time and changes of terrestrial surface which have intervened between the formation of the coal-fields of Virginia and its now growing gum-trees; or between the Rhætic breccias of Wirtemberg and the lacustrine marls of Auvergne?

If Australia possessed Marsupials as far back in time as did America and Europe, analogy would lead us to suppose that the primitive diminutive multimolar insectivorous type prevailed. It has not there yet become extinct; but it seems to have been reduced to the solitary exceptional form of the *Myrmecobius.*

Let us suppose all the now existing Marsupials of Australia to have lived there,

[1] 'Nature of Limbs,' p. 86.

contemporaneously with *Dromatherium* and *Amphitherium* in other and far distant parts of the earth, and with them to have become extinct; let us also suppose that our knowledge of such Australian Mesozoic Mammals depended, as in America and Europe, on the acquisition of their fossilized remnants in Triassic or Oolitic rocks. What, it may be asked, would be the chances of the geologist hitting upon the exceptional Myrmecobian?

At the dates of the publications of the works of WATERHOUSE and GOULD on Australian Marsupials, the *Poephaga* (kangaroos, potoroos, &c.) numbered forty-three species; the *Rhizophaga* (wombats) three species; the *Carpophaga* (phalangers, petaurists, koalas) twenty-two species; the typodentate *Entomophaga* (bandicoots, &c.) ten species; the *Sarcophaga* (thylacines, dasyures, phascogales) twenty-one species.

The probability is that the specially modified diprotodont dentition of the saltatorial herbivorous Kangaroos and Potoroos, since their numerous species are represented by more numerous individuals than are the species of the flesh-feeders, would be exemplified in the fossil series in a like numerical proportion with the multidentate polyprotodont genera in British Mesozoic beds.

Evidence, however, of Mammalian life from the corresponding epoch in Australia has yet to be obtained.

If the correlative Rhætic and Oolitic rocks there exist, entombing relics of the Mammals of the period, analogy would lead us to expect results like those now obtained from the study of the Mesozoic fossils of Europe and America.

Our knowledge of the extinct Australian Mammals has been hitherto supplied by fresh-water deposits and caves; and these, like the correspondingly recent graves of European Quaternary Mammals, yield evidence of progress to great diversity and specialisation of structures; manifested, moreover, in many species, with magnitudes indicating the favorable conditions under which Diprotodons, Nototherians, Thylacoleons, gigantic Kangaroos, Wallabees, and Wombats ranged and flourished before the advent in Australia of the destructive and all-conquering archencephalous biped.

By that which it has been my present aim to make known—the number and nature of British Mesozoic Mammals—and through considerations to which their contemplation has given rise, my belief has been strengthened in the Law of the Progress from the General to the Special, from the low to the high. It is illustrated in the succession of Mammals from the Trias upwards, as it is by that of other classes from the dawn of life (*Eozoon*) to the present period.

Table of Genera of Mesozoic Mammals.

- LYENCEPHALA .
  - Marsupialia
    - With more than two mandibular incisors. Molary series
      - more than the type-number (multidentate) . . .
        - *Microlestes.*
        - *Amphitherium.*
        - *Spalacotherium.*
        - *Dromatherium.*
        - *Amblotherium.*
        - *Peralestes.*
        - *Achyrodon.*
        - *Peraspalax.*
        - *Peramus.*
        - *Stylodon.*
      - in type-number (typodentate)
        - *Phascolotherium.*
        - *Triacanthodon*
        - *Triconodon.*
    - With not more than two mandibular incisors. Molary series
      - less than the type-number (paucidentate) . . .
        - *Plagiaulax.*

INCERTÆ SEDIS.

Stereognathus. Bolodon.

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PLATE I.

Microlestes Moorei.

FIG.
1. Upper molar, working surface.
2. Ib., inner side.
3. Ib., front side.
4. Ib., base view.
5. Upper molar, outer side.
6. Lower molar, working surface.
7. Lower molar, working surface.

7A. Ib., outer side.

8. Lower molar, outer side.

8A. Ib., front side.

9. Lower molar, working surface.
10. Lower (anterior ?) molar, inner side.
11. Lower (anterior ?) molar, side view.
12. Lower (anterior ?) molar, side view.
13. Upper canine.

From near Frome, Somersetshire. In the possession of the discoverer, CHARLES MOORE, Esq., F.G.S.

Microlestes antiquus.

