PALÆONTOGRAPHICAL SOCIETY.

VOL. XVII.

TRILOBITES

OF THE

SILURIAN, DEVONIAN, AND OTHER FORMATIONS.

PART II.

SILURIAN AND DEVONIAN.

FOSSIL BRACHIOPODA.

VOL. III, PART VI, No. II.

DEVONIAN.

BELEMNITIDÆ.

PART I.

INTRODUCTION.

REPTILIA

OF THE

LIASSIC FORMATIONS.

PART I.

ISSUED FOR 1863.

LIST

OF

The Council, Secretaries, and Members

OF THE

PALÆONTOGRAPHICAL SOCIETY.

WITH

A CATALOGUE OF THE WORKS ALREADY PUBLISHED; A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED AND IN PREPARATION, WITH THE NAMES OF THEIR RESPECTIVE AUTHORS; AND A GENERAL SUMMARY, SHOWING THE DATES OF THE SEVERAL MONOGRAPHS, THE NUMBER OF THEIR PAGES, PLATES, AND FIGURES, AND OF THE SPECIES ILLUSTRATED AND DESCRIBED.

1865—6.

President.

W. J. HAMILTON, Esq., F.R.S., G.S.

Council.

J. J. Bigsby, M.D., F.G.S.
J. S. Bowerbank, LL.D., F.R.S.
G. Busk, Esq., F.R.S., L.S.
P. M. Duncan, M.B., F.G.S.
R. Etheridge, Esq., F.G.S.
J. W. Flower, Esq., F.G.S.
R. Hudson, Esq., F.R.S., L.S.
J. W. Ilott, Esq.
J. Gwyn Jeffreys, Esq., F.R.S., G.S.
E. Meryon, M.D., F.G.S.
Prof. Owen, M.D., F.R.S., G.S.
J. Pickering, Esq.
Prof. Tennant, F.G.S.
C. Tyler, Esq., F.L.S., G.S.
A. Tylor, Esq., F.L.S., G.S.
N. T. Wetherell, Esq., F.G.S.

Treasurer.

Searles Wood, Esq., F.G.S., Brentwood, Essex.

Honorary Secretary.

Rev. T. Wiltshire, M.A., F.G.S., Rectory, Bread Street Hill, London, E.C.

Local Secretaries.

Alton—Wm. Curtis, Jun., Esq.
Bath—Wm. Walton, Esq.
Birmingham—W. Mathews, Jun., Esq., F.G.S., Edgbaston.
Blackburn—W. Harrison, Esq., F.G.S.
Blandford—W. Shipp, Esq.
Bristol—W. Sanders, Esq., F.R.S., G.S.
Cambridge—James Carter, Esq.
Cheltenham—T. Wright, M.D., F.G.S.
Cirencester—J. Bravender, Esq., F.G.S.
Colchester—C. R. Bree, M.D.
Doddington—Chas. Faulkner, Esq., F.S.A., G.S.
Devizes—Wm. Cunnington, Esq., F.G.S.
Dublin—Gilbert Sanders, Esq., M.R.I.A.
Edinburgh—Prof. Balfour, F.L.S.
Glasgow—Walter Crum, Esq., F.R.S., Thornliebank.
Guildford—R. A. C. Godwin-Austen, Esq., F.R.S., G.S., Chilworth.
Kendal—Thomas Gough, Esq.
Leeds—Thos. Nunneley, Esq.
Leicester—James Plant, Esq.
Oxford—Prof. J. Phillips, F.R.S., G.S.
Paris—M. F. Savy, 24, Rue Hautefeuille.
Plymouth—J. H. Fuge, Esq.
Richmond, York—Edwd. Wood, Esq., F.G.S.
Scarborough—John Leckenby, Esq., F.G.S.
Stamford—John F. Bentley, Esq.
Torquay—Wm. Pengelly, Esq., F.R.S., G.S.
Wolverhampton—Hy. Beckett, Esq., F.G.S.

CATALOGUE OF WORKS

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY;

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

Vol. I.	Issued for the Year	1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood, 21 plates.
„ II.	„	1848	The Reptilia of the London Clay, Part I, Chelonia, &c., by Profs. Owen and Bell, 38 plates. The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards, 9 plates.
„ III.	„	1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones, 7 plates. The Permian Fossils, by Prof. Wm. King, 29 plates. The Reptilia of the London Clay, Part II, Crocodilia and Ophidia, &c., by Prof. Owen, 18 plates. The Fossil Corals, Part I, London Clay, by Messrs. Milne-Edwards and Jules Haime, 11 plates.
„ IV.	„	1850	The Crag Mollusca, Part II, No. I, by Mr. S. V. Wood, 12 plates. The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett, 15 plates. The Fossil Brachiopoda, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson, 13 plates.
„ V.	„	1851	The Reptilia of the Cretaceous Formation, by Prof. Owen, 39 plates. The Fossil Corals, Part II, Oolitic, by Messrs. Milne-Edwards and Jules Haime, 19 plates. The Fossil Lepadidæ, by Mr. Chas. Darwin, 5 plates.
„ VI.	„	1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne-Edwards and Jules Haime, 16 plates. The Fossil Brachiopoda, Part I, Tertiary, by Mr. Davidson, 2 plates. The Fossil Brachiopoda, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates. The Fossil Brachiopoda, Part III, No. 2, Oolitic and Liassic, by Mr. Davidson, 5 plates. The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates. The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates.
„ VII.	„	1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne-Edwards and Jules Haime, 10 plates. The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates. The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates. The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates. The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates. The Reptilia of the Wealden Formation, Part I, Chelonia, by Prof. Owen, 9 plates.
„ VIII.	„	* 1854	The Fossil Brachiopoda, Part II, No. 2, Cretaceous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formation, Part II, Dinosauria, by Prof. Owen, 20 plates. The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates. The Fossil Corals, Part V, Silurian, by Messrs. Milne-Edwards and Jules Haime, 16 plates. The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates. The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates. The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates.
„ IX.	„	† 1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates. The Reptilia of the Wealden Formation, Part III, by Prof. Owen, 12 plates. The Eocene Mollusca, Part III, No. 2, Prosobranchiata continued, by Mr. F. E. Edwards, 4 plates. The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates. The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates. The Fossil Echinodermata, Part I, Oolitic, by Dr. Wright, 10 plates.
„ X.	„	1856	The Fossil Echinodermata, Part II, Oolitic, by Dr. Wright, 12 plates. The Fossil Crustacea Part I, London Clay, by Prof. Bell, 11 plates. The Fossil Brachiopoda, Part IV, Permian, by Mr. Davidson, 4 plates. The Fossil Brachiopoda, Part V, No. 1, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formation, Part IV, by Prof. Owen, 11 plates.
„ XI.	„	1857	The Fossil Echinodermata, Part III, Oolitic, by Dr. Wright, 14 plates. The Fossil Brachiopoda, Part V, No. 2, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formation, Part V, by Prof. Owen, 12 plates. The Polyzoa of the Crag, by Prof. Busk, 22 plates.
„ XII.	„	1858	The Fossil Echinodermata, Part IV, Oolitic, by Dr. Wright, 7 plates. The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards, 6 plates. The Reptilia of the Cretaceous and Purbeck Formations, by Prof. Owen, 8 plates. The Fossil Brachiopoda, Part V, No. 3, Carboniferous, by Mr. Davidson, 10 plates.
„ XIII.	„	1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson, 20 plates. The Reptilia of the Oolitic Formation, No. 1, by Prof. Owen, 7 plates. The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood, 13 plates.
„ XIV.	„	1860	The Fossil Brachiopoda, Part V, No. 5, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Oolitic Formation, No. 2, by Prof. Owen, 12 plates. The Fossil Estheriæ, by Prof. Rupert Jones, 5 plates. The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell, 11 plates.
„ XV.	„	1861	The Fossil Echinodermata, Vol. II, Part I (Oolitic Asteroidea), by Dr. Wright, 13 plates. Supplement to the Great Oolite Mollusca, by Dr. Lycett, 12 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.

* This Vol. is marked on the outside 1855. † This Vol. is marked on the outside 1856.

LIST OF WORKS CLASSIFIED ACCORDING TO THE SUBJECTS.

Monographs which are in course of completion or preparation :*—

The Flora of the Carboniferous Formation, by Prof. Morris.
The Foraminifera of the Crag, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.
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.
Supplement to the Fossil Corals, by Dr. Duncan.
The Graptolites, by Professor Wyville Thomson.
The Echinodermata of the Oolitic and Cretaceous Formations, by Dr. Wright.
The Crinoidea, by Professor Wyville Thomson.
The Jurassic, Purbeck, and Wealden Entomostraca, by Messrs. T. Rupert Jones and G. S. Brady.
The Bivalve Entomostraca of the Carboniferous Formation, by Messrs. T. Rupert Jones and J. W. Kirkby.
The Trilobites of the Mountain-limestone, Devonian, and Silurian Formations, by Mr. J. W. Salter.
The Crustacea of the Lower Formations, by Mr. H. Woodward.
The Polyzoa of the Chalk Formation, by Mr. G. Busk.
The Devonian and Silurian Brachiopoda, by Mr. Davidson.
The Post-Tertiary Mollusca, by Mr. J. Gwyn Jeffreys.
The Eocene Mollusca, Univalves and Bivalves, by Messrs. F. E. Edwards and S. V. Wood.
The Cretaceous Mollusca (exclusive of the Brachiopoda), by the Rev. T. Wiltshire and Mr. S. P. Woodward.
The Ammonites of the Lias, by Dr. Wright.
The Belemnites, by Professor Phillips.
The Fossil Reptilia, by Professor Owen.
The Fishes of the Old Red Sandstone, by J. Powrie, Esq.
The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.

Monographs which have been completed :†—

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime.
The Tertiary Echinodermata, by Professor Forbes.
The Fossil Cirripedes, by Mr. C. Darwin.
The Tertiary Entomostraca, by Mr. T. Rupert Jones.
The Cretaceous Entomostracea, by Mr. T. Rupert Jones.
The Fossil Estheriæ, by Mr. T. Rupert Jones.
The Polyzoa of the Crag, by Mr. G. Busk.
The Tertiary, Cretaceous, Oolitic, Liassic, Permian, and Carboniferous 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 PALÆONTOGRAPHICAL SOCIETY was established in the year 1847, for the purpose of figuring and describing the whole of the British Fossils.

Each person subscribing one guinea is considered a Member of the Society, and is entitled to the volume issued for the year to which the subscription relates.

Subscriptions are considered to be due on the First of January in each year.

All the back volumes are in stock, and can be obtained (one or more) on application to the Treasurer or Honorary Secretary.

The volumes are delivered free of carriage to any address within three miles of the General Post Office, and are booked free of expense to any place beyond the three miles radius; but in that case the carriage must be paid by the Member to whom they are sent.

Gentlemen desirous of forwarding the objects of the Society can be provided with circulars for distribution on application to the Honorary Secretary, the Rev. Thomas Wiltshire, Rectory, Bread Street Hill, London, E.C.

* 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.

† Directions for binding these will be found on the next page.

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JUNE, 1865); *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.
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*
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, 1858, 1859, 1861	474	43	724	109*h*
" " Vol. II, in course of completion	1861	1862	1863	130	13	159	20
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, in course of completion	1862	1864	1864	64	11	192	13
Fossil Cirripedes, by Mr. C. Darwin, *complete*	1851, 1854, 1858*a*	1851, 1854 *	1851, 1855, 1861	137	7	320	54
The Tertiary Entomostraca, by Mr. Rupert Jones, *complete*	1855	1856	1857	74	6	233	56
The Cretaceous Entomostraca, by Mr. Rupert Jones, *complete*	1849	1849	1850	41	7	176	27
The Fossil Estheriæ, by Mr. 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, in course of completion	1862, 1863	1864, 1865	1864, 1865	128	14	450	67
The Malacostracous Crustacea (comprising those of London Clay, Gault, and Greensands), by Prof. T. Bell, in course of completion	1856, 1860	1857, 1862	1858, 1863	88	22	215	50
The Polyzoa of the Crag, by Mr. G. Busk, *complete*	1857	1859	1859	145	22	641	122
Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous, Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, *complete*	1850, 1852, 1853, 1854	1851, 1852, 1852, 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, in course of completion	1862, 1863	1864, 1865	1864, 1865	131	20	666	92
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. 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	1861, 1864	1861, 1864	136	20	396	146
The Great Oolite Mollusca, by Prof. Morris and Mr. J. 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	1865	1865	28	—	29	—
The 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 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	1851	1851	118	39	262	18
The Reptilia of the Cretaceous, 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	222	82	515	24
The Reptilia of the Oolitic Formations, by Prof. Owen, in course of completion	1859, 1860	1861, 1862	1861, 1863	44	19	88	2
The Reptilia of the Liassic Formations, by Prof. Owen, in course of completion	1863	1865	1865	40	16	62	5
			TOTAL	5131	767	14,161	3031

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 preparation.
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.

LIST OF MEMBERS.*

MARCH, 1865.

HER MOST GRACIOUS MAJESTY THE QUEEN.

Adlard, J. E., Esq., Bartholomew Close, E.C.
Alexander, Mrs. W. H., Ipswich.
Ansted, Professor D. T., M.A., F.R.S., G.S., &c., Athenæum, Club; and Impington Hall, near Cambridge.
Arbuthnot, Capt. W., 111, Lower Bagot Street, Dublin.
Athenæum Library, Liverpool.
Auerbach, Professor, Moscow.
Austin, Miss Helena E., Everton Lodge, Liverpool.
Austen, Rev. J. H., M. A., Ensbury House, Wimborne.
Aveline, W. T., Esq., F.G.S., Museum of Practical Geology, Jermyn Street.

Babington, Professor C. C., M.A., F.G.S., L.S., &c., St. John's College, Cambridge.
Bailey, W. Hellier, Esq., F.G.S., L.S., &c., Acting Palæontologist to the Geological Survey of Ireland, 51, Stephen's Green, Dublin.
Baines, Samuel, Esq., F.G.S., Brighouse, near Huddersfield.
Balfour, Professor, F L.S., &c., 2, Bellevue Crescent, Edinburgh.
Baillière, H., Esq., 219, Regent Street.
Balme, E. B. Wheatley, Esq., Cotewall, Mirfield, Normanton, Yorkshire.
Barclay, Joseph G., Esq., 54, Lombard Street, E. C.
Barr, W. R., Esq., Park Mills, Stockport.
Barthes and Lowell, Messrs., Great Marlborough Street.
Bathurst, Rev. W. H., Lydney Park, Gloucester.
Beaumont, Rev. W. J., M.A., Trinity College, Cambridge.
Beckett, Henry, Esq., F.G.S., Darlington Street, Wolverhampton.
Bell, Professor T., F.R.S., L.S., G.S., &c., The Wakes, Selborne, Alton, Hants.
Benson, Starling, Esq., F.G.S., Swansea.
Bentley, J. F., Esq., Stamford, Lincolnshire.
Bernard, Ralph M., Esq., 5, Victoria Square, Clifton.
Berthand, Professor, Macon.
Bewley, John, Esq., 3A, Brunswick Street, Liverpool.
Bidwell, Henry, M.D., Albrighton, Wolverhampton.
Bigsby, J. J., M.D., F.G.S., 89, Gloucester Place, Portman Square, W.

* The Members are requested to inform the Secretary of any errors or omissions in this list, and of any delay in the transmission of the Yearly Volumes.

Bilke, Edward, Esq., F.G.S., &c., 12, Stamford Street, S.
Binney, E. W., Esq., F.R.S., G.S., &c., 40, Cross Street, Manchester.
Birmingham Old Library, Union Street, Birmingham.
Blackburne, John George, Esq., F.G.S., Mining Engineer, Oldham.
Blackie, W. G., Esq., Ph.D., F.G.S., &c., 36, Frederick Street, Glasgow.
Blackmore, Humphrey, P. M.D., Salisbury.
Bladon, James, Esq., Pontypool.
Blake, W., Esq., Bridge House, South Petherton.
Blanford, H. F., Esq., F.G.S., 21, Bouverie Street, W.
Boase, H. S., M.D., F.R.S., G.S., &c., Claverhouse, near Dundee.
Bohn, Henry, Esq., 4, York Street, Covent Garden, W.C.
Bonney, Rev. George, F.G.S., St. John's College, Cambridge.
Bordeaux, La Faculté des Sciences de.
Borradaile, Charles, Esq., 12, South Square, Gray's Inn, W.C.
Bosquet, Mons. J., Pharmacien, Maestricht.
Bower, Rev. E., Closworth, near Yeovil.
Bowerbank, J. S., LL.D., F.R.S., L.S., G.S., &c., 2, East Ascent, St. Leonard's-on-Sea.
Bowles, Rev. S. J., Balton's-borough, Glastonbury.
Brady, Antonio, Esq., F.G.S., Stratford, Essex; and Admiralty Office, Somerset House, W.C.
Brady, Right Hon. M., Dublin.
Braickenridge, Rev. G. W., M.A., F.S.A., G.S., &c., Clevedon, near Bristol.
Brassey, Thomas, Esq., jun., 56, Lowndes Square, S.W.
Bravender, John, Esq., F.G.S., Coxwell Street, Cirencester.
Bree, C. R., M.D., East Hill, Colchester.
Briggs, General John, F.R.S., G.S., &c., Oriental Club, Hanover Square, W.; and Bridge Lodge, Hurstpierpont.
Briggs, Miss Ellen, 3, Arlington Street, S.W.
Brighton and Sussex Natural History Society, 7, Pavilion Parade, Brighton.
Bristow, Henry W., Esq., F.R.S., G.S., &c., Museum of Practical Geology, Jermyn Street, S.W.
British Museum, Printed Book Department, W.C.
British Museum, Departmental Mineralogical and Geological Library, W.C.
Broome, C. E., Esq., M.A., &c., Elmhurst, Batheaston, Bath.
Brown, Edwin, Esq., Burton-on-Trent.
Brown, Isaac, Esq., Ackworth.
Brown, T. C., Esq., Cirencester.
Browne, Wm. Meredith, Esq., Westminster Fire Office, King Street, Covent Garden, W.C.
Bruce, Rev. J. Collingwood, LL.D., F.S.A., &c., Newcastle-on-Tyne.
Buckman, Professor James, F.G.S., &c., Bradford Abbas, Sherborne, Dorset.
Bunbury, E. H., Esq., F.G.S., &c., 15, Jermyn Street, Piccadilly, S.W.
Busk, George, Esq., F.R.S., L.S., &c., 15, Harley Street, Cavendish Square, W.
Byerley, Isaac, Esq., Seacombe, Cheshire.

Calvert, J., Esq., 189, Strand, W.C.
Cambridge University Library.
Carpenter, Alfred, M.D., Croydon, S.
Carpenter, W. B., M.D., F.R.S., &c., 8, Queen's Road West, Regent's Park, N.W.
Carter, James, Esq., 30, Petty Cury, Cambridge.
Cassini, H. T., Esq., Victoria Cottage, Archway Road, Highgate, N.
Cautley, Colonel Sir P., K.C.B., F.R.S., G.S., 31, Sackville Street, Piccadilly, W.
Cavell, Edmund, Esq., F.G.S., Saxmundham.
Chambers, Robert, Esq., F.R.S.E., G.S., &c., Verulam House, 3, Hamilton Place, St. John's Wood, N.W.
Champernowne, Arthur, Esq., Darlington Hall, Totness, Devonshire.
Chapman, Thomas, Esq., 23, New Street, Spring Gardens, S.W.
Cheltenham Permanent Library, 18, Clarence Street, Cheltenham.
Cherbullier, Mons., Paris.

Cholmeley, Mrs. Octavia, The Priory, Stroud, Gloucestershire.
Christy, Henry, Esq., F.G.S., &c., 103, Victoria Street, Westminister, S.W.
Clabon, J. M., Esq., 21, Great George Street, S.W.
Clark, Professor W., F.R.S., &c., Cambridge.
Clarke, Rev. W. B., F.G.S., &c., St. Leonards, near Sydney, New South Wales.
Clayton, Rev. J. H., Liphook, Hants.
Cobbold, Rev. R. H., Rectory, Broseley, Salop.
Cocchi, Sig. Q., Professor of Geology, Florence.
Colchester, W., Esq., F.G.S., Grundesburgh House, Ipswich.
Collings, Rev. W. T., M.A., F.L.S., G.S., Lord of Sark, Channel Islands.
Collingwood, F. S. W., Esq., Glanton Pyke, Glanton, Northumberland.
Colvin, Col. John, C.B., Leintwardine, near Ludlow.
Compton, Rev. John, Minesteed Parsonage, Lyndhurst.
Cooke, Major A., R. E., Ordnance Survey, Perth.
Cooper, Charles J., Esq., Bridgnorth, Salop.
Cornthwaite, Rev. T. M., M.A., Walthamstow.
Cotteau, Mons., Paris.
Cotton, R. P., M.D., F.G.S., 46, Clarges Street, Piccadilly, W.
Crowley, Alfred, Esq., Bramley Oaks, Croydon, S.
Crum, Walter, Esq., F.R.S., Thornliebank, Glasgow.
Cubitt, George, Esq., M.P., F.G.S., 25, Eccleston Square, S.W.
Cull, R., Esq., 13, Tavistock Street, Tavistock Square, W.C.
Cunningham, James, Esq., 50, Queen Street, Edinburgh.
Cunnington, W., Esq., F.G.S., Devizes, Wilts.
Curtis, W., Esq., Alton, Hants.
Currey, Elliott S., Esq., Erlwood, Bagshot.
Cust, Lady Elizabeth, 13, Eccleston Square, S.W.

Darlington Naturalists' Society (by J. J. Anson, Esq., jun., Hon. Sec.)
Darwin, Charles, Esq., M.A., F.R.S., G.S., &c., Down, Bromley, Kent.
Davidson, Thomas, Esq., F.R.S., G.S., Mem. Geol. Soc. France, &c., 33, Park Crescent, Brighton.
Daw, Rev. E., Rectory, Saxby.
Dawkins, W. Boyd, Esq., F.G.S., Museum of Practical Geology, Jermyn Street, S.W.
Dawson, J. W., LL.D., F.R.S., G.S., &c., McGill's College, Montreal.
Day, Rev. Hen. Geo., M.A., Sedburgh, Kendal.
Deane, H., Esq., Clapham, Surrey.
De Castro, James, Esq., 5, Park Villas, Richmond, Surrey, S.W.
Deshayes, Mons. G. P., F.M.G.S., Paris.
Devonshire, Duke of, Chancellor of the University of London, F.R.S., G.S., &c., Devonshire House, Piccadilly, W.
Devon and Exeter Institution, Exeter (by Ed. Parfitt, Esq.)
Dickenson, F. H., Esq., 8, Upper Harley Street, Cavendish Square, W.
Dickinson, Henry, Esq., Severn House, Coalbrook Dale.
Dickinson, Joseph, M.D., F.L.S., 92, Bedford Street, S., Liverpool.
Dickinson, W., Thorncroft, Workington.
Dickinson, W., 5, St. Mildred's Court, London, E.C.
Digby, Lady T., Minterne, near Dorchester.
Dilke, Sir C. Wentworth, Bart., F.G.S., L.S., &c., 76, Sloane Street, S.W.
Dollfus, Mons. (by Mons. F. Savy, Paris).
Dorset County Museum Library, Dorchester.
Douglas, Rev. Robert, Stoke Lacy Rectory, Bromyard.
Dover Proprietary Library.
Doyen, Mons. J. M.
Ducie, the Earl of, F.R.S., G.S., &c., 30, Prince's Gate, S.W.
Dumortier, Mons. E., Lyons (by Mons. F. Savy, Paris).

Duncan, P. M., M.B., Sec. G.S., 8, Belmont, Lee, S.E.
Durham, the Dean and Chapter of, Durham (by Samuel Rowlandson, Esq., the College, Durham).

Edwards, F.E., Esq., F.G.S., 22, Woburn Square.
Egerton, Sir Philip de Malpas Grey, Bart., M.P., Trustee Brit. Museum, F.R.S., G.S., &c., Oulton Park, Cheshire; and 28B, Albemarle Street, W.
Elliott, John, Esq., Kingsbridge, Devon.
Elliot, Walter, Esq., Wolfelee, Hawick, N.B.
Enniskillen, William Willoughby, Earl of, D.C.L., F.R.S., G.S., &c., Florence Court, Enniskillen; and Athenæum Club, S.W.
Etheridge, R., Esq., F.G.S., &c., Museum of Practical Geology, Jermyn Street, S.W.
Evans, John, Esq., F.R.S., G.S., Nash Mills, Hemel Hempsted.
Evans, Thomas, M.D., Gloucester.
Everest, Rev. R., F.G.S., 50, Cleveland Square, London, W.
Eyton, Thomas C., Esq., F.L.S., G.S., &c., Eyton, near Wellington, Salop.

Falconer, Thomas, Esq., F.G.S., Usk, Monmouthshire.
Falkner, Frederick, Esq., Somersetshire Bank, Bath.
Farnham, Lord, Carlton Club, 94, Pall Mall, S.W.
Faulkner, Charles, Esq., F.G.S., Museum, Deddington, Oxon.
Favre, Mons. Alph., Professor of Geology, Academy, Geneva.
Ferguson, William, Esq., F.L.S., G.S., R.G.S., &c., Kinmundy, Mintlaw, Aberdeenshire, and 2, St. Aidan's Terrace, Birkenhead.
Fisher, Rev. Osmond, M.A., F.G.S., Elmstead Vicarage, Colchester.
Fletcher, T. W., Esq., M.A., F.R.S., G.S., S.A., Lawneswood House, Stourbridge.
Flower, J. W., Esq., F.G.S., Park Hill, Croydon, S.
Forbes, John Edward, F.G.S., 3, Faulkner Street, Manchester.
Fort, Richard, Esq., 24, Queen's Gate Gardens, Kensington, W.
Fox, Rev. W. Darwin, Delamere Forest, near Chester.
Fraser, John, M.D., Wolverhampton.
Froggat, John, Esq., Church Gate, Stockport.
Fryer, A., Esq., Chatteris, Cambridgeshire.
Fuge, J. H., Esq., F.R.C.S.E., Plymouth.

Galton, Capt. Douglas, R.E., F.R.S., G.S., &c., 12, Chester Street, Grosvenor Place, S.W.
Gassiot, I. P., Esq., F.R.S., &c., Clapham, S.
Gatty, Charles, Esq., F.G.S., Felbridge Park, East Grinstead.
Geinitz, Professor Dr. H. B., F.M.G.S., Dresden.
Geological and Polytechnic Society of the West Riding of Yorkshire, Leeds.
Geological Society of Manchester.
Geological Survey of Great Britain, Palæontographical Department, Jermyn Street, S.W.
Geologists' Association, 32A, George Street, Hanover Square, W.
Gibson, G. S., Esq., Saffron Walden.
Gibson, Thomas F., Esq., F.G.S., &c., 124, Westbourne Terrace, Hyde Park, W.
Gilbertson, Henry, Esq., Hertford.
Gilchrist, Dr., Royal Crichton Institution, Dumfries.
Glasgow Geological Society, Andersonian University, Glasgow.
Gloucester Literary Society, Gloucester (by Dr. B. Wagbourn).
Gloyne, C., Esq., 1, Dalia Terrace, Irish Town, Dublin.
Godlee, Burwood, Esq., Leighside, Lewes.
Godlee, Rickman, Esq., Lillies, Upton, Essex.
Godwin-Austen, R. A. C., Esq., F.R.S., G.S., &c., Chilworth, Manor, Guildford, Surrey.
Gomonde, W. H., Esq., F.G.S., Brussels.
Gordon, P. L., Esq., Craigmyle.

Gough, Capt. the Hon. George S., F.G.S., L.S., &c., Lough Cutra Castle, Gort, Galway, Ireland.
Gough, Thomas, Esq., Preston Hall, Kendall.
Gould, John, Esq., F.R.S., L.S., Z.S., &c., 26, Charlotte Street, Bedford Square, W.C.
Gratton, Joseph, Esq., 32, Gower Street, W.C.
Gray, John, Esq., Lyttleton Terrace, Hagley, near Stourbridge.
Gregory, J. R., Esq., Golden Square, W.
Griffith, Sir Richard, Bart, LL.D., F.R.S.E., G.S., &c., 2, Fitzwilliam Place, Dublin.
Grundy, Thomas, Esq., Beatlands, Sidmouth, Devon.
Guillaume, F. A. Esq., 42, Chester Square, Pimlico, S.W.
Guise, Sir W. V., Bart., F.G.S., &c., Elmore Court, near Gloucester.
Guppy, R. Lechmere, Esq., Government House, Trinidad.

Hall, Hugh, F., Esq., 17, Dale Street, Liverpool.
Hall, Townsend, Esq., Pilton Parsonage, Barnstaple.
Hall, James, Esq., F.M.G.S., Geological Survey, States Library, Albany, New York State, U.S.
Hamilton, W. J., Esq., F.R.S., G.S., &c., *President*, 23, Chesham Place, Belgrave Square, S.W.
Hanson, Samuel, Esq., Botolph Lane, E.C.; and 43, Upper Harley Street, W.
Harford, Frederick, Esq., Ocean Marine Insurance Company, 2, Old Broad Street, E.C.
Harmar, Richard, Esq., 9, Brock Street, Bath.
Harris, W., Esq., F G.S., Charing, Ashford, Kent.
Harrison, William, Esq., F.G.S., S.A., &c., Galligreaves Hall, Blackburn, Lancaster
Hartley Institution, Southampton (by Dr. F. T. Bond).
Haughton, Rev. Professor S., M.D., F.R.S., G.S., Fellow of Trinity College, Dublin.
Hawkes, Rev. Henry, B.A., F.L.S., &c., Southsea, Portsmouth.
Hawkins, B. Waterhouse, Esq., F.L.S., G.S., Belvedere Road, Upper Norwood, S.
Hawkshaw, J. Clarke, Esq., 33, Great George Street, Westminster, S.W.
Haythornthwaite, William, Esq., Kirkby Lonsdale.
Hector, James, M.D., F.G.S., Otago, New Zealand.
Heywood, James, Esq., F.R.S., G.S., &c., Athenæum, S.W.
Higgins, E. T., Esq., Eastington, Gloucester.
Hindson, Isaac, Esq., Kirkby, Lonsdale.
Hodgson, Miss E., Cavendish Street, Ulverstone.
Hollier, E., Esq., Dudley and Midland Geological Scientific Field-club, Dudley.
Homfray, D., Esq., Portmadoc, Carnarvonshire.
Hony, Rev. W. E., F.G.S., &c., Archdeacon of Sarum, Beverstock, near Salisbury.
Hopgood, James, Esq., Clapham Common, S.
Horner, Rev. John S., Mells Park, near Frome.
Howard, Mrs., Greystoke Castle, Penrith.
Howitt, Thomas, Esq., Lancaster.
Huddersfield Literary and Scientific Society (by Geo. Tindall, Esq., *Honorary Secretary*).
Hudson, Robert, Esq., F.R.S., G.S., Clapham, S.
Hugh, H., Esq.
Hull, W. D., Esq., F.G.S., &c., Maison Cormalde, Nice.
Hutton, R., Esq., F.G.S., M.R.I.A., &c., Putney Park, S.W.
Huxley, Professor T. H., F.R.S., L.S., G.S., Museum of Practical Geology, Jermyn Street, S.W.

Illingworth, Rev. E. A., 3, Mecklenburgh Street, Mecklenburgh Square, W.C.
Illingworth, R. S., Esq., 9, Norfolk Crescent, W.
Ilott, James, Esq., Bromley, Kent.
Ipswich Museum, Ipswich.

Jackson, Edward S., Esq., M.A., F.G.S., &c., Walthamstow House, Essex, N.E.
James, Colonel Sir H., R.E., F.R.S., G.S., &c., Ordnance Survey, Southampton.

Jarvis, Richard H., Esq., F.G.S., Holmesdale, South Darent, near Dartford, Kent.
Jeffreys, J. Gwyn, Esq., F.R.S., L.S., G.S., 25, Devonshire Place, Portland Place, W.
Jennings, F.M., Esq., M.R.I.A., F.G.S., &c., Cork.
Johnes, J., Esq., F.G.S., Dolancothy, Llandilo, Wales.
Johnson, William, Esq., Eton College.
Jones, Rear-Admiral T., F.L.S., G.S., &c., 18, Harcourt Street, Dublin.
Jukes, J. Beete, Esq., M.A., F.R.S., F.G.S., &c., Geological Survey of Ireland, 51, Stephen's Green, Dublin.

Kenyon, J. R., Esq., 6, Lower Berkeley Street, Portman Square, W.
Kenyon, the Hon. Mrs. Thomas, Pradoe, near Shrewsbury.
King, W. P. Esq., Avonside, Clifton Down, Bristol.
Kinnaird, Lord, 33, Grosvenor Street, W., and Rossie Priory, Inchture, N.B.
Kingston, G. S., Esq., Grote Street, Adelaide, South Australia.
Kirkby, J. W., Esq., 5, High Street West, Sunderland.
Krantz, Herr, Bonn.
Kuprainoff, Lieut.-Colonel, St. Petersburg.

Lawrance, John, Esq., F.G.S., Elton, Oundle.
Leckenby, John, Esq., F.G.S., Scarborough.
Lee, John, LL.D., F.R.S., R.A.S., G.S., &c., 5, College, Doctors' Commons, E.C.
Lee, John Edward, Esq., F.G.S., The Priory, Caerleon, Monmouthshire.
Leeds Library, Leeds, Yorkshire.
Leicester Literary and Philosophical Society, Town Museum, Leicester.
Leigh, J. S., Esq., F.G.S., 54, Leinster Square, Kensington Gardens, W.
Leighton, W. H., Esq., 2, Merton Place, Turnham Green, W.
Lemon, Sir C., Bart., F.R.S., G.S., &c., 10, Charles Street, Berkeley Square, W.
Leonard, Edward J., Esq., Engineer's Office, West India Docks, E.
Lightbody, Robert, Esq., Ludlow.
Lindsay, Charles, Esq. (by W. Stuart, Esq., Walbrook Buildings, Walbrook, E.C.)
Lingard, John R., Esq., 16, Tib Lane, Cross Street, Manchester.
Linth, M. Arn. Escher von der, F.M.G.S., Zurich.
Linnean Society, Burlington House.
Lister, J. J., Esq., F.R.S., &c., Upton, Essex.
Lister, John, Esq., F.G.S., Shibden Hall, near Halifax.
Literary and Philosophical Society of Manchester.
Literary and Philosophical Society of Newcastle.
Literary and Philosophical Society of Sheffield (by J. Holland, Esq., Music Hall, Sheffield).
Living, Professor G. D., M.A., St. John's College, Cambridge.
Liverpool Free Public Library.
Liverpool Natural History Society.
Llewellen, W., Jun., Esq., F.G.S., &c., Pontypool.
Lloyd, John, Esq., 77, Snow Hill, E.C.
Lloyd, Frederick, Esq., 30, Dorset Square, N.W.
London Institution, Finsbury Circus, E.C.
Lovèn, Professor S., Stockholm.
Lowry, J. W., Esq., F.R.G.S., 45, Robert Street, Hampstead Road, N.W.
Lubbock, Sir John W., Bart., M.A., F.R.S., L.S., 15, Lombard Street, E.C.
Lucas, John F., Esq., Middleton, Yolgrave, Bakewell, Derbyshire.
Ludlow Natural History Society.
Lyall, George, Esq., 51, King Street, South Shields.
Lyell, Sir C., Bart., M.A., F.R.S., L.S., G.S., &c., 53, Harley Street, Cavendish Square, W.
Lyon, Bibliothèque de la Ville de.

Mackeson, Henry B., Esq., F.G.S., &c., Hythe, Kent.
Mackey, Colonel, Fairhill, near Exeter.
Maclaren, Charles, Esq., F.R.S.E., G.S., &c., Moreland Cottage, Grange, Edinburgh.
Maclean, William C., Esq., Great Yarmouth.
McAndrew, R., Esq., Bond Street Chambers, Walbrook, E.C.
McMarran, E., Esq., Cheapside, E.C.
Maton, Professor B.
Macredie, P. B. M., Esq., Perceton Irvine, N.B.
Madras Government Museum.
Magendie, A., Esq., F.R.S., G.S., &c., Hedingham Castle, Castle Hedingham, Essex.
Major, Charles, Esq., Red Lion Wharf, Upper Thames Street, E.C.
Mann, C. S., Esq., F.G.S., Eltham, Kent, S.E.
Mansel, John, Esq., F.G.S., Longthorns, Blandford.
Marcou, Mons. Jules, Museum, Cambridge, U.S.
Marès, Mons. P., Paris.
Marsh, John, Esq., Burnt Tree, near Dudley.
Marshall, James G., Esq., F.G.S., Headingley, near Leeds.
Marshall, Matthew, Esq., Bank of England, E.C.
Marshall, Reginald D., Cookridge Hall, Leeds.
Marsham, Hon. Robert, F.G.S., The Moat, Maidstone.
Martin, Miss, Bredon's Norton, near Tewkesbury.
Martineau, F. Edgar, Esq., Solihull, Birmingham.
Mathews, W., Jun., Esq., F.G.S., Edgbaston, Birmingham.
Matthieson, James, Esq., 22, Belitha Villas, Barnsbury Park, N.
Maw, G., Esq., F.S.A., L.S., G.S., Benthall Hall, Broseley, Salop.
Meade, Rev. R. J., Castle Cary.
Merian, Professor Dr. Pierre, F.M.G.S., Directeur de Museum, Basle.
Meryon, Edward, M.D., F.G.S., 14, Clarges Street, W.
Milne-Edwards, Dr. Henry, F.M.G.S., Paris.
Mitchell, F. J., Esq., Llanbrechba Grange, Newport, Monmouthshire.
Mitchenson, Rev. John, King's School, Canterbury.
Monk, James, Esq., Aden Cottage, Durham.
Moore, J. Carrick, Esq., M.A., F.R.S., G.S., &c., 2, Rutland Gate, Hyde Park, S.W.
Moore, Charles, Esq., F.G.S., 6, Cambridge Place, Widcome Hill, Bath.
Moore, Joseph, Esq., 25, Park Terrace, Brixton Road, S.
Morgan, William, Esq., Mile End, Swansea.
Morson, T. N. R., Esq., F.L.S., Southampton Row, Russell Square, W.C.
Morton, George Highfield, Esq., F.G.S., 5, London Road, Liverpool.
Mosley, Sir Oswald, Bart., D.C.L., F.L.S., G.S., &c., Rolleston Hall, Burton-on-Trent.
Murchison, Sir R. I., K.C.B., G.C.St.S., D.C.L., M.A., F.R.S., G.S., L.S., &c., 16, Belgrave Square, S.W.
Murdock, James Barclay, 27, Virginia Street, Glasgow.
Museum of Irish Industry, St. Stephen's Green, Dublin.
Museum of Practical Geology, Jermyn Street, S.W.
Mushet, Rob., Esq., F.G.S., Royal Mint.

Nantes, Musée d'Histoire naturelle de.
Neale, Edward Vansittart, Esq., West Wickham, Kent.
Neale, Henry, Esq., Foxhangers, Devizes.
Neison, Francis G. P., Esq., F.L.S., &c., 2, Waterloo Place, Pall Mall, S.W.
Nicholl, W. H., Esq., Usk, Monmouthshire.
Norfolk and Norwich Literary Institution, Norwich.
Norris, Henry, Esq., Sen., F.R.C.S., &c., Charmouth.
Nunneley, Thomas, Esq., Leeds.

Oldham, Thomas, Esq., F.R.S., F.G.S., &c., 18, Pembroke Road, Dublin.
Oñate, Countess of, Madrid.
Ormerod, G. W., Esq., M.A., F.G.S., &c., Chagford, Exeter.
Oswestry Naturalists' Field Club.
Owen, Professor R., M.D., LL.D., F.R.S., L.S., G.S., &c., British Museum, W.C.

Paine, J. M., Mrs., Farnham, Surrey.
Papillon, Rev. J., Rectory, Lexden, Colchester.
Parker, J., Esq., Turl Street, Oxford.
Parry, Thomas G., Esq., F.G.S., Highnam Court, near Gloucester.
Paynter, Rev. Samuel, Stoke Hill, Guildford, Surrey.
Pearson, Sir Edwin, K.H., M.A., F.R.S., &c., Wimbledon, S.W.
Pease, Thomas, Esq., F.G.S., Henbury, near Bristol.
Peckover, Algernon, Esq., F.L.S., Wisbeach.
Pengelly, William, Esq., F.R.S., G.S., Torquay.
Penny, Rev. James, M.A., &c., Blandford.
Penruddocke, Charles, Esq., Compton Park, near Salisbury; and 12, Hereford Street, Oxford Street, W.
Perceval, Spencer George, Esq., Severn House, Henbury, Bristol.
Perkins, Rev. R. B., Wootton-Underedge, Gloucestershire.
Phillips, John, M.A., LL.D., F.R.S., G.S., &c., Professor of Geology in the University of Oxford, Museum, Oxford.
Philosophical Society of Glasgow.
Phear, Rev. Geo., F.G.S., Emmanuel College, Cambridge.
Pickering, John, Esq., 29, Loraine Road, Upper Holloway, N.
Pictet, Mons. F. J., Professor of Zoology, Academy of Geneva.
Pidgeon, Jonathan S., Esq., Pembridge Villa, Bayswater, W.
Pierson, Charles, Esq., Blenheim Parade, Cheltenham.
Plant, James, Esq., 4, Napier Terrace, Leicester.
Pollock, Lady, Clapham Common, S.
Portal, Wyndham S., Esq., Malshanger House, Basingstoke.
Porter, Henry, M.D., F.G.S., Peterborough.
Portman, Hon. Miss, 5, Princes Gate, Hyde Park, S.W.
Preston Literary and Philosophical Institution.
Prestwich, Joseph, Esq., F.R.S., G.S., 10, Kent Terrace, Regent's Park Road, N.W.
Pritchard, Rev. C., M.A., F.R.S., G.S., &c., Hurst Hill, Freshwater, Isle of Wight.
Prout, Professor, M.D., &c., Academy of Sciences, St. Louis, Missouri, U.S.
Prout, Rev. E., F.G.S., &c., London Missionary Society, Bloomfield Street, Finsbury, E.C.
Powrie, James, Esq., F.G.S., Reswallie, Forfar.
Provis, William A., Esq., F.G.S., The Grange, Ellesmere, Salop.
Purdue, Thomas, Esq., Witney, Oxfordshire.

Queen's College, Galway.
Queen's College, Cork (by Messrs. Hodges and Smith).

Radcliffe Library, Oxford.
Ramsay, Professor A.C., F.R.S., G.S., &c., Museum of Practical Geology, Jermyn Street, S.W.
Ransome, Robert Charles, Esq., Ipswich.
Readwin, T. A., Esq., F.G.S., Stretford, Manchester.
Regnès, Mons., Paris.
Renevier, Mons. E., Professor of Geology, Academy of Lausanne, Switzerland.
Richardson, James, Esq., Glaurafon, Swansea.
Richardson, William, Esq., High Field, Southouram, near Halifax.

Risley, Rev. William Cotton, M.A., Deddington, Oxfordshire.
Robbins, George, Esq., F.G.S., Midford Castle, near Bath.
Rofe, John, Esq., F.G.S., &c., 15, Abbey Place, St. John's Wood, N.W.
Roper, F. C. S., Esq., F.G.S., L.S., 3, Carlton Villas, Edgeware Road, W.
Rose, C. B., Esq., F.G.S., &c., 28, King Street, Great Yarmouth.
Rothery, H. C., Esq., M.A., F.L.S., 94, Gloucester Terrace, Hyde Park.
Rothery, Charles W., Esq., Greta Hall, Keswick.
Royal Artillery Institution, Woolwich, S.E.
Royal College of Surgeons, Lincoln's Inn Fields, W.C.
Royal Dublin Society, Dublin.
Royal Geological Society of Cornwall, Penzance.
Royal Geological Society of Ireland, Dublin.
Royal Institution of Cornwall, Truro.
Royal Institution of Great Britain, Albemarle Street, W.
Royal Institution, Liverpool.
Royal Institution of South Wales, Swansea.
Royal Irish Academy, 19, Dawson Street, Dublin.
Royal Military College, Sandhurst, near Bagshot.
Royal Society of Edinburgh.
Rudd, Rev. Leonard H., M.A., Kempsey, Worcester.
Rutter, John, Esq., Ilminster.
Rylands, T. G., Esq., F.L.S., G.S., Heath House, Warrington.

Saeman, Mons. L., 45, Rue St.-André des Arts, Paris.
Sabine, General, R.A., F.R.S., L.S., &c., 13, Ashley Place, Westminster, S.W.
Salter, J. W., Esq., F.G.S., &c., 8, Bolton Road, St. John's Wood, N.W.
Sanders, W., Esq., F.R.S., G.S., &c., 21, Richmond Terrace, Clifton, Bristol.
Sanders, Gilbert, Esq., M.R.I.A., &c., 2, Forster Place, Dublin.
Sanford, W. A., Esq., F.G.S., Nynehead Court, Wellington, Somerset.
Saul, G. T., F.L.S., Bow Lodge, Bow Road, E.
Saunders, James Ebenezer, Esq., F.G.S., 9, Finsbury Circus, E.C.
Saunders, W. Wilson, Esq., F.R.S., L.S., &c., Lloyds', E.C.
Savy, Mons. F., 24, Rue Hautefeuille, Paris.
Scarborough Philosophical Society (by J. G. Hickson, M.D., Honorary Secretary).
Seaham Natural History Club.
Sedgwick, Rev. Adam, M.A., F.R.S., G.S., &c., Cambridge.
Sharman, George, Esq., 9, St. George's Road, Kilburn.
Sharp, John, Esq., F.G.S., Culverden Hill, Tonbridge Wells, Kent.
Sharp, Samuel, Esq., F.G.S., S.A., Dallington Hall, Northampton.
Shaw, John, M.D., F.G.S., &c., Hop House, Boston, Lincolnshire.
Sheppard, T. Byard, Esq., Selwood Cottage, Frome.
Sheppard, Alfred B., Esq., Torquay.
Shipp, W., Esq., Blandford, Dorset.
Short, Rev. A., The School, Oswestry.
Sidney Sussex College Library, Cambridge (by the Rev. Robert Phelps, D.D., Master).
Simms, George, Esq., Bathwick Hill, Bath.
Sismonda, Mons. A., For.M.G.S., Professor of Mineralogy, Turin.
Skaife, John, Esq., 6, Union Street, Blackburn.
Sloper, G. E., Esq., Devizes.
Smith, Rev. Charles Lesingham, Little Canfield Rectory, near Chelmsford, Essex.
Smith, James, Esq., F.R.S.L. and E., G.S., &c., Jordan Hill, Glasgow.
Smith, Captain Robert, Frankford Avenue, Rathgar, Dublin.
Smithe, J. D., Esq., C.E., F.G.S., Madhopoor, Punjâb (by Messrs. Smith, Elder, and Co.).
St. Peter's College, Cambridge (by the Rev. H. W. Cookson, D.D., Master).

Somersetshire Archæological and Natural History Society, Museum, Taunton.
Sopwith, T., Esq., F.R.S., G.S., 103, Victoria Street, S.W.
South Shields Geological Club (by Geo. Lyall, Esq.).
Sowerby, James de Carle, Esq., F.L.S., &c., Royal Botanic Gardens, Regent's Park, N.W.
Spicer, Henry, Esq., Jun., 19, New Bridge Street, Blackfriars, E.C.
Spragge, W. Kennaway, Esq., The Quarry, Paignton, near Torquay.
Stansfeld, James, Esq., Halifax.
Steedman, John, Esq., Charlestown by Dumferline.
Stevens, H., Esq., F.G.S., &c., The Shaws, Matlock, Derbyshire.
Stewart, John, Esq., F.R.S.E., &c., Collin House by Castle Douglas, N.B.
Stobart, W. C., Etherley House, Darlington.
Stoddart, W. W., Esq., F.R.S., 9, North Street, Bristol.
Studer, Herr B., For.M.G.S., Professor of Geology, Berne.
Stutterd, Samuel, Esq., 59, High Street, Banbury.
Sunderland Corporation Museum.
Sunderland Geological Society.
Sunderland Subscription Library.
Swayne, H. J. F., Esq., Netherhampton House, Salisbury.