14. Lower molar, outside view } (after PLIENINGER).
15. Ib., inside view } (after PLIENINGER).

15A. Ib., working surface } (after PLIENINGER).

From a Rhætic (Keuper) bone-bed at Diegerloch, Würtemberg. In the possession of the discoverer, Prof. Dr. PLIENINGER, of Stuttgart.

Microlestes rhæticus (*Hypsiprymnopsis*, Dawkins).

16. Lower molar.

16A. Side view of abraded surface.

16*a*. Part of working surface, with probable outline restored.

From Lower Rhætic marlstone, Watchet, Somersetshire. In the Geological Museum, Oxford.

All the foregoing specimens of *Microlestes* are magnified 4 diam.; the natural size of the fossil is given in outline.

17. Lower premolar (*p* 4) of *Hypsiprymnus murinus;* nat. size.
18. Ib. (*p* 4) of *Bettongia penicillata;* twice nat. size.
19. Upper molar, working surface, *Myrmecobius fasciatus;* magn. 4 diam.
20. Lower molar, grinding surface, ,, ,, magn. 4 diam.
21. *Amphitherium Prevostii,* left mandibular ramus, mutilated; nat. size.

21A. ,, ,, ib., dentigerous portion; magn. 4 diam.

22. ,, ,, left mandibular ramus, more entire; nat. size.

22A. ,, ,, ib., horizontal portion; magn. 2 diam.

23. ,, ,, right mandibular ramus, with teeth; nat. size.

23A. ,, ,, ib., magn. 2 diam.

24. *Myrmecobius fasciatus,* left mandibular ramus and teeth; nat. size.
25. *Amphitherium Broderipii,* left mandibular ramus and molar teeth; nat. size.

25A. ,, ,, ib.; magn. 2 diam. B. Ib., side-view of a molar tooth; magn. 4 diam.

26. *Phascolotherium Bucklandi,* mandibular ramus and teeth; nat. size.

26 A. ,, ,, ib.; magn. 2 diam.

27. *Stereognathus ooliticus,* portion of mandible, with three molar teeth, *a*, *b*, *c*, upper view; nat. size.

27 A. ,, ,, ib., side view; nat. size.

28. ,, ,, inner side view of crown of molar, *b;* magn. 6 diam.
29. ,, ,, outer side view of ditto; magn. 6 diam.
30. ,, ,, upper view, or grinding surface, of ditto; magn. 6 diam.
31. ,, ,, ib. of lower molar of *Pliolophus vulpiceps;* magn. 2 diam.
32. *Spalacotherium tricuspidens,* part of left mandibular ramus, with teeth; nat. size.

32 A. ,, ,, ib.; magn. 2 diam. B. Ib., oblique view of a molar tooth; magn. 4 diam. C. Ib., upper view of ditto; magn. 4 diam.

33. ,, ,, part of right mandibular ramus, with teeth; nat. size.

33 A. ,, ,, ib.; magn. 2 diam. B. Ib., back view of a molar tooth; magn. 4 diam. C. Ib., upper view of ditto; magn. 4 diam.

34. ,, ,, part of left mandibular ramus; nat. size.

34 A. ,, ,, ib.; magn. 2 diam. B. inner view of the two molars, 4, 5; magn. 4 diam.

35. ,, ,, part of left mandibular ramus; nat. size.

35 A. ,, ,, ib.; magn. 3 diam.

36. ,, ,, part and impression of part of the right mandibular ramus; nat. size.

36 A. ,, ,, ib.; magn. 3 diam. B. Ib., upper view of two fractured molars; magn. 3 diam.

37. ,, ,, part, and impression of part, of the same mandibular ramus in the counterpart slab of matrix.

37 A. ,, ,, ib.; magn. 3 diam.

38. ,, ,, left mandibular ramus.

38 A. ,, ,, ib.; magn. 2 diam.

39. *Spalacotherium minus,* left mandibular ramus; nat. size.

39 A. ,, ,, ib.; magn. 3 diam.

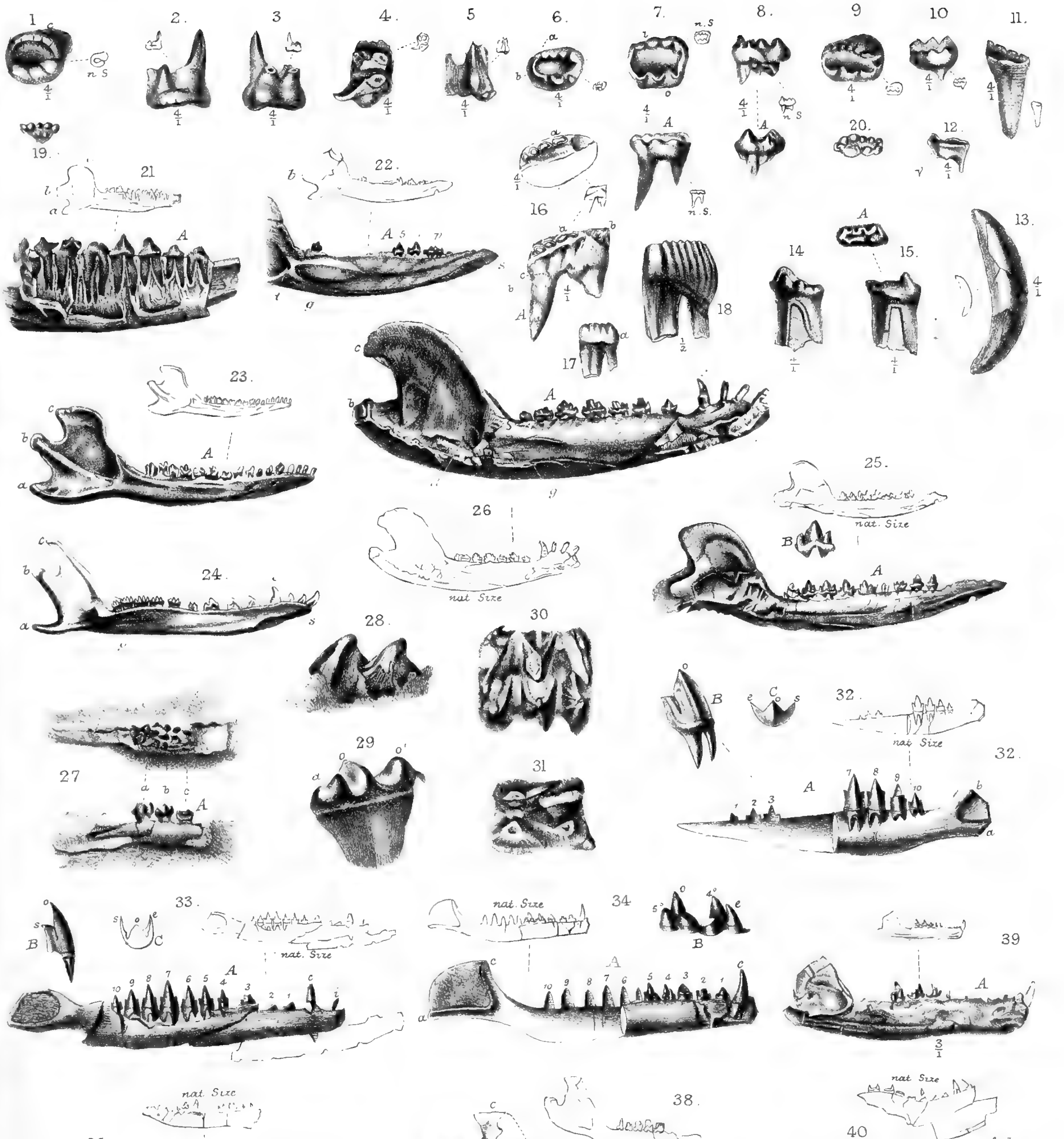
40. *Phascolestes dubius,* part of right mandibular ramus; nat. size.

40 A. ,, ,, ib.; magn. 2 diam.

41. ,, ,, fragment of right mandibular ramus; nat. size.

41 A. ,, ,, ib.; magn. 2 diam.

Figs. 21, 22, 23 are in the Museum of Geology, University of Oxford, and are from the Lower Oolite, Oxfordshire. The subject of fig. 25 is in the Museum of the Philosophical Society, York, that of fig. 26 in the British Museum, that of figs. 27—30 in the Collection of the Rev. J. P. B. DENNIS, M.A.; these are also from the Lower Oolite, Oxfordshire. The subjects of figs. 35—41 are from the fresh-water marl (mammaliferous) of the Middle Purbeck, Durdlestone Bay, Dorsetshire; and are in the Collection of SAMUEL HUSBANDS BECKLES, Esq., F.R.S., St. Leonard's-on-Sea.