Tate, Geo., Esq., F.G.S., Alnwick, N.B.
Tawney, E., Esq., Luleston, Bridgend, South Wales.
Taylor, S. Watson, Esq., Erle Stoke Park, Devizes.
Teale, T. P., Esq., F.L.S., &c., Leeds.
Tennant, Professor Jas., F.G.S., &c., 149, Strand, W.C. (*two copies*).
Teuchner, Professor.
The General Administration of Mines and Salt-works in Munich (by Messrs. Williams and Norgate).
Thiollière, M. Victor, 19, Rue St. Dominique, Paris.
Thomas, Capt. F. W. L., R.N., H.M.S. "Woodlark," Trinity, near Edinburgh.
Thompson, Miss S., Stamford.
Thompson, Jas., Esq., Netherfield, Kendal.
Thomson, Alexander, Esq., F.R.S.E., Banchory House, Aberdeen.
Thomson, Dr. Allen, Professor of Anatomy, University, Glasgow.
Thomson, Thomas, Esq., Hull.
Thomson, Professor Wyville, LL.D., F.G.S., Queen's College, Belfast.
Thornton, Rev. John, M.A., F.G.S., &c., Aston Abbots, near Aylesbury.
Tomes, R. F., Esq., Welford, near Stratford-on-Avon.
Tomes, John, Esq., 37, Cavendish Square, W.
Torquay, Natural History Society.
Townsend, Mrs. M. E., 5, Chester Place, Regent's Park, N.W.
Trautschold, Dr., Moscow.
Trevelyan, Sir W. C., Bart., F.G.S., Wellington, Newcastle-on-Tyne; and Athenæum Club, S.W.
Twamley, Charles, Esq., F.G.S., 6, Queen's Road, Gloucester Gate, Regent's Park, N.W.
Twemlow, Major-General, Payle Lodge, Guildford, Surrey.
Tyler, Chas., Esq., F.L.S., G.S., 24, Holloway Place, Holloway, N.
Tylor, Alfred, Esq., F.L.S., G.S., Warwick Lane, Newgate Street, E.C.

University of Edinburgh (by Messrs. Maclachlan and Stewart).
University of Glasgow.
University Library, King's College, Aberdeen.
University Library, St. Andrews.
University Library, Leipzig (by Messrs. Williams and Norgate).

Verneuil, Mons. Edward de, F.M.G.S., 57, Rue de la Madeleine, Paris.
Vetch, Captain J., R.N., F.R.S., G.S., &c., 48, Finchley Road, St. John's Wood, N.W.
Vicary, William, Esq., F.G.S., 7, Albert Terrace, St. Leonard's, Exeter.
Vivian, H. H., Esq., 5, Upper Belgrave Street.

Wall, Geo. P., Esq., F.G.S., Pitmoor, near Sheffield.
Walmstedt, Dr. L. P., Professor of Mineralogy, Upsala (by Trübner and Co., Paternoster Row).
Walton, William, Esq., 11, Paragon, Blackheath, S.E.
Walton, William, Esq., 17, Grosvenor Place, Bath.
Ward, N. B., Esq., F.R.S., L.S., &c., 14, Clapham Rise, S.
Ward, Henry, Esq., F.G.S., Oaklands, Wolverhampton.
Wardle, Thos., Esq., F.G.S., Leek-Brook, Leek.
Waring, Samuel Long, Esq., The Oaks, Norwood, Surrey, S.
Warrington Museum and Library.
Warwickshire Natural History Society, Warwick.
Watson, Rev. R. B., 35, Royal Terrace, Edinburgh.
West, G. Herbert, Esq., 61, Wimpole Street, W.
Weston, Charles H., Esq., F.G.S., Endsleigh, Lansdowne, Bath.
Wetherell, N. T., Esq., F.G.S., &c., Highgate, N.
Whewell, Rev. William, D.D., F.R.S., Hon.M.R.I.A., F.S.A., G.S., R.A.S., &c., Mast. Trin. Coll., Camb., Lodge, Cambridge.
White, Alfred, Esq., F.L.S., &c., Castle Street, Cow Cross, E.C.
Willaume, T. B. T., Esq., Jun., 24, Chester Terrace, Regent's Park.
Willcock, J. W., Esq., 6, Stone Buildings, Lincoln's Inn, W.C.
Williams and Norgate, Messrs., Henrietta Street, Covent Garden, W.C.
Wilson, J. M., Esq., B.A., &c., Rugby.
Wilson, Rev. Dr., Southampton.
Wilton, John W., Esq., Gloucester.
Wiltshire, Rev. Thomas, M.A., F.G.S., &c., *Honorary Secretary*, Rectory, Bread Street Hill, E.C.
Winstone, Benjamin, M.D., 7, Ely Place, Holborn, E.C.
Wintle, G. S., Esq., East Gate Street, Gloucester.
Witts, Rev. E. F., F.G.S., Rectory, Upper Slaughter, near Stow-on-the-Wold.
Wolley, Rev. Charles, Eton College.
Wood, Edward, Esq., F.G.S., R.S.L., &c., Richmond, Yorkshire.
Wood, Henry, Esq., 10, Cleveland Square, Bayswater, W.
Wood, Rev. Henry H., F.G.S., Holwell Rectory, Sherborne, Dorset.
Wood, S. V., Esq., F.G.S., &c., *Treasurer*, Brentwood, Essex.
Woodall, Capt. J. W., M.A., F.G.S., &c., St. Nicholas House, Scarborough.
Woodd, C. H. L., Esq., F.G.S., S.A., &c., Hillfield, Hampstead, N.W.
Woodward, Charles, Esq., F.R.S., 10, Compton Terrace, Islington, N.
Worcestershire Natural History Society, Foregate, Worcester.
Wright, Joseph, Esq., 39, Duncan Street, Cork.
Wright, Thomas, M.D., F.R.S.E., G.S., St. Margaret's Terrace, Cheltenham.

Yates, James, Esq., M.A., F.R.S., L.S., G.S., &c., Lauderdale House, Highgate, N.
Yorkshire Naturalists' Club, York (by Ed. Smallwood, Esq.)
Yorkshire Philosophical Society, York.
Young, James, Esq., Burr Street, Tower Hill, E.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1863.

LONDON:

MDCCCLXV.

A MONOGRAPH

OF

BRITISH TRILOBITES.

BY

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

LATE OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

PART II,

CONTAINING

PAGES 81 TO 128; PLATES VII TO XIV.

(Pages 1 to 83,* and Plates I to VI, were published in Part I, in 1864.)

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1865.

* Pages 81, 82, and 83, have been reprinted in the present part.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

ERRATA.

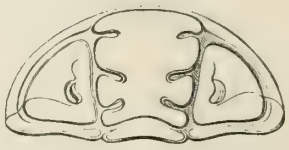
Page 84, line 11, for 1855, read 1851.
„ 95, last line but one, for *brevicapitata*, read *Caractaci*. (See page 96.)
„ 97, line 2, for 5—11, read 6—11.
„ 97, line 11, for 1855, read 1851.
„ 103, line 6, for 'as,' read 'but.'

Plate X, bottom, *Homal. Brongniartii*, for figs. 15, 16, read 15—17.
„ XIII, bottom, for *Homal. Winwoodii*, read *H. Vicaryi*.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

It was a proof of the late General Portlock's scientific acumen to have decided this to be an *Amphion*, a genus, be it remembered, never recognised in Britain before his work appeared; for assuredly the characters of the head are unlike those of the typical species, and yet there is no manner of doubt that we must admit it, and enlarge the generic character so to do. The forehead-lobe is much wider in this than in the other species, as our woodcut will show. (Fig. 17.)

Fig. 17.



The species probably grew three inches long, as indicated by fig. 30. The head is transverse, semicircular, or nearly so; the glabella, which is moderately convex, occupying fully one third, and regularly, but very slightly, tapering backwards to the small neck-segment. The furrows are three on each side, very short, and somewhat radiating, enclosing a linear basal lobe, a clavate middle one opposite the eye, and a subrectangular upper lobe, between which and the very short, wide, and transverse forehead-lobe is only a short, straight furrow; but beneath this it is continued as a faint curved depression (not shown in our figure), so as to follow the direction of the middle or ocular furrow. The forehead-lobe (and this is unusual for the genus) is as wide as the rest, and is a narrow linear segment. It has no central furrow, such as exists in *A. Fischeri*, nor any crenulate border in front; indeed, the front margin must have been very narrow, as our figure (woodcut 17) indicates.

The cheeks are triangular and gently convex, strongly and rather deeply marginal, the margin being not so broad externally as in *A. Fischeri*, and the cheek consequently more triangular and less oblong. The eye is placed far inwards for the genus, and only one third up the cheek. We have not the actual eye. It was small, but is not preserved in our specimen. The facial suture curves largely out and upward beyond the eye, and cuts the obtuse head-angles.

As the glabella is more convex than usual in the genus, so is the axis of the thorax which follows it, and which is not so wide as the sides, but wider in proportion than other species. The pleuræ are each convex, especially within (in the cast), and have the fulcral point at one third, whence they bend backward and curve downward. No pleural groove shows on the exterior surface, but within the crust the furrow is visible on the anterior edge of the segment.[1] The extremities are curved, and apparently rounded, but this last may be deceptive.

The tail is remarkable, and in our largest specimen (fig. 30) shows well the characters which separate it from *A. Fischeri*. Its parabolic flattened axis, divided into five rings, reaches barely more than half the length, divided by only faint axal furrows from the five side pleuræ, of which four are well distinct on each side, and have a sublinear but some-

[1] This is usual in all genera with ungrooved pleuræ, and hence the distinction of those groups which have "plevre à sillon," from those which have "plevre à bourrelet" is an artificial one. Cheirurus and Sphærexochus show the intermediate character.

what clavate form, the truncate ends being oblique. The two terminal ones close so completely behind the axis that the suture is soldered, and they appear as a single rectangular plate, with a terminal notch only. The whole tail is gently and regularly convex, and the appearance thus given is very peculiar.

Locality.—Caradoc Slate of Tramore, County Waterford (Mus. P. Geol.).

Amphion benevolens, n. sp. Pl. VI, fig. 31.

A. minor, capite (solùm cognoto) lentè convexo, latimarginato, margine frontali incrassato nec crenulato. Glabella lentè convexa anticè latior, lobis longis transversis, antico abbreviato triangulari, vix plus quam dimidium frontis efficiente; sulco centrali nullo. Oculi retrorsi, á glabellá paullum remoti. Reliqua absunt.

Much more nearly like the Russian species than the one above described. *A. benevolens,* named in honour of Mr. Nevins, of Waterford, differs from that species in its proportions, and in the presence of a plain, thickened, anterior margin instead of the crenulate border visible in the Scandinavian fossil. It is about the same size. We have only the glabella and a part of the cheeks, which show the eye to have been also very much nearer the glabella than in the species just quoted.

Head seven lines long and about fourteen wide, semicircular, a little pointed in front, gently and regularly convex, the glabella being just as long as broad above, and tapering slowly behind—the axal furrows quite straight. A thick margin runs round the front, quite free from corrugations, and with a small tubercle in the centre, the division between this margin and the glabella being feeble for the extent of the forehead-lobe, which occupies rather more than half the whole width of the glabella in front, and has a pair of very oblique, faint, straight furrows to bound it. Outside this the marginal furrow is as deep (in the cast, which is all we possess) as the abrupt axal furrows of the head. The middle and basal furrows are long, reaching more than one third across the glabella; the middle one straight at first, then gently decurved, the lower one quite straight, and all of them deepest at their inner termination. The neck-furrow rises considerably toward the middle, so as to make the basal lobes cuneate, but neither the neck-segment nor any of the lobes are tumid. All partake of the regular and gentle convexity of the head.

The eye is placed opposite the median lobe; it is small, but elevated, and surrounded by a rather deep furrow, and it is only about twice as far from the glabella as from the neck-furrow (in *A. Fischeri* it is three or four times as remote).

Locality.—Caradoc Slate of Newtown, Waterford, in company with *Phacops Jamesii,* described at p. 32.

A. PAUPER, n. sp. Pl. VI, fig. 32.

Omnino precedenti simillimus, nisi margine antico angustiore, lobis glabellæ longioribus radiatis, postico sinuato, mediano valdè obliquo recto, antico obsoleto. Glabella lentè convexiuscula, lateribus paullum arcuatis. Oculi subremoti.

One specimen only has been preserved of this neat species, which is truly distinct. It is about the same size as the preceding, from which, at a glance, you may distinguish it by the long glabella-furrows, and when closely examined it is found that there is one pair absent, viz., the obsolete anterior ones. A faint marking only indicates their proper position.

Glabella, including the narrow front border, as long as broad, regularly and gently convex, arched slightly in front; the sides not straight, but curved outwards; the upper angles rectangular. Anterior border narrow, not thickened. Anterior furrows quite obsolete. Median furrows starting from the upper angle or a little below it, straight, oblique, and reaching far towards the centre. Lower furrows situated opposite the eye, and reaching nearly as far as the upper ones. The middle lobes are thus subcuneate, the basal lobes broad-linear. The neck-furrow is distinct, but shallow; the neck-segment linear, but not so wide as the basal lobes; none of the glabella-furrows are thickened at their terminations. Axal furrows not deep. Position of eye doubtful, but probably further forward than in *A. benevolens*. The neck-furrow on the cheek is strong.

Compared with the preceding species, *A. pauper* differs in nearly every part. Instead of a thick front margin, it has a narrow one; the anterior furrows are obsolete, a very curious character, and peculiar to this species. The median ones oblique and longer than the basal furrows, which are sinuous instead of straight. Lastly, the head is less convex, and all the furrows—neck-furrow, axal-furrow, and glabella-furrows—less strong. The outline of the glabella is barrel-shaped, not rectilinear.

Locality.—One specimen only is known, from the CARADOC ROCKS of Tramore, where it occurs with the preceding (Mus. Irish Industry, B. 643).

Genus—STAUROCEPHALUS, *Barrande*, 1846.

Head cruciform, with long clavate glabella, greatly swelled in front into a hemispheric lobe;—the base narrow, cylindric, with two pairs of lateral furrows. Cheeks convex, with pedunculate eyes, and serrate edges. Facial suture ending on the external margin. Body-rings ten, without pleural grooves, pointed. Tail of few segments, the apices of the pleuræ free.—BARRANDE.

STAUROCEPHALUS MURCHISONI, *Barrande*. Pl. VII, figs. 13—20.

STAUROCEPHALUS MURCHISONI.		*Barrande*.	Prodrom. Sil. Syst. Bohême, p. 53, 1846.
—	—	„ 1852.	Syst. Sil. Bohême, pl. xliii, fig. 28—32
—	—	*M'Coy*. 1855.	Synopsis Woodw. Mus., pl. i F, fig. 15,
—	—	*Salter*.	Morris's Catal., 2nd. ed. p. 115, 1854.
—	—	*Id*.	Siluria, 2nd ed. p. 540, 1859.
—	—	*Id*.	Decade 11. Geol. Surv., pl. 5, fig. 1-5, 1865.

S. ovatus, tuberculosus, oculis remotiusculis, margine genarum spinoso. Cauda quadrata, pleuris sex, omnibus æqualibus retrorsis parallelis, haud divaricatis.

One of the most curious, if not one of the most conspicuous, of our British species. The globular head, or rather glabella, set on its narrow stalk-like base; the gibbous cheeks, projecting eyes, serrate border, and spiny comb-like pleuræ and tail—combine to give a most unusual and extravagant appearance to the fossil. It is seldom found perfect; but the skill of the Dudley naturalists has long been exercised on it, and specimens are now to be found in several cabinets. Mr. Hollier's and Mr. Ketley's very fine specimens are the principal ones figured. Our fig. 18 is from the Museum of Practical Geology: it was formerly in Mr. E. Davis's collection, and is from Presteign.

About an inch long, of which the gibbous head occupies more than two fifths. This is longer than broad, roughly triangular in general outline, but not truly so. It appears rather four-lobed, or like the heraldic "fleur-de-lis," the truly globular front occupying more than half the length of the glabella, and being at least three times as wide as its semicylindrical base, from which it is abruptly cut off by a transverse furrow; the base is marked by two distinct lateral lobes, besides the neck-furrow. The cheeks reach forward about half way up this globular portion; and the central part is unusually raised, so as nearly to be on a level with the glabella. The cylindrical eyes are on the most convex part of the cheeks, and are directed outwards, scarcely forwards. The margin is distinct in front of the head, has a very narrow prominent ridge, and furnished

on each side with about fourteen truncate spines; the cheek-spine is directed backwards and but slightly outwards, abrupt at its origin, and not reaching beyond the two or three first body-rings. The facial suture cuts the outer border in a direct line from the base of the eye.

All the prominent parts of the head are covered with larger and smaller tubercles; they only fail on the deeper furrows and the truly vertical outer half of the cheeks. They are conspicuous on the border and even on the cheek-spines.

The body and tail united are slightly longer than the head, the body of ten rings many times longer than the short square tail, and the axis about one fourth the whole width and highly convex, especially in front. There are no axal furrows to separate the gibbous axis from the horizontal portion of the pleuræ; and these soon curve downward, and are abrupt and steep on the sides.

The pleuræ are semicylindrical, the front portion, separated by the pleural groove, being very narrow in this and allied genera, placed on the forward margin, and scarcely visible.[1] The apices curve much backward, and in the hinder pleuræ again a little upward, and are produced into strong spines beyond the ovate facetted portion. And all along these pleuræ, and over the axis, tubercles are placed at equal distances, except that the central prominent tubercle fails on the alternate rings of the axis, and the intervening ones, especially the ninth, are stronger than any other tubercles, and remind us of the spines on *Encrinurus,* a genus not yet described in these pages.

The tail is nearly square, concave rather than flat,—the short conical axis of four rings not easily separable from the sides, which are composed of three flat, broad, spinous pleuræ, directed backwards and quite parallel, so as to give a comb-like appearance. A few tubercles are scattered on the surface.

Locality and Geological Position.—Caradoc Rocks, Rhiwlas, near Bala, N. Wales (figs. 19, 20). Woolhope Limestone and Shale, Corton, Presteign (fig. 18). Wenlock Limestone, Dudley and Malvern.

S. globiceps, *Portlock.* Pl. VII, fig. 21.

Ceraurus globiceps, *Portlock.* Geol. Rep. Tyrone, p. 257, tab. i, fig. 7, 1843.
Staurocephalus globiceps, *Salter.* Morris's Catal., 2nd ed. p. 115, 1854.
— — *Id.* Decade 11. Geol. Survey, pl. v, fig. 6, 1865.

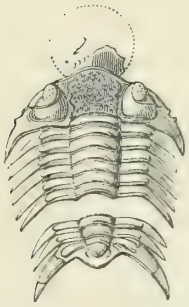
S. ovatus, granosus, caudâ utrinque elongatâ, spinis divergentibus. Glabella stipite brevi vix lobato. Oculi approximati. Spinæ genales et pleurales diffusæ. Cauda brevis, pleuris primariis longè extensis, latis; reliquis—?

[1] Yet I doubt the propriety of making this character so important in classification as Barrande has done. The pleural groove is always present in one form or another. In this case it is anterior, in Cheirurus it is very short and oblique.

A much smaller species than the preceding, and distinct from it by abundant characters of shape and habit. The divergent spines of head, thorax, and tail, enable us at once to recognise it; and of the latter the remarkable extended first pair of pleuræ (the rest of the tail is lost) show a near connection with the *S. unicus*, next described.

Only two good specimens, 10 lines long, are known. The head is equal to the thorax in length, and longer than the caudal portion. It has a very large globular front, longer than the square stipes, and granular all over. This stalk or base seems to be only furrowed beneath. The cheeks are granular, gibbous, with a prominent eye on the front edge near the glabella; and directed forward, not outward, with a broad plain margin, and widely divergent spines.

Fig. 18.



S. globiceps, Portlock, from Ayrshire. Mus. P. Geology.

A very finely preserved specimen, fig. 18, lately acquired by the Geological Survey, shows the body and tail-spines very well, and the free cheek furnished with short spines.

The axis of the thorax is cylindrical, and as wide as the stalk of the glabella. The pleuræ flat as far as the fulcrum, which is less remote than the width of the axis; strongly tuberculate at this point, and thence with patent (not recurved) spines, as long as the portion within the fulcra. The thorax tapers backward rather rapidly to the tail, which has a short three-ribbed axis; and the upper pair of its pleuræ are very much expanded widely divergent, and more arched than in our figure, which also represents the thoracic pleuræ as less curved than they really are. The hinder portion of the tail is absent on our specimen.

Locality. — Caradoc Rocks of Desertcreat, Tyrone; also Ayrshire,—a solitary specimen, figured in the woodcut, (Mus. Pract. Geology).

A third form, very abnormal in its characters and of large size, was named in MS. *S. Maclareni* by Prof. Wyville Thomson, after the veteran Scotch geologist in whose company it was found. It is, however, Prof. Thomson's previously described *Acidaspis unica*. As he has mislaid his own full description, I may supply the following notes from his specimens, and others presented to the Museum of Practical Geology by himself.

S.? unicus, *Wyv. Thomson.* Pl. VII, figs. 22—24.

Acidaspis unica, *Thomson.* Quart. Geol. Journ., vol. xiii, pl. vi, fig. 13; 1857.
Staurocephalus? unicus, *Salter.* Decade 11; Geol. Surv., Art. 5, 1865.

S. 1¼-uncialis, oblongus, sparsè granulosus, glabellâ gibbâ eminentissimâ, corpore plano, caudâ expansâ transversâ. Caput latum, glabellâ clavatâ elevatâ frontem longè impendente, à genis punctatis distinctissimâ; margine crasso utrinque bispinoso. Pleuræ subplanæ,

sulcatæ, rectæ, apicibus abruptè recurvis. Cauda lata brevis, axe appendiculato, pleuris primariis latissimis spatulatis, margine postico truncato.

In the absence of a figure sufficiently complete (for the one quoted above is very defective) it is necessary to give a rather full diagnosis of this remarkable form, which tends to show the passage of the Cheirurid into the Acidaspid family. Indeed, if Prof. Thomson be correct in figuring 12 segments to the body, the species is abnormal for either Acidaspis or Staurocephalus. The shape of the head shows clearly enough that it is to Staurocephalus, or else to one of the sections of Cheirurus, that this bizarre fossil must be referred. *Cheirurus* often has 12 segments, *Acidaspis* 9 or 10, *Staurocephalus* only 10. The grooved pleuræ are unlike Staurocephalus, but like the section Eccoptochile among the genus Cheirurus. But no Cheirurus has so clavate a glabella, though a tendency towards it is exhibited in some species, and *Sphærocoryphe* of Angelin is very near to our fossil. There is an evident relation, too, with *Lichas* in this form, both in the shape of the tail and the character of the pleuræ. But the external position of the facial suture—far up the cheek—easily distinguishes it from that genus. I do not further describe it, as it has already been fully noticed, though not figured, in Decade 11 of the Geological Survey, just published.

Locality.—Caradoc Schists, at the base of the "Orthoceratite and Graptolite Flags," Penwhapple Glen, Ayrshire (Wyv. Thomson).

Staurocephalus. Sp. Pl. VII, fig. 25.

An imperfect fossil, but distinct from *S. unicus*. It has tuberculate pleuræ.

Locality.—Caradoc. Ayrshire (Prof. Thomson's cabinet).

Deiphon, Barrande. 1850.

Deiphon, the most abnormal in appearance of the whole Cheirurid family, is not found, when closely examined, to depart very much from the ordinary type. Except in the extreme reduction of the cheeks, and inflation of the glabella, the head might well pass for that of a *Cheirurus* of the section *Actinopeltis;* while the body and tail, extravagant as they seem at first, have all the usual characters of the family. We have now perfect specimens, and can improve Barrande's description.

Form somewhat circular; very loosely built, and produced into spines on the margin. The head composed of a globular glabella without furrows, long-spinous fixed cheeks, and minute free cheeks,—the facial suture ending on the exterior margin. The eye prominent, not stalked. Hypostome narrow, granular, without any rostral shield. Labrum hexagonal, with a truncate end, small lateral auricles, and an unfurrowed hemispherical centre; the base is narrow and arched. Thorax of ten joints with a very convex axis,

and linear ungrooved pleuræ with free curved spinous ends. The tail is short, with a minute axis of four joints, and is quite truncate below; its two upper pleuræ developed into great divergent spines—the rest obsolete, more so even than in *Staurocephalus globiceps.*

DEIPHON FORBESI, *Barrande.* Pl. VII, figs. 1—12.

DEIPHON FORBESII, *Barrande*, in Haidinger's Berichte, p. 6, 1850.
— — *Salter.* Morris' Catal., 2nd. ed., p. 106, 1854.
— — ,, Siluria, 2nd ed., pp. 539, 262, 1859; and quoted in many general works.

D. uncialis, latus, granulosus. Glabella sphærico-quadrata, oculos impendens, latitudine fere genis æqualis, granulis creberrimis, magnis minoribusque mixtis. Lobus cervicalis angustus. Spinæ a base glabellæ orientes; in juniore curvæ, tenuiores; in ætate crassæ, sinuosæ, retroflexæ, haud patentes. Thorax pleuris antrorsúm curvis, ad basin contractis, apicibus recurvis; anticis posticisque brevioribus; ultimá brevissimá, et sæpissime caudam adhærente, néc connatá. Cauda lata, ad basin truncata, axe 4-annulato stellato depresso, pleuris solúm duobus, crassis, patentibus, apicibus recurvis.

I have been diffuse in the diagnosis, for the reason that I suspect more than one species is confounded under the name of this most odd-looking, rare, and precious Trilobite. Not that fragments are uncommon, they are frequent in the Dudley slabs; but perfect specimens are of the rarest occurrence; and we are fortunate in being able to present naturalists with the complete form.

The specimens figured in our plate show that the species must have grown fully an inch long; and as the breadth is greater than the length, it must have measured one and a quarter inch from tip to tip of the curved spines. The glabella forms the greater part of the head, is hemispherical, rather quadrate in age, but truly hemispheric in the junior stages, or rather subspherical, for it forms at least three quarters of a sphere, and in front it is only somewhat less convex beneath than on the dorsal surface. In very old specimens, fig. 6, the large glabella overhangs the eyes, which are placed close to it on the forward edge of the narrow spine-like cheeks. These arch upward more in young specimens, so as to be like the figure given by Barrande; but are more horizontal at their origin in the adult. Hence they curve outward and backward (most backward in the older state) and are longer than the width of the glabella itself: they are also covered with a more imbricate granulation; see fig. 9. The eyes are supported by folds of the crust, which occur both on the fixed cheek behind the eye and on the small triangular free cheek, which last projects a little at the facial suture beyond the spine, and is more finely granular than the spine itself.

The eyes are (according to Barrande) coarsely granular;—they appear to be more finely so

in ours, which, from several differences of proportion in all the parts, I suspect to be a different species. If so, I shall call it after the distinguished palæontologist who discovered the genus. It may be only a local variety.

The thorax, now for the first time figured, has a narrow convex axis, of ten rings, tapering slowly backward, and strongly distinguished from the gently curved pleuræ. These arch a little upward, and at the recurved pointed apices strongly downward, giving a singular aspect, as of the prickles of a *Geum* or a teazel-head. The pleuræ are semi-cylindric, contracted at the base, most convex along the median line, and flatter towards the tips. They are quite separate from each other, not touching, so far as I can see, along the fulcral edge; nor is there any distinct fulcrum, only a little expansion on the forward edge. We have omitted an enlarged view of the thorax-ring on the plate, and supply it here.

Deiphon Forbesii. Enlarged view from above, not endwise, of seventh thorax-ring.

The front pleuræ are shorter than those which follow them, to accommodate the former to the shape of the head-spines; the hinder pleuræ, in like manner from the seventh, begin to shorten; and the last is so short and slender, and so frequently attached to the tail (not connate with it, however, as Barrande supposed and figured it), as to look like a part of that organ.

Tail—a pair of widely divergent broad-pointed prongs, strongly curved back at the tips; and more divergent in the adult (figs. 11, 12) than in the younger state (figs. 1, 2, 3). The end is quite truncate, the base of attachment narrow; and the axis, of three or four rings arranged in a stellate fashion, is depressed below the whole of the general surface.

Locality.—Wenlock Limestone of Dudley and Wallsall; Wenlock Shale of Malvern Tunnel. I do not know it elsewhere in Britain.

Foreign distribution.—Etage E. Bohemia. The genus occurs in Regio D—E. in Sweden (Angelin).

I do not enter upon the description of those doubtful members of the Cheirurid group—the genera *Cybele*, *Encrinurus*, &c., for the reasons before assigned, viz., the imperfection of the materials, and the doubt I still feel whether these genera should not form a distinct family group. I shall also omit the family *Acidaspidæ*, the materials for which are more complete, but the knowledge we yet have of them is not so. It is better to leave these, and begin upon those groups of which we have abundant materials. I shall therefore follow on with the families *Calymenidæ* and *Asaphidæ*.

CALYMENIDÆ, *Brongniart.*

The group so named must for the present be restricted to two genera, both of which are the most common of all Trilobites, and grow to a large size. If we admit more than *Calymene* and *Homalonotus* into the family, we shall have a heterogeneous group, some of which have the facial suture ending in the posterior angles, and others on the posterior margin—some with more and others with less than thirteen rings to the body. But if these latter are considered to form a distinct family—the Conocephalidæ, the two genera above named constitute a most natural group. *Calymene* has the trilobation of the body complete. *Homalonotus* is singularly deficient in this respect. Some of the species, indeed, of this last genus are sufficiently trilobed to connect them with *Calymene,* others are so slightly lobed that the term Trilobite is a misnomer as applied to them. But in the essential characters of thirteen body-rings, and a notched labrum attached to a distinct rostral shield, both agree; and the facial suture in each ends exactly on the angle, a position midway, it will be observed, between that in the two groups already described, and that which it assumes in all the 'Primordial' genera of the Conocephalidæ, which have it posterior. Restricted thus, we have a numerous set of species, belonging to two natural genera, included in this group. They have a thick granulated crust, often ornamented and even spinous superficially, but without produced spines or angles to any part of the margin.

Calymene, *Brongniart.*

One of the most graceful and compact of all the Trilobite group; the head and tail well developed, but not extravagantly so; the former with a three-lobed glabella, very convex and narrowed in front, and with prominent supine eyes, which have evidently a very thin cornea, in which, only very rarely, the lenses are visible;[1] a thick margin to the head, the suture being in front submarginal and subtending a broad rostral shield. This bears a notched labrum, with a central gibbosity, conspicuous in all the species. Body of thirteen rings, the axis convex, and the pleuræ facetted and rounded at the ends. The tail, of about five lateral segments duplicated throughout, and the convex axis reaching to the very end in all the species, and with eight or ten rings to it.

The range of the genus is from the Arenig Group to the Ludlow Rocks. In Bohemia alone is *Calymene* known to rise somewhat higher; the upper limestones of that country, containing *Calymene,* being generally considered to be the lower beds of passage in the Devonian strata.

[1] Hall, in his 'Palæontology of New York,' has figured the lenses. I have never seen any traces of them.

C. TUBERCULOSA, *Salter*. Pl. VIII, figs. 1—6.

CALYMENE BLUMENBACHII, *var.* TUBERCULOSA, *Dalman*, p. 36? (not tab. 1, fig. 2). 1826.
— — — *Hisinger*. Lethæa Suecica, p. 10? (not tab. 1, fig. 3), 1837.
— — *Murchison*. Sil. System, pl. vii, fig. 5 only, 1839.
— TUBERCULOSA, *Salter*. Mem. Geol. Survey, vol. ii. pt. 1, pl. xii, 1848.
— — *Id.* Decade 2, Geol. Survey, pl. viii, 1849.
— — *Id.* Morris Catal. 2nd edit., p. 102, 1854.
— — *Id.* Siluria, 1st ed., pl. xviii, fig. 11, 1854 (by accident not introduced in the 2nd edit., 1859).
— BLUMENBACHII, var. *Hall*. Pal. New York, vol. ii, pl. A 66, fig. 6? 1852.

C. lata biuncialis depressa alutacea, nec tuberculosa; margine frontali capitis valde producto recurvo; genis gibbosis, glabellâ brevi depressâ. Thorax axe angusto, pleuris planis usque ad fulcrum, quod anticè ad dimidium, posticè ad tertium positum est. Cauda lata depressa, lateribus abruptè deflexis, axe conico subplano 7—8 *annulato; costis lateralibus* 5 *planis, sulcis acutis haud interlineatis.*

If species be anything more than confirmed varieties, this is a good species; and being common in Shropshire, there is sufficient material to judge from. It is entirely different in aspect from the common Dudley Trilobite, being greatly more depressed, and having a projecting recurved snout, which distinguishes it at a glance.

Our specimens are not more than $2\frac{1}{2}$ inches in length, and in breadth $1\frac{1}{2}$ inch. Whole surface equally and minutely scabrous. General form broad for the genus, not much attenuated posteriorly, depressed. Head short, wide; the glabella not more prominent than the cheeks, and much narrower, contracted in front, and separated by a deep furrow from the front margin: it has three lobes on each side, the basal one large, the middle one nearly spherical, the third minute; the forehead-lobe is small, the neck-lobe large and prominent. The neck-furrow is continued nearly to the posterior angles, which are rounded. Cheeks gibbous, often more elevated than the glabella, bearing the small eyes on their most prominent part. These are placed opposite the middle lobe of the glabella, and at some distance from it. A strong deep furrow separates the cheeks from the glabella, except opposite the eye, where a buttress is thrown across from the cheeks touching the middle glabellar lobe. The wings are strongly bent downwards, and even inwards on the under surface of the head, and the anterior margin is much recurved, and produced into a snout. On looking at the under view of the head, the margin appears greatly bent, and in the angle so formed, the curved rostral shield, half as long as broad, is inserted; beneath this is attached the hypostome, which is squarish-oblong, with the terminal angles rounded; it is strongly convex forward, the convexity terminating in a compressed tubercle;

one or two concentric lines, as if of growth, mark the surface, which is also scabrous, like the general crust of the body. The axis of the thirteen body-rings is convex, but narrower than the pleuræ, and constantly tubercular on the sides. The pleuræ are horizontal half-way, and then strongly decurved; their ends rounded posteriorly, and bent forward. Fulcrum distant from the axis, about half-way from it near the head,—at one third, or rather less, behind. Pleuræ sharply furrowed, the forward or fulcral half somewhat narrower than the posterior. Tail nearly semicircular, with the front angles truncated; evenly and gently convex, the axis not prominent, the sides decurved strongly towards their edges. Axis not percurrent, narrow, conical, with seven rings and a terminal boss. Lateral ribs flattened, separated by sharp, narrow furrows, starting at a wide angle from the axis, and curved back on the sides, simple, or but rarely marked by a central line near their ends,—not bifurcate, as in *C. Blumenbachii.*

—— *Junior.*—The proportions of the axis to the sides, and the structure of the pleuræ are similar; but the glabella is more cylindrical, not widened below; the tail is proportionately smaller, has the axis wider and more convex, with fewer ribs; and there are but four distinct ribs on each side.

Variations.—In some the axis is a little more prominent; in others a greater or less depression of the glabella occurs, and apparently the production forwards of the snout is not always in the same degree. But these variations are within narrow limits, and our species never seems to approach *C. Blumenbachii* in convexity, especially with regard to the glabella and caudal axis. The front is constantly produced, the surface minutely scabrous, not covered with scattered tubercles; but this last character occurs in some varieties of *C. Blumenbachii,* which is more variable than we formerly believed.

This really beautiful species shows in the reduction of the glabella a tendency towards the characters so strongly displayed in the Lower Silurian forms. In the projecting buttress which stretches from the region of the eye towards the second lobe of the glabella, an approach is made to the very curious *C. camerata* of Conrad, in which the processes from behind the eye form projecting wing-like covers to the axal furrows. And in the slight furrows of the arched lateral lobes of the tail, several foreign species are imitated.

Localities.—Wenlock Shale, Burrington, Shropshire, abundant. Ludlow Rocks, Underbarrow, Westmoreland.

Foreign localities.—Clinton Group (May Hill Group). Hall's figure probably represents this species.

C. Blumenbachii, *Auctorum.* Pl. VIII, figs. 7—16. Pl. IX, figs. 1, 2.

Lyttelton. Phil. Trans., vol. xlvi, pls. i, ii, p. 598, 1750.
Mortimer. Ib. p. 600. *Mendez da Costa,* ib., vol. xlviii, p. 296, 1753; also *Guettard, Wilckens, Klein, Walch, Beckmann,* &c., 1757 to 1773.
C. platys, Green's Monograph; cast No. 4, 5, (not C. Blumenbachii, *id.*) 1832.
Trilobites tuberculatus, *Brunnich.* Nye Samml., &c., i, 389, 1; 1781.
— — *Blumenbach.* Abbild. Naturh. Gegenst., i, t. 50; 1810.
Entomolithes paradoxus, *Parkinson.* Org. rem., III, pl. xvii, figs. 11, 13, 14; 1811.
— tuberculatus, *Wahlenberg.* Nov. Act. Ups., viii, 31, 6; 1821.
Calymene Blumenbachii, *Brongniart.* Crust. foss., ii, 1, pl. i, fig. 1 a—c; 1822.
— — *Dalman.* Palæad. 35, 1, tab. i, figs. 2—3 a—c; 1826.
— — *Payton.* Trilob. of Dudley, fig. 14 (plate only) 1827.
— — *Murchison.* Sil. Syst., pl. vii, figs. 6, 7 (not fig. 5) 1837.
— *var.* Niagarensis, *Hall.* Pal. N. York, vol. ii, p. 307, pl. lxvii, figs. 11, 12; 1852.
Calymene Niagarensis, *Hall.* Geol. Report 4th district, p. 101, fig. 3; 1843.
— subdiademata, *M'Coy.* Pal. Foss. Woodw. Mus., pl. i f, fig. 9 only; 1851.
— spectabilis, *Angelin.* Palæont. Suecica, t 19. f. 5; 1852.

C. magna 3—5 *uncialis, elongata, valde convexa,—per totum tuberculosa. Caput glabellâ magnâ longâ, utrinque trilobâ, marginem frontalem compressum crassum haud productum attingente; genis declivibus, vix glabellâ latioribus. Thorax axe quam pleuris lato, convexo ferè gibbo; pleuris deflexis nec planis, fulcro approximato, anticè ad tertiam, posticè ad quintam partem latitudinis posito. Cauda angusta, subtrigona, axe gibbo, lateribus declivibus* 5-*costatis, costis omnibus bifidis, sulcis profundis.*

It is necessary to be diffuse in the specific character; for in this genus it is only by contrasted differences of proportion that we are able to distinguish the species. *C. Blumenbachii*, like all common Trilobites, has a considerable range of variation; but the greatly extended large glabella is after all the best character of the species. It occupies fully a third of the head in width, and is so long as to touch the thickened front margin, which is neither produced nor much reflexed. In this all the specimens agree, while they differ in points of mere proportion. The glabella is sometimes a little wider, especially at the base; sometimes less convex, but always more prominent than the cheeks, and even overtopping the eye-tubercles. The tail varies in width, but is always trigonal with deflexed strongly ribbed sides; and the pleuræ, always strongly decurved, are sometimes flatter, and sometimes very convex, *i. e.*, curved very strongly down, as in our figure 15.

The species being so common, it is only necessary to describe the points relied on for its distinction from others; for the Dudley fossil has been much confused with kindred forms, and these differ sufficiently from it when closely examined.

C. Blumenbachii is the largest of the genus; our fine central specimen, the one figured in

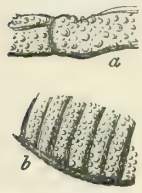
the 'Silurian' System, being 4 inches by $2\frac{1}{2}$ broad. Swedish specimens sometimes reach 5 inches. Form ovate oblong, not much pointed in front, and obtuse behind. The head occupies more than a fourth the whole length, and is semicircular,—our fig. 8 giving the true shape, while fig. 7 is more pointed than usual. The glabella is more than equal to the width of the cheeks; and reaches quite to the thickened front margin. It is very convex, especially in front, and is bell-shaped, the base expanded, the large, round, lower lobes fully $\frac{2}{5}$th the whole length, the middle ones about half this length, the upper minute. All are convex and well circumscribed. The marginal furrow and the axal furrows deep; the cheeks convex, but not nearly so much so as the glabella; and the eyes, placed two thirds up, are not very prominent, nor is there any strong buttress connecting them with the central glabella-lobe. The neck- and marginal furrows strong, and all but complete, sometimes (fig. 18) quite so.

The margin is very thick, and seen on a front view (fig. 16) not so much bent upward as in the last species. The rostral shield is a good deal wider than long, and the sutures converge much toward the labrum, which (fig. 10) is squarish-oblong, with parallel sides beneath the broad ascending processes. The centre is gibbous, with a strong tubercle; and there is a strong concentric furrow separating a broad margin. The tip is emarginate, with obliquely truncate angular lobes.

The axis of the 13 body-rings is very convex, and as wide as the deflexed pleuræ, from which it is abruptly separated, but not by a furrow. The axis tapers very little backwards. The pleuræ, horizontal for a third of their width, bend strongly down at the fulcrum, placed at one third near the head, and in the last joint at $\frac{1}{5}$th the width of the pleuræ. Pleural groove strong, the forward half of the pleura being the smallest.

Tail roughly trigonal, with the front greatly arched, and the base-line very little curved. The convex axis occupies one third the width, converges quickly near the tip, and is thence continued by a short appendix to the very end of the tail. It has six or seven rings, and a smooth, convex, terminal portion, beyond which is a smooth appendix. The sides have five strong bifid ribs, very little arched, subparallel, the hinder ones becoming quite longitudinal in direction. The margin is strongly bent inwards at right angles to the surface, but not further incurved. All the tail is granulated. The granulation of the margin is very close and fine, (fig. 18 *b*) but over all the rest of the body tubercles are mixed with the granules (fig. *a*) often conspicuously. (See also Pl. VIII, figs. 7, 15, &c.)

Fig. 19.



Body-ring and tail of *Calymene Blumenbachii*, showing mixed granules.

The following variations may be noted. Our Pl. VIII, fig. 7, has a somewhat more pointed head and longer glabella than usual, while fig. 16 has it rather shorter than ordinary, and more expanded at the base. Fig. 8 has the normal shape of the glabella-lobes; the basal ones being pyriform and somewhat wider than long. In fig. 14 the length is greater. Fig. 16 has the large lobes triangular. Fig. 15, in the 'Mus. Pract. Geology,' has the granulation stronger than in most

specimens we have seen,[1] and is also deeper in the body; the vertical height of the very convex form being exactly half the width. Few specimens have the height greatly more than one third. In some, fig. 16 for instance, the marginal furrow is continuous all round the front. Fig. 14 has scarcely any interval behind the thick front margin and the glabella.

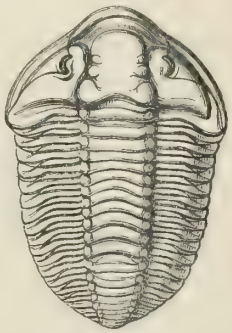
Var. pulchella, Dalman; Palæadæ, p. 35, &c., has the glabella narrow in the young state; our fig. 19 may very well represent such a form. The head is more triangular, and the glabella narrower than usual. Fig. 11 has the same character. Fig. 16, on the contrary, has a wide short glabella. But all these variations are within narrow limits.

There are differences of proportion in the tail. Some have the length as ten, to a breadth of eleven. A second has it in the proportion of seven to ten. In others it has a length of five, to a breadth of seven. And there are all intermediate proportions; I figure a variety from Mr. Allport's collection, which differs more from the ordinary form of the species than any other Upper Silurian specimen I know. I call it

Var. Allportiana;— *capite trigono, fronte productâ, glabellâ breviore.*

In this variety the knots on the axis are very strong; the fulcrum is further out than usual, the glabella more sunk, and the front so much produced as to suggest the idea of a strictly intermediate variety between this and the preceding species. Such specimens as this tend to shake our faith in species, and make us ready to believe that they are after all only confirmed varieties of some more common type. *Even if this be true,* they are not, for this reason, of less consequence either to the naturalist or to the geologist: nor is it necessary to extend the idea indefinitely to genera and families.

Fig. 20.



C. Blumenbachii, var. *Allportiana,* from Dudley. Mr. Allport's collection.

Fig. 12 shows decided knots down the sides of the axis, and this is very probably Dalman's variety *tuberculata.* Figs. 15, and in part 16, also show them; they are absent in the majority of Dudley specimens. But these variations are all slight compared with the amount of difference seen on comparing the Dudley fossil with the Lower Silurian forms distinguished under the name *C. senaria.*

The internal casts figured from the Woolhope beds, Pl. IX, fig. 1, and from the Llandovery beds, Pl. IX, fig. 2, show a tendency to a narrower and shorter form of the glabella; and some Dudley specimens also tend this way. And it will be well in comparing *C. Blumenbachii* with its var. *brevicapitata,* to bear in mind that we must compare casts with casts in order to understand the amount of difference. For instance, Pl. IX, fig. 1, is that of

[1] Another specimen in the Mus. P. Geology, imperfect, but as large as our central figure, has the granulation remarkably close, covering the whole surface. And, whenever the true surface is preserved by careful cleaning of the specimens, this character is more or less conspicuous.

a very thick old crust, and that partly accounts for the space between the glabella and the front. In fig. 2 the crust is much thinner, and the space is consequently not so great. But in both these the glabella reaches nearly to the front margin; and is bell-shaped, not triangular. In the species which follow, the glabella is more and more reduced in size, till it reaches its minimum in the *C. parvifrons*, Pl. IX, fig. 21 We shall take these species in descending order.

Localities.—Caradoc, Ireland (Prof. McCoy), Lower Llandovery, Carmarthenshire; Radnorshire; Pembrokeshire; Mullock, Girvan, in Ayrshire; Mayhill Rocks of Norbury and the Longmynd; Malverns, &c.; also Dingle, Ireland. Woolhope beds, Bogmine, Shelve, Shropshire. Wenlock Shale and Wenlock Limestone, everywhere in Great Britain and Ireland, where these rocks or their equivalents occur; the chief specimens from Dudley and Walsall. Lower and Upper Ludlow Rocks, Shropshire (rarely). Marloes Bay, Pembrokeshire. Aymestry Limestone—Leintwardine (*C. subdiademata*, McCoy).

Foreign Distribution.—Sweden and Norway, in Upper Silurian. *Niagara Group* of New York and Pennsylvania, &c. *Etage E.* Bohemia; *Barrande.* (This last locality is somewhat doubtful.) Kindred species are found all the world over in rocks of Silurian age.

C. Blumenbachii, var. CARACTACI.—*Glabellâ angustiore breviore, caudâ normali, axe lato, lateribusque deflexis.* Pl. IX, figs. 3—5.

[C. selenecephala, *Green's* Monogr. Cast No. 3, 1833?]
C. subdiademata, *M'Coy.* Pal. Foss. Woodw. Mus. pl. i f, (fig. 10 only); 1855.
C. Blumenbachii, *var.* brevicapitata, in part. *Salter* in Mem. Geol. Survey, vol. iii, pl. xvii, fig. 9 only, 1865.

Not above $1\frac{1}{3}$ inch long, and fully $1\frac{1}{4}$ broad, ovate, the head semicircular, with the glabella equal in width to the cheeks, and in length rather greater than its breadth. The glabella is parabolic, blunt in front, and has the three side-lobes well developed,—as in the type-variety. The eye is rather forward, and there is no buttress opposite the middle lobe. Except in this reduced size of the glabella, and in a slightly narrower axis and more arched side-ribs to the tail, there is no essential distinction between it and the ordinary form. It has been, however, occasionally (being always in the state of casts only, confounded by myself and others with the true *C. brevicapitata*, which, indeed, being the *C. senaria* of Conrad, the name had better be extinguished. I would call the present variety Var. *selenecephala*, were I sure of Green's name; but his cast is very imperfect.

Locality.—Caradoc Rocks of Shropshire; abundant. (Mr. Edgell, Mr. Lightbody, Geol. Surv. Collections, &c.) Bala, Llanwyddyn, Llangollen, Snowdon, &c., in N. Wales. Desertcreat, Tyrone; Col. Portlock (Mus. Pract. Geology). Coniston, Westmoreland.

Foreign localities.—North America, if *C. selenecephala* of Green be the same.