A T. Hollick delt et lith

W.West imp

PLATE II.

Fig.		
1.	*Amblotherium soricinum.*	Right mandibular ramus; nat. size.
1A.	,, ,,	Ib.; magn. 3 diam.: B, third molar, magn. 6 diam.
2.	,, *mustelula.*	Right mandibular ramus; nat. size.
2A.	,, ,,	Ib.; magn. 3 diam.
3.	*Peralestes longirostris.*	Right maxilla; nat size.
3A.	,, ,,	Ib.; magn. 3 diam.
3B.	,, ,,	Ib.; working surface of molars; magn. 3 diam.
3C.	Outer side view of third upper molar of *Sarcophilus ursinus;* nat. size.	
4.	*Peralestes longirostris.*	Left mandibular ramus; nat. size.
4A.	,, ,,	Ib.; magn. 3 diam.: B, third molar magn. 6 diam.
4C.	Inner side view of third lower molar of *Sarcophilus ursinus;* nat. size.	
5.	*Achyrodon nanus.*	Part of right mandibular ramus; nat. size.
5A.	,, ,,	Ib.; magn. 3 diam.
6.	,, ,,	Left mandibular ramus; nat. size: A, ib.; magn. 3 diam.
7.	,, ,,	Ib.; nat. size: A, ib., magn. 3 diam.: B, sixth molar; magn. 6 diam.
8.	,, *pusillus.*	Ib.; A, ib., magn. 3 diam.
9.	*Peraspalax talpoïdes.*	Left mandibular ramus; nat. size.
9A.	,, ,,	Ib.; magn. 3 diam.: B, sixth and seventh molars; magn. 4 diam.
9C.	*Didelphys opossum.*	Inner side view of molar; nat. size.
10.	*Peramus tenuirostris.*	Left mandibular ramus; nat. size.
10A.	,, ,,	Ib.; magn. 3 diam.: B, under border of ascending ramus; magn. 3 diam.
10C.	,, ,,	Outer side view of molar; magn. 5 diam.
11.	*Peramus tenuirostris.*	Fore part of left mandibular ramus; nat. size.
11A.	,, ,,	Ib.; magn. 3 diam.
12.	,, ,,	Fore part of left mandibular ramus; nat. size: A, ib.; magn. 3 diam.
13.	,, *minor.*	Left mandibular ramus; nat. size: A, ib., magn. 3 diam.
14.	*Stylodon pusillus.*	Left maxilla; nat. size.
14A.	,, ,,	Ib.; magn. 3 diam.
14B.	,, ,,	Ib.; working surface of sixth and seventh molars; magn. 3 diam.
15.	,, ,,	Ib.; hind part of left mandibular ramus; nat. size: A, ib., magn. 3 diam.
16.	,, ,,	Ib.; right mandibular ramus, with parts of maxillary molars; nat. size.
16A.	,, ,,	Ib.; magn. 3 diam.
17.	,, ,,	Fore part of left mandibular ramus; nat. size.
17A.	,, ,,	Ib.; magn. 3 diam.
18.	,, ,,	Mandibular rami; nat. size.
18A.	,, ,,	Ib.; left ramus; magn. 3 diam.
19.	,, ,,	Portion of the left mandibular ramus; nat. size: A, ib., magn. 3 diam.

From the fresh-water mammaliferous marl-beds of the Middle Purbeck, Durdlestone Bay, Dorsetshire. The subject of figure 15 is in the Collection of the Rev. Peter Bellenger Brodie, M.A., F.G.S., Rowington Vicarage, near Warwick; the subjects of the other figures are in the Collection of Samuel Husbands Beckles, Esq., F.R.S., St. Leonard's-on-Sea.