Subspecies I.

CALYMENE SENARIA, *Conrad.* Pl. IX, fig. 5—11.

C. BLUMENBACHII, *Green*, in part, No. 1 cast, 1832.
C. SENARIA, *Conrad.* Ann. Geol. Rep., N. Y., p. 49, 1841.
— *Hall.* Palæont. N. York, vol. i, pl. lxiv, fig. 3, 1847.
— *Emmons.* Geol. Rep., p. 390, fig. 2, 1842.
C. BREVICAPITATA, *Portlock.* Geol. Report, pl. iii, fig. 3 only?, 1843.
— *Salter.* Mem. Geol. Surv., vol. ii, pt. 1, pl. xi, figs. 1, 2, 1848.
— ,, ,, vol. iii, pl. 17, figs. 10—12 (not fig. 9). 1865.
— ,, Morris Catal., 2nd ed., p. 102, 1854.
— *M'Coy.* Pal. Foss. Woodw. Mus. 165, tab. i F, figs. 4—6, 1855.
C. BAYLEI, *Id.* *Op. cit.*, tab. i F, fig. 8 (not of Barrande).
C. FORCIPATA, *Id.* Sil. foss. Ireland, pl. iv, fig. 14 (head only), 1846.

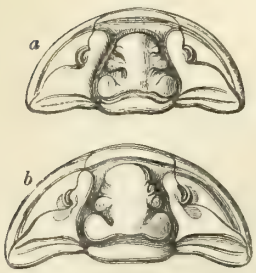
C. modica vix biuncialis, elongata, alutacea; glabellâ brevi trigonâ, trituberculosâ, lobis rotundis. Gena convexa, absque processu oculari, oculis submedianis. Frons producta recurva, longitudine tertiam partem glabellæ æquans. Thorax axe convexo, pleuris valde deflexis, fulcro approximato. Cauda trigona, axe lato conico; lateribus deflexis 5-*costatis,* —*costis furcatis.*

Under the name *brevicapitata* of Portlock have been commonly included two marked Caradoc varieties or subspecies, in one of which the glabella, though nearly resembling that of the ordinary form, is narrowed in front, and has a smaller proportion as compared with the cheeks. This I have already distinguished in the previous page by the varietal name, *C. Caractaci.* It is, in truth, not far removed from the Dudley variety. The other there will be much less hesitation in admitting as a distinct species. It has so short a glabella as to have suggested the specific name to Gen. Portlock, and so cylindrical a form as to have formerly induced me to rank with it *C. parvula,* Barrande, a truly distinct fossil. And by the convexity of the form, and the breadth of the axis, it is distinct enough from our next variety or subspecies, while the finely granular surface easily distinguishes it from the "Dudley fossil."

C. senaria is a rather small species, the fragments seldom indicating a size of more than two inches in length. It is elongate-oval and very convex, the width of the head being less than half the whole length, of which the head itself occupies two-sevenths. It is semicircular, with the front produced and elevated; and the triangular glabella is fully as wide at the base as the whole length from the neck-furrow to the front margin: it is also as wide as the cheeks in their full measure. The lobes are rounded, and all three quite distinct, the basal ones not so wide as the central portion of the glabella. The axal furrows deep, but not broad; and in the cast the attachment for the ascending processes

is well marked (as in figs. 5—7). The cheeks gibbous anteriorly, but without any buttress opposite the middle lobe. The thorax convex, its axis as broad as the sides; the fulcrum (as in *C. Blumenbachii*) approximate. The tail is trigonal; but its sides slightly arched,—the axis convex, not much tapering, abrupt at the end, and with six or seven rings. The sides are deflected, but a little arched, and have five ribs, forked thoughout.

Fig. 21.



Calymene senaria. a is from British Lower Silurian, a cast. *b* from Ohio, with the crust preserved.

The whole surface is granulose (not roughly tubercular as in *C. Blumenbachii*), with larger and smaller tubercles. I think *C. callicephala*, Green, Cast No. 2, is too extreme a form to be reckoned with this subspecies, though closely allied. Hall says it is identical, but the *C. Blumenbachii* of his work (*C. senaria*, Conrad) is quite our species, and is as common in the Lower Silurian Limestones of the Western States as in our own Caradoc and Welsh Slate Rocks. See woodcut, fig. 21, *b*.

Localities.—Caradoc or Bala Rocks of Shropshire and North Wales—everywhere; Westmoreland; North and South Ireland, &c. Figs. 5 and 6 are the original specimens of General Portlock's work; and fig. 8 is the perfect young specimen given in the 'Memoirs of the Geological Survey.'

Foreign Localities.—Trenton Limestone of the United States, abundant (under the name *C. senaria*). (*Calymene nivalis*, Salter, is the representative species in the Thibetan range of the Himalaya. See Col. Strachey's collection, now in the Mus. P. Geology.)

Subspecies II.

Calymene Cambrensis, *Salter*. Pl. IX, figs. 12—14.

C. brevicapitata, *Salter*. Mem. Geol. Surv., vol. ii, pt. 1, pl. xi, figs. 3—5, 1848.
C. brevicapitata, *M'Coy*. Pal. Foss. Woodw. Mus., pl. i f, figs. 4, 5, 1855.
C. Blumenbachii, *var.* Cambrensis, *Salter*. Mem. Geol. Surv., vol. iii, pl. xvii, figs. 13, 14, 1865.

C. modica, alutacea, fronte subrectâ; glabellâ vix trigonâ brevi trituberculatâ. Cauda axe angusto, lateribus valde arcuatis, multisulcatis,—sulcis profundè interlineatis.

This marked species or subspecies has the glabella of the same shape with the Caradoc fossil *C. senaria*, last described; but is flatter, and the upper glabella-lobe is almost obsolete. The front margin is produced, but not recurved. The body is elongate, and not so convex as in *C. brevicapitata*, and the tail especially is more expanded,—its sides less deflected and more arched, resembling in this respect our *C. tuberculosa*. The axis

is narrow, compared with the width of the sides, and seven- or eight-ribbed. The sides have six ribs, strongly interlined throughout, and arched outwards; and the general shape of the tail is more transverse, ovate, and less triangular than in either the Dudley or the Caradoc species.

Locality.—Llandeilo flags of S. Wales, abundant at Llandeilo; at Lann Mill, near Narberth, &c. Fig. 13 is from a very perfect specimen observed by Sir H. De la Beche, and of which a cast only of the external surface is preserved in the Mus. P. Geology. The original is, I believe, in the rich cabinet of Mr. J. E. Lee, of Caerleon; and is the finest known.

Calymene Tristani, *Brongn.* Pl. IX, figs. 15—18.

Tristan, Journ. des Mines, tom. xxiii, page 21. 1807.
Calym. Tristani, *Brongniart.* Cr. foss. 12, pl. i, fig. 2, a—k. 1822.
— — *Schlotheim.* Nachtr. ii, 14, 2, 23, 2, and 40, tab. xxii, fig. 5, 1823.
— — *Dalman.* Palæad., 62, 3. 1826.
— — *Emmerich.* Dissert, 39, 4. 1839.
— — *Milne-Edwards.* Crust. iii, 320, 5. 1840.
— — *Burmeister.* Org. Trilob., tab. 2, figs 7, 8, 1843, and Ray Ed. p. 40. 1846.
— — *Salter.* Quart. Geol. Journ., vol. xx, pl. xv, fig 5. 1864.

Calymene Tristani is a fossil belonging to the French, and not the British, Silurian fauna. But imperfect heads of this species are certainly found in the quartzose strata of Gorran Haven, near Mevagissey, Cornwall; and the tail, fig. 17, is found in company with several other French fossils in the now famous Budleigh Salterton pebble-bed.

Our specimens from Gorran Haven, figs. 15, 16, show only the glabella and front of the head. The former is short, and wider than long, with the base broad, so as to form a nearly equilateral triangle. All the lobes deeply marked, and oblique forwards; the basal lobes triangular, the middle ones nearly linear; the upper ones strong for the genus. The cheeks highly convex, separated from the glabella by broad but shallow axal furrows; which at the base expand over a triangular flattened depressed space (fig. 18) analogous to the corresponding portion in *Homalonotus*, see p. 104, line 6. The eyes are placed forward opposite the upper glabella lobes. The cheeks strongly margined exteriorly. The front is produced, very convex and recurved; and the space from the front of glabella forwards is nearly equal to the length of the glabella itself. We have not the body,—which in foreign specimens has a broad axal lobe and greatly decurved convex pleuræ. The axis of the subtrigonal tail, fig. 17, is highly convex and broad, of six or seven rings, and an appendix which reaches the end. The sides have five strong ribs interlined for nearly their whole length. I do not consider our British specimens sufficient to afford a regular diagnosis of the species.

Calymene Arago, a kindred species found with *C. Tristani* in the French and Spanish deposits, has a smooth trilobed tail, with scarcely a trace of ribs.

Localities.—Llandeilo (or Arenig) rocks, of Gorran Haven, Cornwall, figs. 15, 16, Mr. Edgell's cabinet. Budleigh Salterton, fig. 17. [Fig. 18 is added from a specimen from Néhou, Normandy, where the species is very common.]

Calymene duplicata, *Murchison.* Pl. IX, figs. 19—24.

Asaphus duplicatus, *Murch.* Sil. System, pl. xxv, fig. 8, 1839.
Calymene duplicata, *Id.* Siluria, 2nd edition, pl. iii, fig. 6, 1859.
— — *Salter.* Mem. Geol. Survey, vol. iii, pl. xvii, figs. 15—20, 1865.

C. modica, rarissime biuncialis, alutacea, depressa, fronte paullum productâ recurvâ. Glabella parallela, longa; oculi antici. Axis corporis angustus, caudæ longus præangustus (nec quartam partem latitudinis caudæ subplanæ efficiens) 9—10-annulatus. Costæ laterales 7—8, valde interlineatæ, arcuatæ, haud deflexæ.

An inch and a half long,—seldom more, and fourteen lines broad,[1] greatly depressed, with a scarcely produced front not above one third the length of the glabella; a very narrow axis, and a many-ribbed flattened tail. The head is wide, semicircular, and depressed, with a strong but very narrow margin all round.

The glabella rather parallel-sided than parabolic (in the ♀ form, figs. 19, 20, somewhat broader and more arched on the sides), and not occupying above one fourth the width of the head. It has three well-marked lateral lobes, the lowest not greatly projecting beyond the others. The glabella is depressed, and does not rise above the level of the broad gently convex cheeks; on which the small eye is placed very forward, and distant from the glabella about half its width. The neck-furrow is sharp, narrow, and strong; the axal furrows narrow and deep. The surface of the head, and indeed of all the body, is finely granular.

The thorax has a very narrow convex axis, in some specimens less than a fourth the whole width. The pleuræ are very flat at first, and then, beyond the fulcrum, which is placed far out (at one half in the front rings, and one third posteriorly) they are strongly and vertically decurved, but not abruptly bent.

The shape of the tail is semioval, depressed above, but convex around the margin. The form is remarkable for the genus, being so flat as to be more like the tail of an *Ogygia* or *Asaphus* (see fig. 21); and the numerous ribs, 9—10 on the axis, and 18 on the sides, heighten the resemblance. The axis is barely more than one fifth the width of the tail in the ♂ (fig. 19), and about one fourth in the ♀ form (fig. 24);—long conical, and rather abruptly contracted about the middle. The end of the axis is abrupt, and

[1] Mr. J. Lee, of Caerleon, has one specimen with the head $1\frac{1}{2}$ inch broad.

there is no appendix beyond it (see fig. 21). The side ribs arch widely out, and are so strongly interlined throughout, as to give the appearance of having twice the proper number of ribs.

I have ventured to call fig. 24 the ♀ form, or it may stand for variety β, *fœmina*. All the characters are the same as those of the typical variety α, except the somewhat broader axis. And such a difference we should be prepared to expect in Trilobites, for nearly all, as Barrande has shown, have a "forme longue" and a "forme large."

Accordingly, in our *var. fœmina* the general shape is rounder, and the glabella broader and less pointed; the axis of body and tail broader, and the proportion borne by them to the sides consequently greater. But these differences do not constitute a distinct species, and the general aspect is much alike in both forms.

The labrum is oblong, twice as long as broad, with parallel sides. It has a narrow, not extended base, and is concave under the front border, then very convex, and with a blunt tubercle above the centre. Two small tranverse lobes lie beneath this, forming a nearly continuous ridge, and the limb is tumid beyond as far as the base of the short furcate terminal lobes.

C. Baylei, Barrande, is a closely related species, the tail is especially like; but Barrande's figure and good Bohemian specimens in the British Museum show a species with more remote eyes, and the axis of the tail yet narrower than in the British form (Barrande, 'Sil. Syst. Bohème,' Pl. XLVIII, fig. 49). It is an Upper Silurian fossil.

Localities.—Llandeilo flags, near Shelve and Wilmington, Shropshire; Builth, Radnorshire; abundant. Lann Mill, near Narberth; Abereiddy Bay, Pembrokeshire, abundant. The species is not known beyond the British Isles, and appears to be very restricted in its range. It has been found at Waterford by Major Austin.

Such species as the above help to conduct us to the *Conocephalidæ*, and show the near connection of *Calymene* with that group.

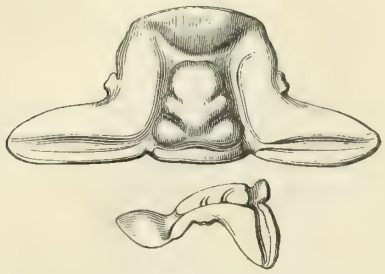
Calymene parvifrons, *Salter*. Pl. IX, figs. 25—28.

Calymene parvifrons, *Salter*. Appendix A, p. 3 of Pal. Foss. Woodw. Museum, 2, pl. i f, fig. 7. 1855. *M'Coy*, ib., p. 167, pl. i f, fig. 7. 1855.
— — *Salter*, in Morris' Catalogue, 2nd ed., p. 102, 1854.
— — *Id.* Siluria, 2nd. ed., p. 53, fig. 4, 1859.

C. biuncialis et ultra, convexa, sublævis; capite subtrigono lato, fronte valde productâ tumidâ elevatâ, ⅔ glabellæ brevissimæ æquali,—hâc parabolicâ quam longâ latiore, lobis tribus elongatis subradiatis. Genæ valde convexæ, glabellam latitudine ⅓ superantes; oculis prominulis remotis, subcentralibus. Thorax axe angusto, pleuris valdè deflexis. Cauda lata, axe convexo, lateribus valde decurvatis 5-costatis, omnino interlineatis.

We formerly only knew the head of this curious species (see fig. 25). It is 16 lines wide, and only 7 lines long. And of this length the tumid and produced front is two thirds as long as the small parabolic glabella. The latter is very little convex, a good deal wider than long, truncate in front, and with the three lateral lobes all distinct, oblique forwards, and reaching well into the glabella, especially the basal ones, which are subtriangular and much contracted at their inner edge. The cheeks are large and tumid, and the small eyes are placed far forwards, on a level with the upper glabella-lobe, about as remote from it as the width of the glabella. The neck-furrow is strong beneath the glabella, but broad and shallow underneath the capacious cheeks, and the lower margin of the latter is much curved.

Fig. 22.



C. parvifrons, nat. size and magnified.

Prof. M'Coy's figure is very inaccurate in proportion. I have only lately been able to see the specimen, and give a more correct outline in our woodcut than fig. 25 in the plate, which was unfortunately copied from the Cambridge Synopsis.

Var. Murchisoni. Pl. IX, figs. 26—28.—*Glabellâ latiori, oculis vix remotis.*

Imperfect as our materials are, it is clear this variety must be distinguished from the typical *C. parvifrons*. The var. *Murchisoni* has a broader glabella, and the eyes less remote, and larger. Such differences may be due to sex rather than variety, and there is reason to suspect sexual variations to a small amount in this genus, as I have above shown (p. 101).[1] This variety, *Murchisoni*, is much more like *C. Tristani*, from which, indeed, except by the more truncate and less triangular form of the glabella, and far less strongly ribbed tail, it is somewhat difficult to separate it.

Locality.—Arenig or "Skiddaw" group. Tai hirion, on the road from Bala to Ffestiniog; collected in 1844, by Prof. Sedgwick and J. W. Salter (Woodw. Mus.).

Of the *var.* Murchisoni;—the Stiper Stones; viz. at Lord's Hill, and other neighbouring localities. Also at Cae Glyd, under the Manod Bach, near Ffestiniog—and at Ty-obry, near Garth, Portmadoc (Mus. P. Geology; and the cabinets of Messrs. Ash and Homfray).

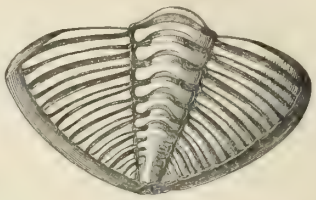
[1] Prof. Thomson, who has observed hundreds of specimens of the *Calymene Blumenbachii*, thinks there is no difference of sex observable in that species. But that is no reason for doubting it in others.

CALYMENE? DAVIESII, *n. sp.* Fig. 23 (Woodcut).

C. caudâ latâ subtrigonâ, depressâ, anticè subrectâ, posticè rectangulâ: axe angusto longo, 9-annulato, percurrente; lateribus 7-costatis-costis radiatis, valde duplicatis: sulcis profundis, fasciâ caudali angustâ convexâ. Lat. $1\frac{1}{2}$ *unc. Long.* 1 *unc.*

The general character of this curious specimen forbids us to associate it with any other genus, as it is unlike the usual Upper Silurian forms.

FIG. 23.



C.? Daviesii, from the Wenlock Shale.

The tail is much depressed for the genus, wide, and rectangular behind, the sides very little curved, the apex obtuse. The length is rather more than two thirds the width, which is $1\frac{1}{2}$ inch; the axis occupies only one fourth of the whole width, and is regularly conical, convex, and reaching the very end of the tail. It has eight distinct rings and a short terminal portion. The axal furrows are strong, the side-lobes convex along the middle, but not towards the margin, which is only slightly decurved. There are seven distinct lateral ribs reaching almost to the margin, and strongly duplicated throughout. The direction of the ribs is outwards, not much backward. The specimen is only an interior cast, and the actual margin is not seen. But the caudal or subcaudal fascia is very distinct, convex, and narrow all round, and the furrows, both of the axis and the sides, are strong and deep. The fulcral point is so remote, that if, after all, this should prove to be an unusual form of *Phacops*, I should not be greatly surprised. Still I think it is a *Calymene*.

Locality.—WENLOCK SHALE of Glan Wye, 3 m. N.W. of Builth, in Radnorshire. (Cabinet of Griffith Davies, Esq., of Islington.)

HOMALONOTUS, *König.*

Dipleura, Trimerus, Green, &c.

A natural genus, which has been admitted by every writer on Trilobites, since our old friend Dr. König gave us the figure in the 'Icones Sectiles.'

There is no pretence for separating any of the forms except as convenient subgenera. From *Calymene*, its near ally, as, indeed, from most Trilobites, it is distinguished at once by its want of distinct trilobation; and this peculiarity is only less distinct, not absent, in the earlier species. In the characters of the thorax, eyes, labrum, and even in the contour of the tail, the resemblance is so close to *Calymene* that it is often difficult to distinguish fragments of one genus from the other. In general, the very obscure glabella, scarcely lobed; and the broad, highly convex, and slightly trilobate thorax, distinguish it.

Homalonotus is—Elongate, convex, with steep sides and a very broad axis, scarcely distinguished from the pleuræ. There are thirteen body-rings, deeply grooved, and the fulcrum is close to the axis in most of the species. The head with an obscure quadrate glabella, slightly lobed; a rostral shield; and a quadrate labrum, tuberculate and gibbous in the middle, and with a bilobed tip. Surface of the body scabrous, occasionally spinous. Internally the cheeks have at their base a broad flat space next the glabella.

Range.—Upper Silurian, and Lower (and Middle?) Devonian.

The genus has not yet been satisfactorily divided, but the species may be conveniently arranged in five, or possibly six, groups or subgenera, as follows:

1. *Brongniartia*, Salter, 1865. Depressed, with broad rounded head, remote eyes, well-defined lobeless urceolate glabella, and many-ribbed rounded tail. Lower Silurian.

§ 1. Body scarcely trilobed; the axis broad. (*H. bisulcatus* is the type of the subgenus, and of this section.) Lower Silurian.

H. bisulcatus, Salter.
H. Sedgwickii, id.
H. Edgelli, id.
H. platypleurus, Green.

§ 2. Body strongly trilobed; the axis narrow. (Type, *H. rudis*; this leads off directly towards *Calymene*.) Lower Silurian.

H. rudis, Salter.
H. Bohemicus, Barr.
H. rarus, Corda.
H. brevicaudatus Deslongch.
H. Vicaryi, Salter.

2. *Trimerus*, Green, 1832. Elongate, convex, with triangular head; eyes not remote; a defined, but obscurely lobed, broad glabella. Thorax slightly lobed; tail many-ribbed, pointed, often acuminate. (Type, *H. delphinocephalus*.) Upper Silurian.

H. delphinocephalus, Green.
H. Johannis, Salter.
H. cylindricus, id.

3. *Kœnigia*, Salter, 1865. Convex; head wide transverse, with concave and tricuspidate front. Glabella subquadrate, well defined. Eyes rather approximate, on gibbous cheeks. Tail pointed, many-ribbed. (Type, *H. Knightii*.) Upper Silurian.

H. Knightii, Murch.
? H. ludensis, Salter.

4. *Dipleura*, Green, 1832. Convex; head wide, semi-oval, or subtriangular, with somewhat pointed front. Glabella narrow, well defined. Eyes rather remote, on gibbous cheeks. Thorax slightly lobed. Tail obtuse, hardly ribbed. (Type, *H. Dekayii.*) Upper Silurian; Lower Devonian.

H. Dekayii, Green.
H. sparsus, Eaton.
H. obtusus, Sandberger.
? *H. crassicauda*, id.
? *H. Ahrendi*, Roemer.
&c. &c.

5. *Burmeisteria*, Salter, 1865. Elongate, convex; head triangular; eyes approximate on gibbous cheeks. Glabella distinct, lobeless, spinous. Thorax slightly lobed and spinous, as is also the many-ribbed pointed tail. (Type, *H. Herschelii.*) Devonian.

H. Herschelii, Murch.
H. armatus, Burm.
H. Greenii, Goldfuss.
H. elongatus, Salter.
H. Pradoanus, De Vern.

I have been obliged to include some foreign species, but these are inserted in italics. The genus *Homalonotus* seems to have been chiefly a northern one in Silurian times, but during the Lower Devonian epoch it was common both north and south of the equator. After this period the whole group was extinct.

Section—Brongniartia, § 1.

Homalonotus bisulcatus, *Salter*. Pl. X, fig. 2—10.

Homalonotus bisulcatus, *Salter*.			Appendix to Sedgwick and M'Coy, Synopsis Brit. Pal. Foss., pl. 1 G, figs. 24—31, 1851.
—	—	*M'Coy*.	Ibid., fasc. 1, p. 168, 1851.
—	—	*Salter*.	In Morris' Catal., 2nd ed., p. 109, 1854.
—	—	Ib.	Siluria, 2nd ed., p. 74, foss. 12, fig. 2, 1859.
—	—	Ib.	Memoirs Geol. Surv., vol. iii. Appendix, pl. xvi, figs. 1—8, 1865.

H. 7-uncialis ovatus lævis, capite caudáque semiovalibus, rotundatis. Glabella depressa. Genæ latæ, extús deflexæ; oculi submediani, valdè remoti. Frons unà cum genis continua, plano-concava. Thorax vix lobatus. Cauda semiovata, obtusa, margine angusto recurvo; axe conico, 11—12*-annulato, per* $\frac{4}{5}$ *longitudinis caudæ extenso, et appendice conico; lateribus* 8*-sulcatis, sulcis duobus anticis valde profundis, haud interlineatis.*

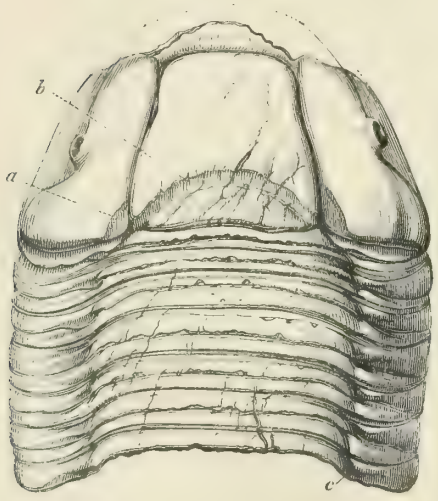
Long-ovate, but broader than in many of the genus, with a blunt semi-ovate head and rounded tail, ribbed strongly throughout. Trilobation conspicuous, but not deep.