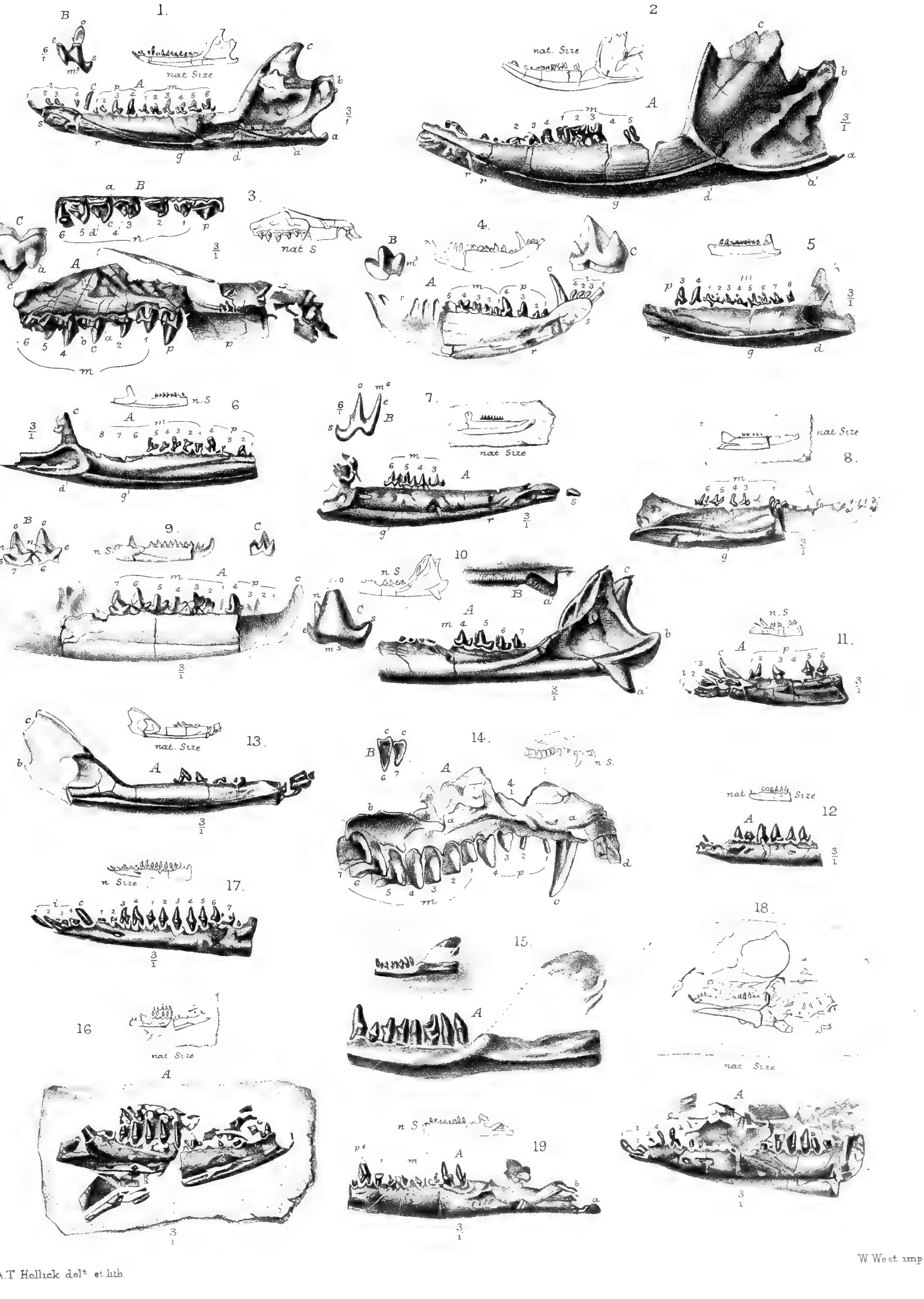


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PLATE III.

Fig.		
1.	*Stylodon robustus.*	Left mandibular ramus; nat. size.
1 A.	,, ,,	Ib.; magn. 3 diam.
2.	,, *pusillus.*	Portion of left mandibular ramus, and teeth; nat. size.
2 A.	,, ,,	Ib.; magn. 3 diam.
3.	,, ,,	Left mandibular ramus; nat. size.
3 A.	,, ,,	Ib.; magn. 3 diam.
4.	*Leptocladus dubius.*	Left mandibular ramus; nat. size.
5.	*Bolodon crassidens.*	Right maxilla; nat. size.
5 A.	,, ,,	Ib.; magn. 3 diam.
5 B.	,, ,,	Working surface of upper molars; magn. 3 diam.
6.	,, ,,	Portion of upper jaw and palate; nat. size: A, two left upper molars: B, three right upper molars; magn. 3 diam.
7.	*Triconodon mordax.*	Left mandibular ramus; nat. size.
7 A.	,, ,,	Ib.; magn. 2 diam.
8.	,, ,,	Portion of left mandibular ramus; nat. size: A, molar tooth; magn. 3 diam.
9.	,, ,,	Portion of right mandibular ramus; nat. size: A, molar tooth; magn. 3 diam.
10.	,, ,,	Left mandibular ramus; nat. size: A, teeth, magn. 3 diam.
11.	*Triconodon ferox.*	Ib., A, third molar; magn. 3 diam.: B, broken angle of the jaw; magn. 3 diam.
12.	,, ,,	Left mandibular ramus; nat. size.
13.	,, ,,	Hind part of left mandibular ramus; nat. size.
14.	,, sp. ind.	Portion of right mandibular ramus; nat. size.
14 A.	,, ,,	Worn molar; magn. 3 diam.: B, premolar; magn. 3 diam.
15.	,, sp. ind.	Portion of right mandibular ramus; nat. size.
15 A.	,, ,,	Ib.; magn. 3 diam.
16.	,, sp. ind.	Left mandibular ramus; nat. size.
16 A.	,, ,,	Ib.; magn. 3 diam.
17.	*Triconodon ferox.*	Portion of right maxilla; nat. size.
17 A.	,, ,,	Ib.; magn. 3 diam.
18.	,, ,,	Portion of left maxilla; nat. size.
18 A.	,, ,,	Ib.; magn. 3 diam.
18 B.	,, ,,	Ib.; working surface of premolar and molar teeth; magn. 3 diam.
19.	,, ,,	Fragment of right mandibular ramus; nat. size.
19 A.	,, ,,	Ib.; magn. 3 diam.
20.	,, sp. ind.	Impression of left mandibular ramus: A, canine; magn. 3 diam.
21.	,, sp. ind.	Portion of right mandibular ramus; nat. size.

From the fresh-water mammaliferous marl-beds of the Middle Purbeck, Durdlestone Bay, Dorsetshire. In the Collection of SAMUEL HUSBANDS BECKLES, Esq., F.R.S., St. Leonard's-on-Sea.

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W. West imp.

PLATE IV.

Fig.		
1.	*Triconodon ferox.*	Portions of upper and lower jaws; nat. size: A, upper molar; magn. 4 diam.: B, right, C, left, mandibular ramus; both magn. 2 diam.
2.	,, *occisor.*	Right and left mandibular rami; nat. size.
2 A.	,, ,,	Teeth of left ramus; B, teeth of right ramus; both magn. 2 diam.
3.	,, *major.*	Right mandibular ramus; nat. size: *a*, section of fractured fore part.
4.	,, sp. ind.	Right mandibular ramus; nat. size.
5.	,, ,,	Portion of right maxilla; *a*, under view; *b*, end view; nat. size.
5 A.	,, ,,	Side view; magn. 3 diam.
6.	,, *minor* (?).	Right mandibular ramus; nat. size: A, ib., three molars; magn. 3 diam.
7.	*Triacanthodon serrula.*	Portion and impression of left mandibular ramus: A, ib.; magn. 2 diam.
8.	,, ,,	Counterpart impression and portion of the same ramus; nat. size: A, ib.; magn. two diam.
9.	*Plagiaulax minor.*	Dentigerous part of right mandibular ramus and teeth; nat. size.
9 A.	,, ,,	Ib.; magn. 3 diam.: B, the two molars; magn. 6 diam.
10.	,, *Becklesii.*	Portion and impression of right mandibular ramus; nat. size.
10 A.	,, ,,	Ib.; magn. 3 diam.: B, condyle, magn. 3 diam.: C, condyle of *Hypsiprymnus minor*, nat. size: D, condyle of *Thylacinus*; $\frac{1}{3}$rd nat. size.
11.	,, ,,	Counterpart impression and portion of the same ramus; nat. size.
11 A.	,, ,,	Ib.; magn. 3 diam.
12.	,, ,,	Fragment of right mandibular ramus; nat. size.
12 A.	,, ,,	Ib.; magn. 3 diam.: B, working surface of the two molar teeth; magn. 3 diam.
13.	,, ,,	Fore part of right mandibular ramus, inner side; nat. size.
13 A.	,, ,,	Ib.; magn. 3 diam.: *b*, section of jaw and premolar, *p* 4.
14.	,, ,,	Ib.; ib.; outer side, nat. size.
14 A.	,, ,,	Ib.; ib.; magn. 3 diam.
15.	,, ,,	Ib.; teeth and impression of the fore part of a mandibular ramus; nat. size.
15 A.	,, ,,	Ib.; magn. 3 diam.: 13 *b*, section of laniary incisor, magn. 3 diam.
16.	,, *Falconeri.*	Right mandibular ramus, nat. size.
16 A.	,, ,,	Ib.; magn. 3 diam.: B, section of laniary, magn. 3 diam.