Glabella without lobes. These general characters will enable us to recognise the species, which is a very common one in the Caradoc sandstones and slates of Britain, and especially of Shropshire and North Wales. The finest head is from Mr. Lightbody's cabinet (fig. 9); the most complete body and tail are from the Geological Society's Museum (fig. 4). The species is a large one, and, judging from fragments, must have been fully ten inches long. It is ovate and blunt at both extremities.

Head semioval, of which the glabella occupies three fifths; it is pyramidal, but with sinuous sides, and truncate above; and at its base is exactly as broad as the cheek. It is rather abruptly raised above these, in a step-like manner. The cheek itself is gently convex, but not abruptly so towards the eye, which is placed about centrally[1] and outside the highest point of the cheek, but does not nearly rise to the level of the glabella. This gives a peculiar character to the present species, for in the genus *Homalonotus* the cheek is often very convex. Young specimens (fig. 7) have the glabella greatly more distinct and more separated from the cheeks than in the adult, and the proportions are not quite the same, the glabella being longer.

In front of the glabella the head is slightly concave only; and the cheeks are as gently convex, without any central gibbosity or any strongly distinct margin. The neck-furrow is distinct all along, especially in the cast (fig. 9). It is strongest beneath the glabella, and then descends to a lower level beneath the cheek, along the base of which it is continuous almost to the rounded angle. The facial suture is vertical in front of the eye, and beneath it curves boldly outwards. The eye is small and apparently ovate (not globular, as in the last species). The free cheek is tumid just outside the eye, and much deflected.

Fig. 24.



H. bisulcatus, Marshbrook, Shropshire.

The body, of thirteen rings, has its axis suddenly and greatly wider than the base of the glabella, as indicated by the diverging lines on the neck-segment (woodcut). It is not actually a great deal wider than the pleuræ; but, from the general and regular convexity (the back is not depressed as in *H. delphinocephalus*), it appears much more on a front view. The axal line is less strong in the adult than in younger specimens (fig. 7), and is marked out chiefly by a sudden angular thickening of the pleuræ over the fulcral point (see figs. 4, 5). (Inside the crust this point is marked on the cast by an oblique furrow, indicating, of course, an

[1] The deflected cheeks give the eye in our figure 9 too exterior a position; and the eye is really placed a little too far out in the figure.

internal ridge.)[1] The pleuræ are themselves regularly convex and not abruptly bent down. Their facets are large, their ends expanded, and not much bent forward. The pleural groove is narrow.

The tail is semi-oval, its end obtusely rounded, its margin all round slightly concave; the anterior edge not greatly curved, and the facet very strong. The axis is gradually tapering, and reaches four fifths of the length; and it is then continued by a conical appendage nearly to the margin. It is not very prominent or strongly marked out, but is nearly as wide as the side-lobes, with eleven or twelve segments, of which the two anterior are much stronger than the rest; sides gently sloping, with about seven broad flat ribs, separated by narrow sulci, the two anterior of which are disproportionally deep, the rest very shallow. These side-furrows are straight, and have a marked interval between their origin and the furrows on the axis. The contrast between the two deep upper furrows of the tail and the remaining faint ones is very striking, and suggested the name.

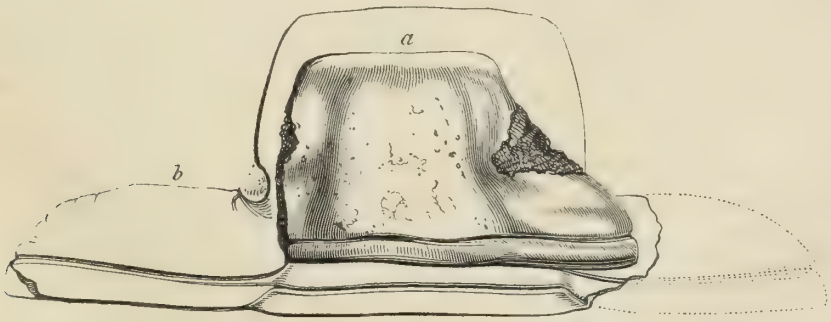
Variations.—The young have the head-furrows somewhat stronger. The tail-axis varies a little in width, and has nine to ten or eleven rings; and the sides have stronger or fainter furrows.

Trimerus platypleurus of Green, ('Silliman's Amer. Journ.,' vol. xxxii, p. 169), nearly resembles ours in the caudal shield, but differs in its proportionate length and breadth; in the short-conical form of its axis, and the stronger lateral furrows. *H. Jacksoni,* Green, is another allied American form.

Localities.—Arenig group, Tremadoc, N. Wales. Llandeilo flags, Anglesea? Caradoc sandstone, everywhere in N. Wales and Shropshire.

Homalonotus Sedgwicki, *n. sp.* Woodcut, fig. 25.

Fig. 25.



Homalonotus Sedgwicki, n. sp. From Caradoc Rocks in Westmoreland.

[1] The condition of the fulcrum is rather complicated in Homalonotus, from its coinciding with the axal line, and it is difficult at first to interpret the casts of exterior and interior.

H. magnus, 7-9 uncialis; capite latissimo, longitudine haud dimidium latitudinis attingente; fronte latè truncatâ rectâ. Glabella subquadrata, sulcum obscurum marginalem frontis petens, ad basin latitudini genæ convexæ æqualis. Oculi post medium capitis positi, subremoti. Sutura facialis margini postico parallela.

Heads only are known of this splendid species. It must have grown eight or nine inches long, and has, strangely enough, been quoted by M'Coy, in the Cambridge Collection, not only as *H. bisulcatus,* from which the wide transverse head separates it, but even as *Asaphus Powisii.*

The head is transverse, more than twice as wide as long, with so truncate a front as to have that edge parallel to the hinder one. The front margin has a slightly concave furrow within it, up to which the glabella reaches. This is subquadrate, its sides a little contracted, its base not much the widest, but still broad; the front emarginate, and defined by the front furrow, as before stated.

The cheeks are as wide as the base of the glabella, convex, almost gibbous at the eyes, which are somewhat remote. The facial suture curves out boldly from the eye, parallel to the hinder margin, and cuts the outer edge in advance of the blunt angle. The neck-furrow is strong in the cast, and reaches all across; it is sharp under the glabella, and broader and blunter beneath the cheeks, separating there a broader and more convex neck-segment than that beneath the glabella.

The eyes, in large fine specimens in the Cambridge Museum (fig. 25) show a small eye-lobe. I only know two specimens; and yet I expect the species to be a common one, and its body and tail-portions should be looked for in the following—

Locality.—Caradoc Slates of Ravenstone Dale, Westmoreland. Both specimens are in the Woodwardian Museum.

Homalonotus Edgelli, *n. sp.* Pl. X, fig. 11 (and fig. 10?)

H. minor, H. bisulcato *simillimus, nisi caudâ (solùm cognotâ) angustiore, axe angusto conico, 8-annulato, á lateribus declivibus bene sejuncto. Costæ laterales 7 planæ, haud interlineatæ, ad marginem angustum ferè tractæ, duo superiores profundè exaratæ.*

It is possible that the small head (fig. 10) from Horderley may belong to this species, but I only describe the tail.

A neat species, which has so strong a resemblance to the preceding that it may be difficult to distinguish it when more specimens are found; and it may possibly, though, I think not probably, be the ♂ form of *H. bisulcatus.* Nevertheless the proportions are so different that we cannot well mistake it. The tail is very convex: the axis is decidedly narrower,—hardly more than half the breadth of the side-lobes, and the ribs fewer: and though these are only differences of proportion, and we must wait for better materials to be certain about the species, they are probably sufficient in a genus like the present, where the forms are so closely allied.

Locality.—Caradoc beds. Acton Scott, Shropshire. Mr. H. W. Edgell's cabinet.

Section—Brongniartia, § 2.

Homalonotus rudis, *Salter*. Pl. X, figs. 12—14.

Homalonotus rudis, *Salter*.		In Appendix to Sedgwick's and M'Coy's Synopsis. Foss. Woodw. Mus. pl. 1 E, fig. 20, 1851.
—	— *M'Coy*.	Ibid., fasc. 1, p. 168, 1851.
—	— *Salter*.	Morris' Catal., 2nd ed., p. 109, 1854.
—	— ,,	Siluria, 2nd ed., p. 539, 1859.
—	— ,,	Mem. Geol. Surv., vol. iii, plate xvi, figs. 9—11, 1865.

H. maximus, pedalis et ultra, valdè trilobus, costatus et corrugatus. Glabella convexa benè distincta. Oculi antici. Thorax axe lato convexo, pleuris usque ad fulcrum planis, dein deflexis. Cauda semicircularis et latior, axe convexo conico appendiculato, 7—8-sulcato, vix $\frac{3}{4}$ *caudæ efficiente, convexo noduloso; lateribus costis* 6—7 *duplicatis, haud marginem lævem attingentibus.*

A still larger and coarser species, in all respects, than the last. Our largest specimen must have been a foot long when perfect. The several specimens now collected together show that the lower furrows of the tail are all nearly equal in strength to the upper two, contrary to what is known in *H. bisulcatus*. Moreover, *H. rudis* is trilobate, while the other follows the usual form of the genus.

We have but one specimen of the head, and that, belonging to the specimen fig. 14, is so crushed that it is not worth while to figure it. But it shows that the glabella is convex, and well distinguished from the cheeks, which bear a small eye rather forward; the neck-furrow is distinct.

The body has a narrow axis for the genus, and the axal furrows lie some distance within the fulcrum. The axis is convex, as in ordinary genera, and the axal furrows deep. The posterior half of each segment is convex, the anterior, separated by the groove, is flattened. The pleuræ are flat as far as the fulcrum, which is placed about one fourth out (as seen in fig. 14 *a*), and has the usual angular character; the pleural groove is deepest beneath this point. In all these respects *H. rudis* resembles a *Calymene*, and differs from the ordinary forms of the genus.

The tail is semi-oval, the front much arched; the axis prominent, conical, and well raised above the sides, which slope gently down, and have seven nearly straight furrows, of which the two front ones are the strongest. The axis has seven or eight rings, faintly nodular on their sides and central part. It extends three fourths the length of the tail, exclusive of its pointed appendix. The side-ribs, six or seven in number, are, at least in the front ones, faintly interlined.

If fig. 13 be of the same species, of which there is some little doubt, the whole upper surface is finely tubercular. Fig. 12 shows the great size attained by this fossil.

Locality.—Caradoc Rocks of North Wales and Shropshire; Cader Dinmael, near Corwen, Denbighshire (fig. 14); of Nantyr, near Llanarmon, Denbighshire (fig. 12): Capel Garmon, same county (Woodw. Mus.): Cressage, Shropshire; fig. 13 (Mus. Pract. Geol.).

Homalonotus Brongniarti, *Deslongsch.* Pl. X, figs. 15—17; Pl. XIII, fig. 9.

Asaphus Brongniarti, *Deslongschamps.* Trans. Soc. Linn. Calvados, vol. ii, p. 301, pl. xix, xx, (fig. 12?) 1825.

Homalonotus Brongniarti, *Marie Rouault.* Bull. de la Soc. Géol. France, 2me Sér. vol. vi, p. 379, 1849. Id. in vol. viii, p. 370 (not of De Verneuil, id., vol. xii, pl. xxiii, fig. 1).

— — *Salter.* Quart. Geol. Journ., vol. xx, p. 290, pl. xv, fig. 1, 1864.

P. 9-uncialis et ultra, oblongo-ovatus, capite caudáque minoribus. Glabella parabolica, vix lobata, sulco distincto circumdata, á fronte curvá benè sejuncta. Genæ elevatæ, oculi retrorsi. Thorax trilobus, axe lato. Cauda rhomboidea, ut longa quam lata, axe distincto 8—9-annulato; lateribus subplanis lævibus, sulcis angustis 7—8; margine serrato.

Although the figures in the Calvados Transactions are rather out of date, yet the care which M. Deslongschamps took to figure all the varieties leaves no doubt as to what species he intended. It was rather a large fossil; some of the foreign specimens appear to have grown more than nine inches long, and it is rather conspicuous for the trilobation of the body. Deslongschamps has not shown the curious serration of the tail-margin, but except in that point his figure is exact. The swelled front border, the slightly lobed parabolic glabella, the backward eye; and the tail, with its shortened axis and almost smooth sides,—are very well figured; and his description is characteristic and complete.

I will only describe our own specimens, and add a note upon the body-rings from the French author, who had larger specimens than we possess.

Head an inch long, of which the parabolic glabella occupies seven lines, and is eight lines broad at the base, depressed, very slightly lobed, and well distinguished from the sides by a shallow furrow. The front margin ("chaperon") is much elevated, and the interval between it and the cheeks depressed. The latter are tumid and rather narrow; the small eyes placed considerably behind the middle: the free cheek triangular and smooth, except on the vertical outer margin, which is roughly granular all over.

The body in French specimens is very convex, but not semicylindrical, being depressed above. The sides bend down abruptly. The central lobe is well marked out, and is wider than the pleuræ in front, but narrower behind; the distinct trilobation takes place some distance within the fulcral points. The facet is large and distinct, and the pleural groove nearly reaches the broad tip. The separate figures of the pleuræ given by Deslongschamps much resemble our figure 16, *a b*.

The tail is regularly convex, ten lines long by eleven broad; its front margin greatly arched, and the sides retreating at almost a right angle from the centre; the axis broad, conical, nearly reaching the end of the tail, its tip blunt and prominent; it is marked by eight or nine rings (ten in larger French specimens), and the furrows which separate these are distinct though shallow,—several of the front ones showing a plane pseudo-articular surface between the rings (this character is well shown in the foreign figures).

The axal furrows of the tail are sharp, but shallow. The sides slope regularly outwards, and have a very smooth appearance. They are scored by seven or eight narrow sharp lines, which reach the sharply incurved margin and decussate it so strongly as to produce sharp serratures, a character not observable, so far as I know, in any other species. The incurved edge is very abrupt, but this is usual in the genus.

H. Brongniarti is described by Rouault as having a slightly prominent glabella, narrowed in front, and showing two lateral lobes; and the tail with a shortened axis, marked by ten ribs, and an equal number on the side-lobes. It is somewhat doubtful if M. Rouault's be the true species, but ours is clearly the form described by Deslongschamps. The fossil quoted by De Verneuil from the Sierra Morena has a longer and more triangular tail, with interlined ribs, and the head so figured has wider cheeks. The two are nevertheless allied forms.

Locality.—Lower Silurian pebbles, in New Red Sandstone! at Budleigh-Salterton Cliff, South Devon.

Foreign localities.—May, Normandy; also Gahard, near Rennes (Rouault), and possibly Vitrè (Rouault).

Homalonotus Vicaryi, *n. sp.* Pl. XIII, fig. 10.

This small species, of which we have only the caudal portion, is quite distinct from any other, and I wish to distinguish it by the name of the gentleman who has paid so much attention to the fossils of the locality in which it is found. The shape is blunt-triangular. There are seven nodular rings on the axis, and six ribs partly interlined on the convex sides, the outer margin strongly incurved, the apex notched beneath. The regular conical axis, distinct all round, resembles that of the *H. Brongniarti*, with which it is found. But the smooth blunt incurved edge has none of the serrations seen in that species, nor do the furrows quite reach the margin. It is, moreover, quite distinct from the unnamed species in our Pl. X, fig. 18.

Locality.—Llandeilo (or Arenig ?) Rocks; found in the pebbles of Budleigh Salterton, South Devon: (cabinet of W. Vicary, Esq., who first drew attention to the fossils of this remarkable pebble-bed, and has laboriously collected and investigated them, thus adding to the British series a new fauna, which is identical with that of Normandy).

Foreign Distribution.—I have figured (fig. 10 *b*) a Normandy specimen of the species. It is from the May Sandstone of Caen (Mus. Geol. Society).

HOMALONOTUS, *sp.* Pl. X, fig. 18.

H. sp. caudâ latâ brevi, profunde sulcatâ, axe angustiore, lateribus convexis curvis (nec subplanis declivibus); sulcis lateralibus 6—7 profundis vix marginem granulatum attingentibus, et ad apices paullulum interlineatis.

There is some indication in Deslongschamps' figures, pl. xx, figs. 1, 2, of a distinct species, with a squarer front to the head than in his *H. Brongniarti*, figured above. But these indications are obscure: they certainly do not represent our second species, for this has fewer and stronger, not more and fainter, ribs to the tail.

The tail was broad when perfect, probably $2\frac{1}{4}$ inches by less than $1\frac{1}{3}$ in length. Of this width the axis can scarcely be one third, and it is well marked out and scored with several rather deep furrows. The sides are convex, not steeply sloping off, and deeply grooved by at least seven curved furrows, which do not quite reach the granular margin, and are interlined near their tips. The facet is very broad and distinct, and the upper furrow strongest, but not greatly so.

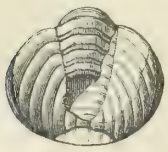
This I do not name, for it is possibly a described foreign species. But it is clearly not the *H. Barrandei*, of Rouault, a species with only four lateral ribs to the tail, and a very strongly marked axis, which reaches the border.

Locality.—Budleigh Salterton (Mr. Vicary's cabinet).

HOMALONOTUS, *sp.* Woodcut, fig. 26.

? H. BISULCATUS, *M'Coy.* Quart. Journ. Geol. Soc., vol. viii, p. 13.

FIG. 26.



Homalonotus, sp., Lower Silurian, Gorran Haven, Cornwall.

I figure here a small species, which, by its distinct ribs on the axis and sides, appears to differ from the others, and which may possibly be the species catalogued by Prof. M'Coy as *H. bisulcatus.* It differs from that fossil in several points; having a greatly more arched anterior margin, and strong ribs on the narrower axis, with numerous lateral ribs. We wait for better specimens.

Locality.—LOWER SILURIAN quartzites of Gorran Haven, S. Cornwall; (cabinet of Mr. H. W. Edgell). These beds appear to me to be identical with those which supplied the pebbles for the Budleigh Salterton bed above referred to. They contain at least some of the same fossils. (See 'Geological Magazine' for July, 1864, vol. i, p. 9.)

HOMALONOTUS VULCANI, *Murchison.*

Siluria, 2nd edition, pl. ii, figs. 3, 4, 1859. (*Asaphus* of the original work.)

(The description and figures will appear in the appendix.)
Locality.—LLANDEILO FLAGS, Corndon mountain, Shelve, Shropshire.

Section—TRIMERUS, *Green.*

HOMALONOTUS DELPHINOCEPHALUS, *Green.* Pl. XI, figs. 1—11.

ASAPHUS CORNIGERUS, *Brongniart.* Crustacés Foss., pl. iv, fig. 10 (from a drawing of a Dudley specimen) not of pl. ii, fig. 1, 1822.
TRIMERUS DELPHINOCEPHALUS, *Green.* Monog. Tril. N. America, pl. i, fig. 1; model No. 32, 1832.
BRONGNIARTIA PLATYCEPHALA, *Eaton.* Geol. Text-book, pl. ii, 1832 (fide *Hall*).
HOMALONOTUS DELPHINOCEPHALUS, *Murchison.* Sil. Syst., pl. lxxvi bis, figs. 1, 2, 1837.
— — *Murchison.* Siluria, 2nd ed., p. 123, Foss. 16, 1859.
— — *Milne-Edwards.* Crust., iii, 314, 1840.
— — *Hall.* Geol. Report, N. York, 1843. Palæont. N. York, vol. ii, pl. lxviii, figs. 1—14; 1852.
— — *Emmrich.* Dissert. 41-7, 1839. Neues Jahrbuch, 1845.
— — *Goldfuss.* Syst. Uebersicht Tril.; Neues Jahrb., p. 559, 1843.
— — *Bronn.* Lethæa Geognostica, 1, 112, tab. ix, fig. 5.
— GIGANTEUS, *Castelnau.* Essai Syst. Sil., p. 20, pl. iii, fig. 1, 1843. (Also *H. Atlas* and *H. Herculaneus*, ib., p. 20. All from Lockport, N. York.)

H. 6-*uncialis, depresso-convexus, alutaceus fere scaber, capite caudáque æqualibus acutis, hác acuminatá, illo triangulato. Glabella undulata punctata, vix lobata, anticè truncata, bis quam fronte angulato plano longior. Genæ declives angustæ, margine vix distincto, angulis obtusis. Oculi convexi, præ medio genarum positi. Thorax haud lobatus. Cauda brevis trigona, convexissima, acuminata; axe haud distincto, per totam caudam extenso per-annulato, annulis* 10—11; *lateribus declivibus* 8—9-*sulcatis, sulcis obscuris.*

It is a curious synonym we have to head the above list withal. Mr. Charles Stokes was very liberal in communicating English specimens and drawings to Brongniart, whose artist has in this case faithfully copied the course of the facial suture, and enabled us to recognise the species. The reference by Brongniart is evidently an inadvertence; at least, the species has no resemblance to the Russian *Asaphus cornigerus*, figured correctly in his plate ii. Brongniart made other mistakes with his English materials.

Elongate, broadest in front and regularly tapering backwards, pointed at both ends; semicylindrical, with strongly deflected sides and flattened back; the head depressed, truly triangular; the tail regularly convex, and rather rhomboidal than triangular, about as long but not nearly so broad as the head. Young specimens seem to have the same general proportions. We may now consider the details, and they are taken from the magnificent central specimen long known as the ornament of Mr. E. Blackwell's collection, and which we are enabled to figure afresh (the specimen served for Murchison's very accurate figure), together with others in the collections of Mr. E. J. Hollier, jun., of Dudley, of Mr. Ketley, and of Mr. H. W. Edgell, of Sandhurst College.

The largest specimen known, in Mr. Hollier's cabinet, is not given on the plate; it measures fully six inches by about three inches broad at the base of the head, which forms nearly a right-angled triangle, and is shaped in front like a pointed gothic arch. Behind it is nearly straight, and the angles are obtuse, but not rounded.

The glabella is less than half the width of the head, and is four-sided, exactly as long as broad, but narrowed rather suddenly towards the front, and therefore apparently longer than broad. It is distinct all round, and shows faintly a central ridge, and traces of three lateral furrows. It is also slightly emarginate in front, and opposite the notch there is a depression in the rather concave front border, which is less than half as long as the glabella. Cheeks moderately convex, and most so toward the outer angle; the border distinct, except in advance of the angle, where it is fused with the cheek. Neck-furrow plainly marked, as a narrow sharp line beneath the glabella, and a broad furrow beneath the cheeks. The eye is round, prominent, and placed opposite the middle of the glabella, in advance of the centre of the cheek. All the head is covered by large and small puncta, the former equally spaced over the surface; and these on the outer margin pass into and are mixed with squamous granules and short lines. The facial suture is very prominent, running close along the front border for a short distance; it describes a narrower arch than the front of the head to reach the eye, and thence curves largely out in advance of the angle.

The thorax is half as long again as the head, and is very regularly arched from side to side, scarcely a slight indentation marking the place of the fulcrum, which is in this genus the boundary of the axis.[1] Beyond this fulcral point the rings arch down a little, and then suddenly descend in a vertical line, the broad ends of the segments curving forward and much expanded at their tips, especially in the front rings. The facet is very large, commencing at the fulcrum. The pleural groove, as in all the genus, bisects the pleuræ very unequally, the forward half being narrow, the hinder broad; the groove is deep, but narrow, ends abruptly before quite reaching the broad tip, and inwards continues quite across the axal lobe, separating a narrow, flat, articular band in front of each segment,

[1] In nearly all other Trilobite genera the fulcrum is beyond the axis; in the section *Dipleura* of *Homalonotus* it coincides with it. Some few other genera have it nearly in the same place: *Æglina*, *Barrandia*, and *Remopleurides* are instances of this character.

which lies at a lower level than the body of the ring, and is often quite covered in the act of bending (see fig. 1). The hinder rings gradually decrease in width towards the tail, but very slowly so.

The tail at its origin is rather less than three fourths as wide as the base of the carapace. It is highly convex, trigonal, but with the front so much arched forward as to give a sub-rhomboidal shape to the whole. The width and length are equal; the axis, more than one third the whole width, is convex above and highly prominent behind. It extends nearly to the pointed tip, and is annulated for the greater part of its length by ten or eleven rings, bent forward a little in the middle. The front furrow is sharper than the rest, and is continuous with its pleural groove; the others diverge more or less from the corresponding axal furrows, and divide the lateral lobes into fewer than ten or eleven rings, seldom more than eight ribs being visible on the sides. These do not quite reach the margin, which is curved down and vertical, and is not produced or at all flattened. The apiculus in most cases is but short; its difference in length may indicate the sex.

The cornea of the eye has never yet been described for this genus, which is generally supposed to have hiant or hollow eyes, *i. e.* with so thin a cornea that it is not preserved. This, however, is not the case. It is very convex and finely reticular, covered with minute lenses (see fig. 6). But it appears to be but loosely connected with the free cheek, a very unusual character, and of course this would make it easily separable, for there is no real connection with the upper eye-lobe in any Trilobite possessing a facial suture. Mr. Hollier's little specimen figured above in the plate, fig. 3, shows the cornea apparently connected with the upper lobe. The very perfect young head (fig. 4) (Mr. Edgell's) has the same appearance. The cornea seems to be soldered to the upper lobe, and divided from the supporting free cheek. But this is an appearance only, as fig. 6 plainly shows.

Locality—Woolhope Limestone, [Woolhope Valley, Herefordshire, ?] Malvern; Dudley, abundant. Wenlock or Ludlow rocks. Marloes Bay, Milford; Llandeilo. I am not quite sure if this or the following species be the one found in numerous fragments along the South Welsh Silurian border.

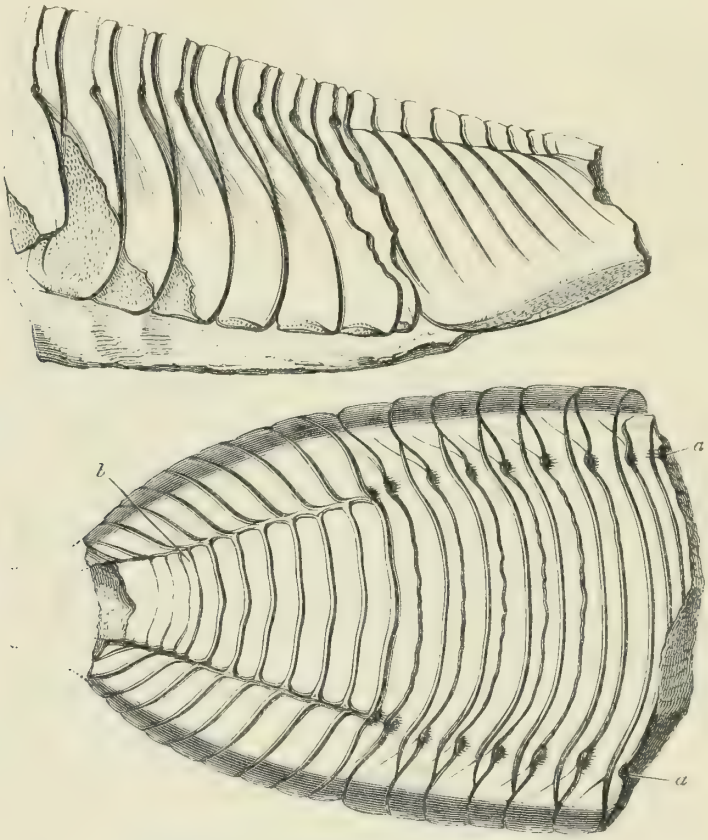
Foreign.—Niagara Limestone of North America; abundant.

Homalonotus cylindricus, n. sp. Pl. XI, fig. 12, and woodcuts, figs. 27, 28.

H. 6-uncialis, convexus, minutè granulosus, (capite triangulato?) caudâ longâ productâ. Thorax convexissimus, insuper planatus, pleuris longè deflexis, axe angusto posticè contracto. Cauda longa trigona, axe longiconico 10-costato, et apice læve circumscripto; mucrone terminali elongato cylindrico distincto vix elevato; costis lateralibus 7 convexis, haud marginem verticalem angulatum attingentibus.

I have only lately obtained a good specimen, which is given in the woodcut; and ascertained that this Woolhope species is quite distinct from the *H. delphinocephalus*, of which it was formerly thought a variety.[1] It is a far more convex species, and might easily be mistaken for the *H. Johannis*, to which it is indeed nearly allied (we have not the head as yet), and differs only, so far as I can see, in the want of trilobation, more tapering body-axis, and rather longer pleuræ; but especially by the cylindrical convex tail, with a much flatter axis, and less distinct side-ribs than in that species. The

Fig. 27.



Homalonotus cylindricus; Woolhope. (Mr. Edgell's cabinet.)

differences in the tail are indeed so marked, that I cannot doubt its being a distinct form, and it has probably been always quoted as *H. delphinocephalus* from Woolhope.

Rather a large species. It must have been full $5\frac{1}{2}$ inches long when perfect, and $2\frac{1}{2}$ inches broad. The sides are very parallel as far as the root of the tail; the outline thence curves rapidly inwards towards the end of the tail-axis, and is again much produced into a straight and somewhat cylindrical point. The depth is very great for a Silurian

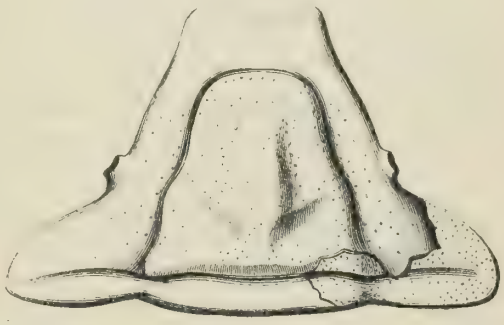
[1] *H. cylindricus* is probably the common Woolhope species. It is now distinguished for the first time.

species, being exactly half the breadth. The axis is broad in front, but narrows much behind towards the origin of the tail; the trilobation being quite obsolete in the body-rings, while in *H. Johannis* it is distinct.

The tail is a long triangle, nearly half as long again as the breadth; and of this the long-conical axis is at first more than half the breadth of the whole tail, and thence tapers less slowly than in *H. Johannis*, but not so rapidly as in *H. delphinocephalus*. The axis is, moreover, very flat, even quite to the end, and is well distinguished, but not deeply so, from the side-lobes. It is annulated by eleven furrows, of which the uppermost is much the strongest; all are angulated in the middle, not straight across as in the Wenlock fossil. The sides are very convex, almost gibbous outwards, and turning down quite vertically; on their lower third they are again sharply angulated, leaving a broad rough-sculptured area above the final incurvation on the lower surface, a character common to all the Upper Silurian species. The side-furrows are curved, shallow even in the cast, and reach only three fourths to the margin: and, except the upper three, they do not coincide with the axal-furrows, while in *H. Johannis* at least five of them do so.

It is unfortunate that we do not possess the head; but I figure one found at Woolhope, which certainly differs in proportion from that of *H. delphinocephalus*, and was found by the late Hugh Strickland, Esq., at Woolhope. The glabella is very flat, and this coincides with the character of the axis in our species. It is, moreover, very pyramidal, almost triangular, but truncate in front. The eyes are somewhat more approximate than in *H. delphinocephalus*, if I may trust in this respect a careful sketch made some eighteen years back (fig. 28). The cast is punctate all over the glabella, and has larger puncta over the lower portion of the fixed cheeks.

Fig. 28.



Head of *H. cylindricus ?* Woolhope Limestone. Collection of the late Mr. H. Strickland.

Locality.—Woolhope Limestone of Woolhope. Plate XI, fig. 12, is in Mr. Edgell's collection. Our fig. 27 is from a fine specimen in the Woodwardian Museum. Fig. 28 was in the late Mr. Hugh Strickland's cabinet. I do not know where that collection now is, and shall be glad of the information.

Homalonotus Johannis, n. sp. Pl. XII, fig. 11; and Pl. XIII, figs. 1—7.

H. modicus elongatus, 6-pollicaris, scaber, cauda acutâ, quam capite triangulato paullo longior. Glabella valde distincta, pyramidata, subcarinata, anticè truncata, lobata,—lobis

basalibus tumidis. Frons[1] *concava, subacuta, scuto rostrali quam lato longiori. Genæ convexæ: oculis ante medium positis. Thorax benè lobatus, granulis posticis spinoso-pectinatis. Cauda triangularis convexa acuminata; axe prominente* 12*-annulato, lateribus declivibus* 8*-sulcatis, sulcis profundioribus.*

With great pleasure I recognised this new form in the very choice cabinet of my friend John Lee, Esq., of Caerleon, and beg to dedicate it to him. It seems not to be a rare species; but has hitherto been confounded with the *H. delphinocephalus*, from which it differs in every particular. More strongly trilobed, more roughly tubercular, with a more triangular and far more deeply lobed head, a narrower tail-axis, and deeply sulcate side-lobes to the tail, it is rather surprising the species had not attracted attention before.

The length of large specimens is just 6 inches, the base of the head, which is the widest part, being there $3\frac{1}{2}$ inches. This gives a size all but equal to the great species just described. The head itself is trigonal, $3\frac{1}{2}$ inches wide at base, and $2\frac{1}{4}$ long, with a blunt-pointed front and similar posterior angles. A broad neck-segment is deeply divided from the tumid four-sided glabella, and these taken together are rather longer than the concave front. The glabella is twice as wide behind as in front, trapezoidal in shape, the angles rounded, the sides tumid, and the lateral lobes very distinct for the genus; the centre is raised and somewhat carinate, as in its ally *H. delphinocephalus*, but the glabella is greatly wider behind. A distinct, wide, and rather strong sulcus borders it all round, separating the tumid cheeks with their sub-central eyes. The course of the facial suture is the same as in the last species. One specimen (fig. 2) shows the rostral shield; it is longer than broad, and is of a nearly rectangular shape. The whole head is covered with a coarse and fine granulation; but, as we have only internal casts, we cannot give further details.

Thorax depressed; the rings convex, well separated from each other, and projecting posteriorly more than usual; the hinder half large, the anterior portion separated by the pleural groove narrow, as in *H. delphinocephalus*. The trilobation is distinctly marked; the axis thus marked out being narrower, and more tapering backwards, than in the last-mentioned species. Internally the pleural groove is very strong (see fig. 6). The pleuræ are square at their ends (fig. 5).

The tail is strongly ribbed. The axis, not much broader than the sides, is tapering, long-conical, and distinctly ribbed all down by nine strong ribs, while the sides have seven strong furrows. The axis is prominent and pyramidal at their tip, and does not fade off into the broad-pointed mucro, which is more than one third the whole length of the tail, acute, not recurved; it is much longer than in the allied species so often quoted.

[1] I use the term *frons* for the produced front of the head, in front of the glabella. Some authors use it for the glabella:—it is best to keep the terms distinct.

The whole thorax and tail are sparsely covered with rather strong granules, which become (see fig. 5) spinous combs along the hinder edges of the thorax-rings, but are not so produced in the tail-portion.

Altogether the species is very distinct from the Dudley fossil with which it has hitherto been confounded. It appears to be abundant at the following locality.

Locality.—WENLOCK SHALE (soft mudstone) of Craig y Garcyd, in the bed of the Usk, Monmouthshire, whence a plentiful supply has been obtained by Mr. J. E. Lee, of Caerleon, whose fine series of specimens we have figured. Mr. Nichols, jun., late of Usk, now of Cowbridge, has also a fine series. Also Golden Grove, Llandeilo (Mus. Pract. Geol.).

Section—KOENIGIA, *Salter.*

HOMALONOTUS KNIGHTII, *König.* Pl. XII, figs. 2—10, and Pl. XIII, fig. 8.

HOMALONOTUS KNIGHTII, *König.* Icones Sectiles, pl. vii, fig. 85, 1825.
— — *Bronn.* Lethæa, 1, 119, tab. ix, fig. 14, 1835; also in Leonh. und Bronn's Neues Jahrb., p. 445, &c., 1840.
— — *Murchison.* Sil. Syst., pl. vii, fig. 1, 2, also *H. ludensis,* ib., figs. 3, 4, 1837.
— — *Milne-Edwards.* Crust., iii, 315, 1840.
— — *Goldfuss.* Neues Jahrb., p. 559. *H. ludensis,* ib., 560, 1843.
— — *Emmrich.* Dissert. 41, 8, 1839. Neues Jahrb., 1845.
— — *Burmeister.* Org. Trilob., Ray ed., p. 86, 1846.
— RHINOTROPIS, *Angelin.* Palæont. Suec., t. xx, fig. 1, 1855.

H. fere 6-*pollicaris, depresso-convexus, scabriculus, capite acuto, caudâ multo breviore, truncatissimo. Glabella haud convexa seu lobata, a genis latis distincta; margine frontali brevissimo tricuspidato. Oculi antici. Thorax omnino homogeneus, nec lobatus. Cauda triangulata acuminata, apice obtuso vix recurvo; axe distincto contracto, per* $\frac{4}{5}$ *longitudinis annulato, sulcis* 9 *intùs profundis, et cum tot sulcis lateralibus profundè exaratis omnino continuis. Ad apicem caudæ sulci axales et laterales subitò absunt. Margo abruptè incurvus angulatus, ad latera contractus, scabrosus.*

Of this fine species little need be said, as it has figured in every book of fossils since König instituted the genus and gave the appropriate name. It is one of the commonest and yet most choice of the Ludlow rock fossils. Fragments are found in every locality. The barren mountains of Radnorshire present us with fine and nearly perfect specimens. Others have been disinterred by the patient labour of the Shropshire geologists, and we are indebted to Mr. G. Cocking, of Ludlow, especially, for saving every specimen that could be preserved when the Ludlow railway was being made. Figs. 2—4 are from his specimens, the crust being beautifully preserved in fig. 3. But the largest and finest we

have yet seen is our fig. 7, from the cabinet of Dr. Grindrod, of Malvern. With his usual kindness he has sent me every specimen that could illustrate this or other species.

A large convex species, $5\frac{1}{2}$ inches long, and nearly 3 inches wide at the shoulders. Foreign specimens occasionally attain the length of 9 inches? The form is oblong, pointed behind, and abruptly truncate in front, the head being nearly a parallelogram, twice and a half as wide as long, and divided by the distinct axal-furrows into three nearly equal parts. The glabella is urceolate, a good deal widest below, where it is wider than the cheeks, and rather abruptly contracted halfway-up; the front is straight-truncate, and slightly emarginate. The cheeks, separated by broad axal furrows, are decidedly gibbous, the greatest convexity towards the front in advance of the eye, which is placed two thirds up the cheek and not quite halfway-out. It is small, oval, prominent, and subtended by a flattened base. The facial suture runs nearly direct to the front margin from the eye, and beneath it turns abruptly outwards, gaining the outer margin considerably in advance of the facial suture. [On the cast the cheek is both granulate and punctate. I do not know the exterior; but it is figured as granular by Angelin.] Neck-furrow strong and broad, but not reaching the angle. No outer marginal furrow to the gibbous cheek.

Fig. 29.

a. H. Knightii, young (Mr. Edgell's cabinet).
b. Front view of the head enlarged.

The front margin is of most singular structure, and may be described as tricuspid. The narrow edge is so deeply indented, and at the same time folded, that the front portion overhanging the rostral shield (fig. 2 *b*) forms one projecting angle, flanked by two smaller projections opposite the axal-furrows, exactly like the salient and re-entering angles of a fortification.

The rostral shield can only be indistinctly seen in fig. 2, at *b*. It is pointed in front. But the labrum (fig. 10), from a good specimen of Mr. Edgell's, is a flattened quadrate plate, deeply bilobed at the apex, and with parallel sides, no lateral wings, a convex centre separated from the margin by a shallow furrow; and with a pair of lateral tubercles well developed (as in *Asaphus*, to be described hereafter).

The thorax-rings are convex on the back, but descend so abruptly at the sides as to give a square appearance to the body. The convexity of the back is greater than in *H. delphinocephalus*. The axal furrows are but very slightly marked; the fulcrum a very short distance outside them. The facet large, but not flat, a depression followed by a longitudinal ridge occurring near the apex, which is rather abruptly truncate (fig. 8 *a*).

The pleural groove is narrow externally, very deep and strong on the inner surface (see figs. 5 and 8). It separates the ring into two unequal parts, of which the front is less convex than the hinder part, and is smooth, while the latter is squamous near the

edge. The pleuræ are strongly granular, the granules taking the form of closely placed squamæ over the whole surface.

On the tail the granules are rounder and less closely placed, but they cover the whole surface. The shape of the tail is truly triangular, as wide as long, contracted near the apex, and then pointed, the tip somewhat recurved.[1] The axis is rather narrow, and not much distinguished from the sides, the furrows being quite continuous across. There are eight of them, the upper not stronger than the rest; and all are deep furrows, only rather less broad than the intervening ridges. They arch across the axis, which is only slightly convex, and pass direct across the sides, which are gibbous externally, but rather flattened above.

The eight furrows abruptly cease at rather beyond halfway down the tail: on the sides they cease entirely; on the axis there are one or two faint ribs beyond them. The incurved under margin of the tail is very remarkable. It is sharply incurved, strongly concave, and roughly granular, and there is besides a strong lateral contraction about halfway down the tail (see fig. 9).

Localities.—Abundant in the Upper Ludlow Rocks of Shropshire, and all the border counties; also of Radnorshire, and other places in South Wales; Llangollen, North Wales; Westmoreland, near Kendal, abundant; and under the name of *H. rhinotropis* it occurs in Gothland. Dr. Honeyman has found it at Arisaig, Nova Scotia.

H. ludensis, of Murchison, is now well understood to be a synonym;[2] but nevertheless there are two species in the Ludlow rocks, even in England. And to preserve this old name, I beg to apply it to the very unpretending looking head, fig. 1 (lent to me by Mr. H. W. Edgell, jun.). That species has not the tricuspid front of *H. Knightii*, but a smooth regular contour to the margin; and is, indeed, more nearly like the *H. bisulcatus;* but I cannot be sure to what sub-genus it should be referred—possibly to *Dipleura*. It may be shortly described as follows:

Homalonotus ludensis, *n. sp.* Pl. XII, fig. 1.

(Not of Sil. Syst., pl. vii, figs. 3, 4, for which see *H. Knightii*.)

H. capite transverso semicirculari convexo, glabellâ brevi distinctâ, fronte concavâ subplanâ angustâ, genis modicis, oculis haud remotis, sulco cervicali perdistincto.

[1] Angelin's figure does not show this. Our figures 9 (and fig. 5, copied from the 'Silurian System') show it best. It is not very conspicuous.

[2] The original specimen of *H. ludensis*, 'Sil. Syst.,' pl. vii, fig. 3, was in the cabinet of the late Mr. J. Evans. It is now in the Museum of the Worcestershire Nat. Hist. Society.

Distinct at once from *H. Knightii* by the form of the front margin, which is not sinuous and tricuspid. I do not know the body or the tail, and have much doubt if the species belong to the section *Kœnigia*. It may be referable to *Dipleura*, and I think it is so.

Locality.—Upper Ludlow Rock, Ludlow (Mr. W. H. Edgell's cabinet).

Section—Burmeisteria, *Salter*.

Homalonotus elongatus, *n. sp.* Pl. X, figs. 1, 2.

Homalonotus Herschelii, *Phillips*. Pal. Foss. fig. 253 (not of *Murchison*), 1841.
— sp. *Salter*. In Morris' Catal., 2nd ed., p. 109, 1854.

H. caudâ $2\frac{3}{4}$*-unciali, vix* 2 *uncias latâ, longè trigonâ, valde convexâ fere gibbâ. Axis dimidium latitudinis efficiens, convexus, et ad apicem obtusum longum gibbus,* 12-*annulatus, annulis perdistinctis,—primo, secundo, quarto, quinto bituberculatis. Latera gibba, costis circiter* 8 *valdé obliquis, secundo quintoque tuberculatis, tuberculis magnis.*

Mr. Townshend Hall, junr., of Wadham College, Oxford, has made a fortunate discovery, for we have long wanted to know what spinose species of *Homalonotus* furnished the fragments described from South Devon. The Lower Devonian in every country yet examined shows some species or other of this peculiar group—the *H. armatus* on the Rhine, the *H. Pradoanus* in Spain, the *H. Herschelii* in South Africa. In South Devon we now have a new form, remarkable even in this elongated genus for the lengthened shape. We have only the tail as yet; but a diligent search at Meadsfoot Sands will surely discover all the portions of this fine species. And I beg of our friends to make the inquiry. Prof. Phillips has figured some fragments.

Caudal portion $2\frac{3}{4}$ inches long, and only 2 inches wide at the top, and the convexity about $1\frac{1}{4}$ inch. Of this form (a frustum of a cone) the axis occupies fully one half the width, and is well marked out, convex in front, and very prominent below. It is annulated nearly the whole way down, eleven or twelve rings being distinctly marked, and there is but a small terminal smooth portion. Of these rings, the first, fourth, and fifth bear a pair of approximate spinous tubercles, and the second ring a pair wider apart. The side-ribs are about eight on each side, very oblique, broad, with narrow intervening furrows; the first and the fourth rib bear each a strong tubercle (probably spinous), directed outwards, and placed less than halfway out. There is a narrow, recurved, lateral margin. The apex of the tail is not recurved or mucronate, but obtuse, the axis being prominent.

This may be compared with the *H. Herschelii*, Murchison, a common South African species; but ours has a much more elongate and more nodular tail than that fossil. The

H. armatus, Burm., from the Lower Devonian of Germany, hardly needs comparison, as it has a minute tail for the size, with but a single lateral spinous tubercle. The species figured, but without a name, by Steininger in the 'Mém. Soc. Géol. France,' vol. i, pl. xxi, fig. 8, has a large spinous tubercle on the first and fifth lateral ribs; but the tail is truly triangular. I think that probably this species does occur in the German Devonian; and that there is a fragment of it in the Geol. Soc. Museum from the Rhine Provinces, (marked as from the Eifel; Drawer 40); but I cannot identify it with any of the published forms.

Locality.—Lower Devonian; Meadsfoot Sands, S. Devon. (Mr. Hall's cabinet).

Family—ASAPHIDÆ, *Emmrich*, 1839 (?).

If the *Calymenidæ* are but a small group, the *Asaphidæ* are at present an unwieldy one. This is to a great extent a natural family, and I am unwilling to divide it; though we may well distinguish in it several sub-groups, hereafter, perhaps, to be called families—*Ogygides, Asaphides, Illænides, Æglinides*, &c.

Taken as a whole, the *Asaphidæ* comprehend the most bulky and expanded forms of the Trilobite family, together with some which are of much less stature. The head and tail are in general of great comparative size, the latter often free from visible segments, though really composed of many. The thorax is reduced in size, and generally of eight segments, but not always—for instance, *Illænus* and *Stygina*. Respecting *Æglina*, which has only six rings, and which genus I have kept apart in the preliminary sketch, p. 2, there may be reason to suspect it to belong to a distinct family when we know more of its relations. We must exclude it from the character of the family, which, as above said, has in general eight, more rarely nine or ten, body-rings.

Taking the general characteristics, we may say that the *Asaphidæ* are—Large Trilobites, generally of an oval form, without any ornaments except a close striation (which is very common), and totally destitute of tubercles or spines on the surface. The head and tail are large and well developed, and the former has usually an obscure glabella, with but indistinct lobes. Yet in this family we have Trilobites possessing distinctly four lateral lobes to the glabella, *Ogygia, Barrandia*, and *Niobe* having that number.

The facial sutures end on the posterior margin. The eyes are smooth and large; occasionally, but rarely, very prominent (*Asaphus*); usually conical or even depressed (*Illænus, Ogygia*,) &c. The head-angles are more often obtuse than spinous, and never greatly prolonged.