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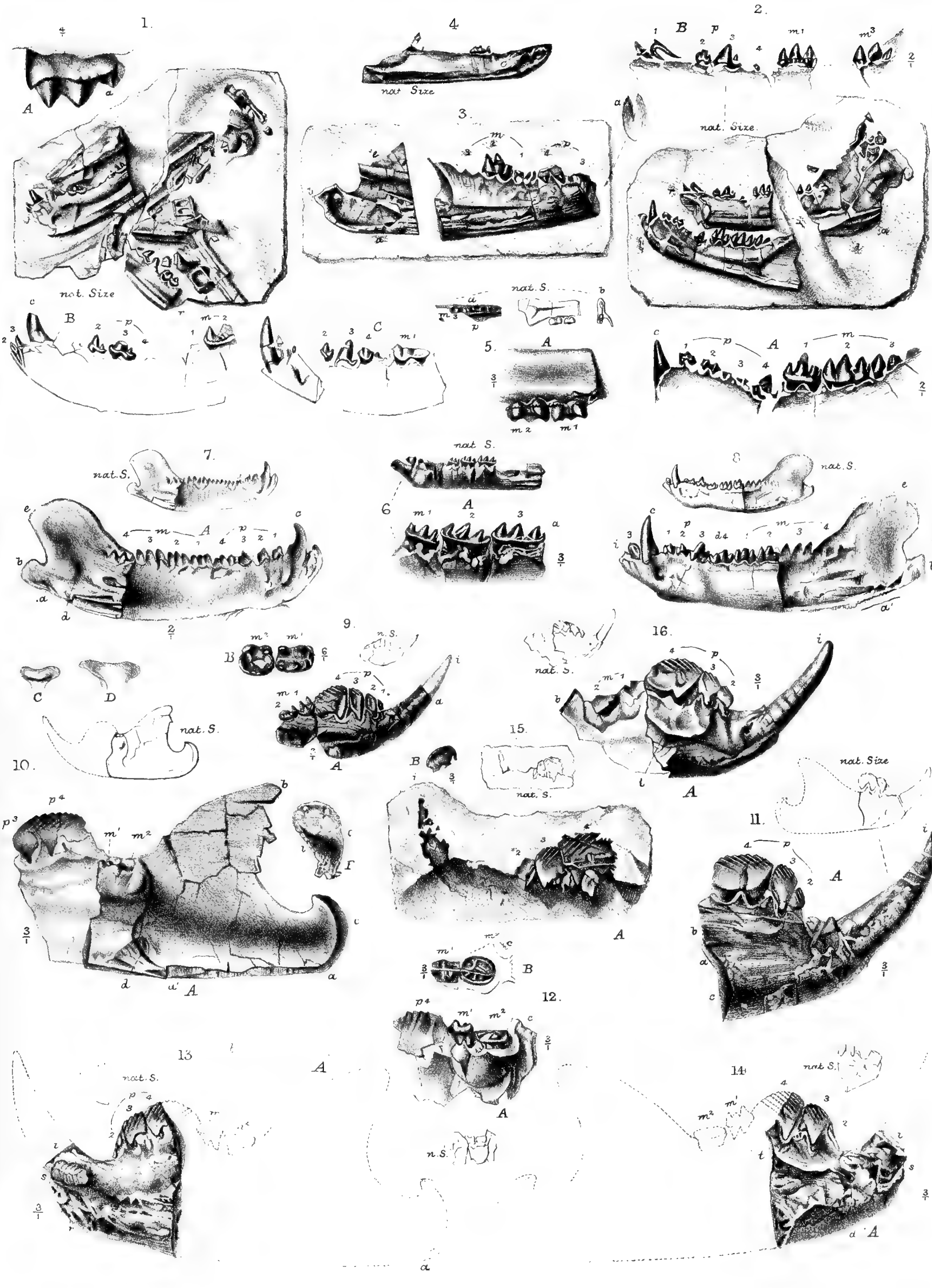

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W West imp

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