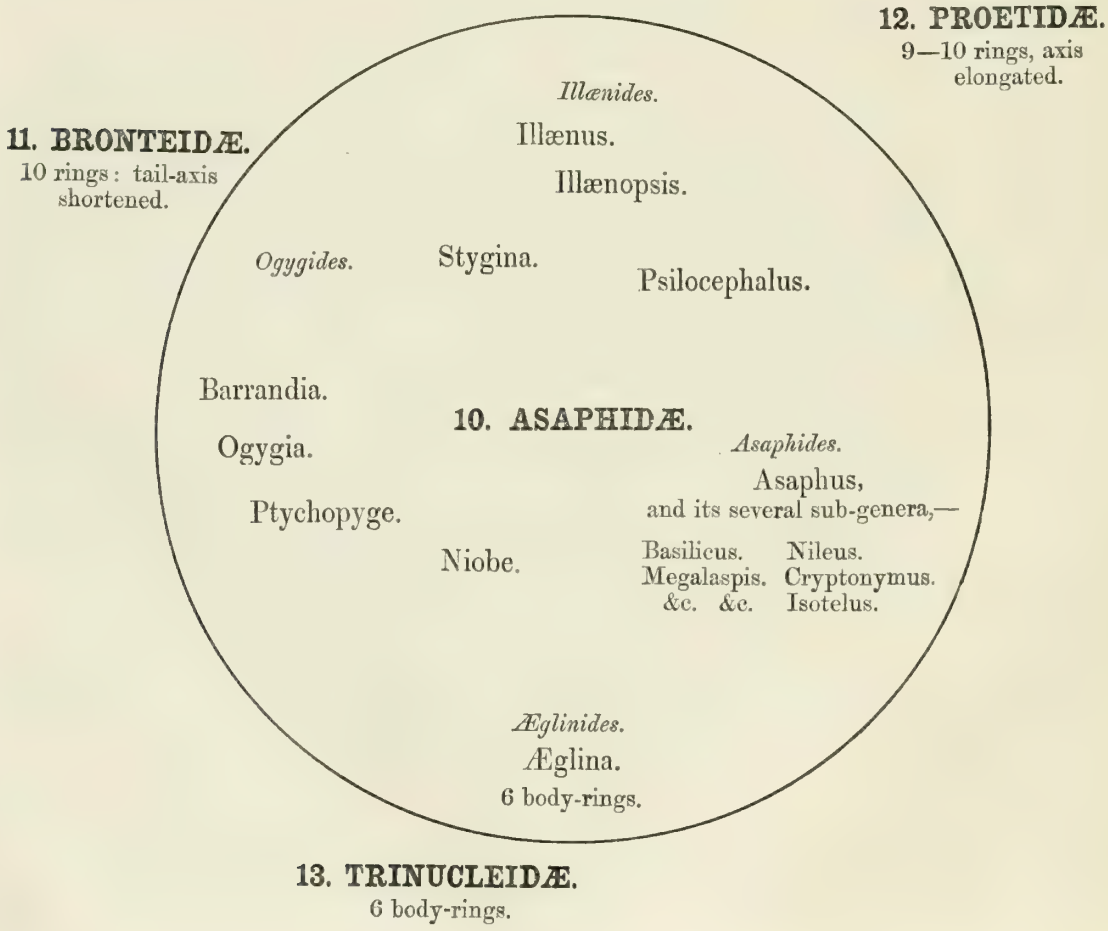
The thorax of eight rings (rarely more, as in *Illænus* and *Stygina*), always facetted, and, with few exceptions, grooved throughout: the apices blunt, or only shortly pointed.

The large tail is of many segments, and there is every gradation in it from a flat

expanded form, with the segments all distinct, through others which have them more or less obscure, to such convex forms as *Nileus* and *Illænus*, where they are obsolete, or only visible on the interior of the crust. The margin of the tail is not unfrequently sharply striated, and the incurved portion (caudal fascia) is broad, distinct, and strong, and often convex beneath.

The hypostome varies in character. In most of the genera it is continuous, or in some species of *Asaphus* it has a vertical suture only; the rostral shield being in this case atrophied. In *Illænus* the rostral shield is very large and transverse. Indeed, this genus is abnormal in many characters, and leads the way to the next family, No. 12, in which the form is more compact, the body-segments more numerous, and the rostral shield a necessary part of the structure. The labrum varies much in shape in the different genera, and only in this group is it occasionally forked: but it is constantly so in *Asaphus*.

Having said so much on the general characters, we may proceed to describe one of the most typical and constant of the genera. *Ogygia* is a very limited genus; it has all the elements of the *Asaphidæ*, and has a great resemblance to some of the sub-genera of *Asaphus*, which genus has, on the contrary, the greatest variety of forms within a single generic group.



Genus—Ogygia, *Brongniart*, 1822.

Flat or very slightly convex, with wide semicircular head, large many-ribbed tail, and slightly pointed body-segments. The glabella well marked, wider in front, and with four lateral furrows. The eyes large, lunate, depressed, and smooth. Facial suture generally marginal in front. The hypostome continuous, the labrum pointed.

The thorax has a narrow very distinct axis, and the pleuræ are pointed, strongly grooved, and have a very obscure and remote fulcrum, so that the animal could only bend, not roll up completely (and it is probable that some of the species never did so). The tail has many segments: these are very distinct, and generally strongly duplicate.

Range.—*Lower Silurian only.* North and central Europe: not yet known in America (or the southern hemisphere?). The species are rather numerous, and often attain a great size, but not so large as that of *Asaphus*.

Ogygia Buchii, *Brongn.* Pl. XIV, figs. 1—7; Pl. XV, figs. 1—6.

Dr. Llhwyd, in the Philosoph. Trans., vol. xx, 279, tab. addit., fig. 15, 1698.
Buglossa curta strigosa, ib., Ichnograph. Brit. Epist. 1, t. xxii, fig. 2, 1690.
Trilobite from Llanelly, *Parkinson*, Org. Rem., vol. iii, t. xvii, fig. 13, 1811.
Asaphus de Buchii, *Brongniart.* Crust. Foss. t. ii, fig. 2, 1822.
Trilob. de Buchii, *Schlotheim.* Nachtr. ii, 34 (excl. the locality "Norway"), 1823.
Asaphus Buchii, *Dalman.* Paleadæ., 68, 1826.
— — *J. D. C. Sowerby.* Loudon's Mag. Nat. Hist., vol. ii, fig. 27, 1829.
— — *Buckland.* Bridgwater Treatise, t. xlvi, fig. 7, 1836.
— — *Murchison.* Sil. Syst., t. xxv, fig. 2, 1837.
— — *Quenstedt.* Wiegm. Archiv, vol. iii, 1, 346, 1837.
— — *Emmerich.* Dissert. 28, 1839.
— — *Milne-Edwards.* Crust. 3, 309, 1840.
— — *Burmeister.* Org. Trilob., t. i, fig. 2, 1843, Ray edition, p. 59, (facial suture wrongly figured), 1846.
— — *Corda.* Böhm. Tril., t. iv, fig. 39 (bad), 1847.
— — *Barrande*, Sil. Syst. de Bohême, pl. ii a, f. 25, 26, 1852.
Ogygia Buchii, *Salter.* Decade II, Geol. Survey, pl. vi, 1849.

Junior. Pl. XIV, figs. 5, 6.

Trinucleus? asaphoides, *Murchison.* Sil. Syst., t. xxiii, fig. 6, 1837.
— — *Milne-Edwards.* Crust. v, iii, 333, 1840.

O. ovalis 5—7-*uncialis, capite semicirculari, glabellâ angustâ utrinque quinquesulcatâ, oculis ad medium capitis; spinis posticis brevibus; labro obtusè acuminato; thoracis axe bis pleurâ angustiore,—caudæ longo abrupto; sulcis lateralibus* 12—14 *perduplicatis, propè marginem angulatim deflexis.*

Length occasionally near seven inches, generally three or four; proportion of length to breadth in some 7 × 5, in others 10 × 8, a considerable variation, to which we must refer by and by. "General form a broad oval, depressed; the head nearly semicircular, and as long as the thorax; the tail semi-elliptical and longer than either; glabella at its base occupying one fourth or less of the width of the head, broader and more convex above, and a little pointed in front; it extends nearly to the front margin, and is marked a little within each side by a longitudinal depression, which is curved, with the convex side inwards. Along this hollow lie five pits, which represent the glabella-furrows: the basal one is the neck-furrow; that above is deepest, and placed nearer towards the centre of the glabella; the other three recede more,—the fourth is opposite the top of the eye, and the uppermost just above it. Eyelid large, semicircular, and not touching the glabella. The facial suture above the eye is curved a little outwards to reach the margin, along which it runs for some distance; beneath the eye it curves largely outwards, and cuts the posterior edge just within the border. The latter is broad and striate, more or less concave, and marked off by a distinct marginal-furrow. Eye placed half-way up the head, smooth; the lentiferous surface broad; its minute structure is shown in Pl. XIV, fig. 7. Head-angles short-spined, the spines not produced below the third body-segment. Labrum broad above, narrowing below, where it is suddenly and obtusely pointed (Pl. XV, figs. 2, 3); the centre is gently raised, and a furrow runs down each side; there are two transverse furrows near the apex, with compressed tubercles between them.

"The cheeks appear to be nearly smooth, but the glabella is covered by fine, short, broken, almost microscopic lines. The labrum is strongly and concentrically striate.

"Thorax with the axis gently convex, variable in proportion, but seldom more than half the width of the pleuræ. In the broad form it is not so much as this. The pleuræ are flattened, furrowed along the upper margin as far as the fulcrum, at which there is an obtuse bend backward and very little downward; the pleural groove diverges from the margin here, and does not quite reach the recurved and pointed extremity; it becomes widest immediately beneath the fulcrum; and from the lower margin of the pleuræ at this point a narrow ridge runs obliquely upwards and meets it. The curved sabre-shaped tips are strongly striated transversely.

"Tail varying from little more than a semicircle in the broad form, to a half ellipse in the narrow form; very slightly convex; the axis gently tapering, ribbed by about thirteen or fourteen furrows, which have a slight angular downward bend in the middle; its obtuse tip projects abruptly. Lateral furrows twelve, or in some specimens fourteen, at nearly right angles to the axis, angularly bent downwards at the place of the fulcrum,[1] interlined all the way by fainter furrows, and leaving but a narrow caudal fascia. The interlining furrows nearly meet the primary ones at the end, and here the ribs are sud-

[1] The tail, consisting of anchylosed segments, preserves traces of nearly all the characters of the thorax; the strong furrows are analogous to the furrows of the pleuræ, the fainter lines between to the joints. This is, of course, universal, but *Ogygia Buchii* shows it more clearly than most species.

denly tumid, so as to undulate the flat marginal band. Incurved under portion of the tail (caudal fascia) narrow, closely striate, not indented by the axis; the upper side has a striate band of the same width,[1] which is indented by every rib of the tail. The fascia is continued (of the same width) along the ends of the pleuræ, and the striæ run in the same direction, while on the upper surface they are transverse, as above said, and reach further inwards. Numerous fine striæ, arched upwards, cover the axis.

"*Variations.*—This fine Trilobite varies a little in convexity, but greatly more in proportionate length and in the width of the axis; this variation appears to be chiefly due to sex. If we are right in referring the long form to the ♂, we must allow the Pl. XIV, fig. 3, and Pl. XV, fig. 1, to be males, and the remainder female specimens. The difference is rather extreme in this species. But there is also another variety. Pl. XV, fig. 5 (a ♀ form), has a pair of tubercles on each segment of the axis; they are distinct and strong in this specimen, and are faintly seen in some others, both ♀ and ♂ forms. It might be called var. *tuberculata.*

"*O. Buchii* is known from the French species *Asaphus Guettardi* by its less elongate and more truly oval shape, and the greater width of the pleuræ in proportion to the axis. In *A. Guettardi* they are but half as wide again. The axis of the tail is longer; has thirteen instead of nine ribs; and is abrupt, not attenuated, at the tip. In *A. Guettardi* it extends but three quarters the length. Our fossil has also duplicate, bent, and more numerous side-furrows; the French fossil has but eight or nine straight simple ones; the labrum also is subconical, not dilated laterally. But the general aspect of the two fossils is much alike.

"*O. dilatata,* Brünnich (not of Portlock), which seems to have been frequently esteemed a variety of *O. Buchii,* has the glabella short, with its lobes crowded down towards the base and the eyes remote. The facial suture behind the eyes appears much less arched in Sars' figure. He also describes the tail as with ten ribs, separated by broad furrows. The labrum of *O. dilatata,* according to Sars' figure, is but slightly different from that of the British species; but an important difference resides in the facial suture, which in *O. dilatata* is within the front margin on the upper side, but in *O. Buchii* is along the edge itself," as in *Asaphus tyrannus,* soon to be figured.

"The earliest mention we can find of Trilobites is concerning this species, and is that which all writers on these fossils have quoted. Dr. Edward Llhwyd, in a letter to Dr. Martin Lister, of the Royal Society (1698), writes 'concerning several regularly figured stones lately found by him.' 'The fifteenth,' he says, 'we found near the Lhan Deilo, in Caermarthenshire, in great plenty; it must doubtless be referred to the sceleton of some flat fish;' but he remarks a few lines after, 'Not that these or any other marine terrestrial bodies were really parts or exuviæ of animals; but they bear the same relation to them as fossil shells to marine ones,' &c. This latter opinion he maintains in his '*Lithophylacii*

[1] In many of the *Asaphidæ* the caudal fascia is much wider than the upper striated band.

Britannici Ichnographia' (1699), where he again says the specimen represents only the sceleton of a sole fish, and wants the tail; and he marvels that the 'Piscis Icon' should be raised above the surface of the stone, 'ac si verus piscis esset.' It is curious that Brongniart should have placed this species in his heterogeneous group *Asaphus*, at the very time he was founding *Ogygia*, as he appears to have recognised the latter genus more by its marked habit than by any positive characters; and the principal species, *O. Guettardi*, turns out to be an *Asaphus*. He probably meant to unite *A. dilatatus* with *A. Buchii*. Dalman distinguished them, but with doubt, in 1826, and gave a figure of the Norwegian fossil from a plaster cast; and had not Sars, in 1835, given a complete description and a good figure of the head, the identity might still have been maintained. But, though often quoted, *O. dilatata* does not occur in Britain. Dalman described a specimen of it with seven body-segments; and Prof. Quenstedt, in 1837, two specimens of *O. Buchii* with seven rings; whether an accidental variety, or, as Burmeister thinks, occasioned by the slipping of one ring under the others, it is difficult to say. Quenstedt, however, relied on these and Dalman's seven-ringed specimen of *O. dilatata*, and asserted the same number for *Asaphus* (*O.*) *Guettardi*. But the error in both cases led him to see the generic affinity between the two former species, and he distinctly says that their union with the typical *Asaphi* is unjustifiable. Burmeister, in his first edition, set the number of rings right, but confounded *O. dilatata*, which Sars had well distinguished in Oken's 'Isis' (1835), with our species; and adhered to this view in the Ray edition (1846). Emmerich had, in the mean time, spoken of them as different species, and figured *O. dilatata* in Leonhard and Bronn's 'Neues Jahrbuch' for 1845;" and Corda, in his notoriously incorrect work, in 1847, maintained the error of the seven rings, after everybody else had clearly understood that all the *Asaphi* and *Ogygiæ* had eight segments.

Localities.—Llandeilo Flags only. Shelve and Hope Mill, Shropshire; Rorington, Middleton, and Meadowtown, Shropshire; Builth, Radnorshire; Llangadoc and Llandeilo, Caermarthenshire; near Haverfordwest; Musclewick Bay, Pembrokeshire; and Abereiddy Bay, Cardiganshire, where it is abundant.

It is not known in any foreign country; nor, indeed (though often so quoted), has it been found out of South Wales. It must be esteemed an extremely local and very abundant species, and not very variable, except as regards those differences referable to sex.

PLATE VII.

UPPER SILURIAN (WENLOCK).

Figs. 1—12. *Deiphon Forbesii*, BARRANDE. All the principal specimens known.

1. ,, ,, The most perfect specimen extant; natural size and magnified. It is in the rich cabinet of my friend Dr. Grindrod, of Malvern, and shows the eyes, pleuræ, and tail, to perfection. Malvern Tunnel.
2. ,, ,, A younger, but nearly perfect, example. Same locality and cabinet.
3. ,, ,, From Mr. C. Ketley's collection. Same locality.
4. ,, ,, Young head, from the late Mr. Mushen's collection. Dudley.
5. ,, ,, Somewhat older. Dudley. (Mr. Mushen's cabinet.)
6. ,, ,, Largest head known. (Mr. Mushen's collection.) 6 *a*. Front view. 6 *b*. Side view. Dudley.
7. ,, ,, Portion of glabella, magnified.
8. ,, ,, Side view of perfect eye and free cheek; from fig. 1.
9. ,, ,, Showing the supporting folds of the eye (the lentiferous surface lost) from fig. 5. This specimen also shows the curious blunt process on the forward edge of the head-spine.

10 *a*. ,, ,, Mr. Ketley's specimen, showing hypostome and labrum, and the underside of the first six pleuræ; a beautiful specimen, which also shows the eyes in place. 10 *b*. The same, enlarged. 10 *c*. Is a magnified front view of the labrum; 10 *d*, side view of ditto. From Malvern Tunnel.

11. ,, ,, Tail, and part of the tenth body-segment. Dudley. (Woodwardian Museum.)
12. ,, ,, Do., enlarged to twice its size. (Mr. Mushen.) Dudley.

Figs. 13—20. *Staurocephalus Murchisoni*, BARR.

13 *a*. ,, A Dudley specimen, from Mr. E. Hollier's cabinet, magnified.
13 *b*. ,, Side view of another. (Same cabinet.) Dudley.
14. ,, Coiled specimen. (British Museum.) Natural size.
15 *a*. ,, Do. a fine example from Dr. Grindrod's cabinet: Wenlock Shale, Malvern. *a*. Natural size. *b*. Magnified.
16. ,, Do., showing the border-spines to the head. (Same cabinet.)
17. ,, Fragment with the frontal crest of tubercles and the blunt labrum. (British Museum.)
18. ,, Middle and last body-segments, and tail; from the Decades of the Survey; partly restored, and magnified.

LOWER SILURIAN.—CARADOC.

19. *Staurocephalus Murchisoni*. Small specimen, figured by M'Coy, and in the Woodwardian Museum. Rhiwlas, Bala, N. Wales.

20 *a*. ,, ,, Do. (In Mus. Pract. Geology.) Same locality; 20 *b*, enlarged.

Fig. 21. ,, *globiceps*, PORTLOCK. The original specimen figured in Portlock's work and in Decade 11, Geol. Survey. *a*. Natural size; *b*, enlarged; the tail is broken off at the apex. Tyrone.

Figs. 22—24. ,, *unicus*, THOMSON. A series of fine specimens from Professor Wyville Thomson's cabinet. Others are in the Museum Pract. Geology. Girvan, Ayrshire.

22 *a*. ,, ,, The same head, front view, nat. size; *b*, viewed sideways. *c*. Fig. 22 *a* magnified; it shows the gibbous glabella, forward eyes, and minute free cheeks.

23, 24. ,, ,, Body and tail. Nat. size, same locality.

Fig. 25. ,, *sp.* (*St. nodulosus*, MS., SALTER), Professor Thomson's cabinet. This shows many differences from *St. unicus*, but is not sufficiently preserved for me to be quite sure of its distinctness from *St. globiceps*. Girvan, Ayrshire.

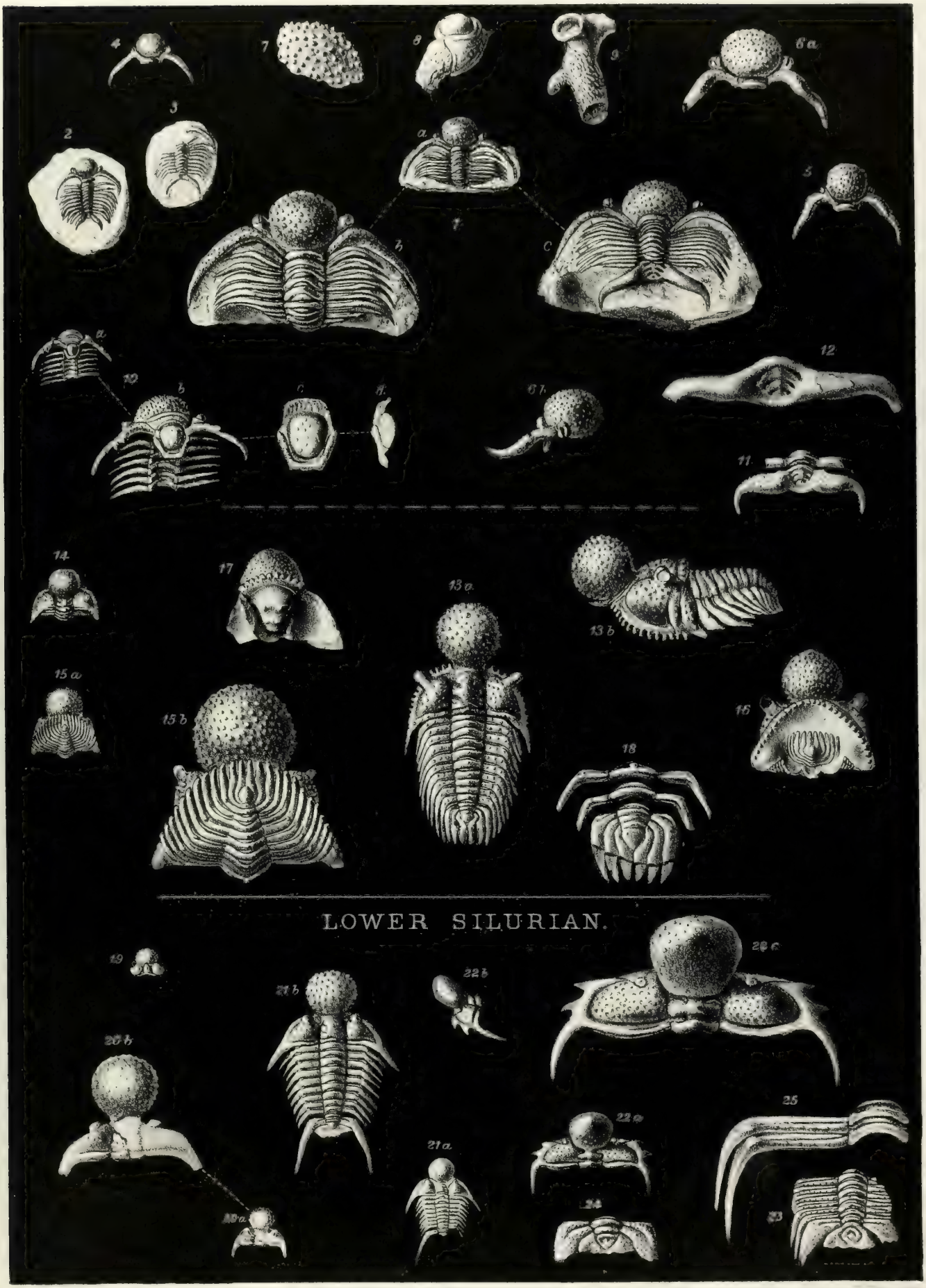

4
7
8
9
6a
2
3
a
1
b
c
5
a
10
b
c
d
6b
12
11
14
17
13a
13b
15a
15b
16
18
LOWER SILURIAN.
19
20b
21b
22b
20c
22a
21a
25
23
15a

PLATE VIII.

UPPER SILURIAN (WENLOCK).

Figs. 1—6.	*Calymene tuberculosa*, SALTER [Mus. Pract. Geology]. Burrington, Shropshire.		
1.	,,	,,	Full grown.
2.	,,	,,	Specimen figured in Decade 2, pl. viii, fig. 1.
3.	,,	,,	Side view of the same.
4.	,,	,,	Coiled specimen, showing the labrum imperfect; this is also figured in the plate of Decade 2, above quoted.
5.	,,	,,	Young specimen.
6.	,,	,,	Another specimen, with the labrum *in situ*.
Figs. 7—16.	,,	*Blumenbachii*, BRONGN. Ordinary Dudley variety.	
7.	,,	,,	The largest specimen known, the same that is figured in the original 'Silurian System,' and in 'Siluria,' both editions. (Cabinet of W. Matthews, Esq., junr., Edgbaston, Birmingham.)
8 *a, b, c,*	,,	,,	Outlines of characteristic head and tail, from a Dudley specimen in Mr. E. Hollier's cabinet, Dudley.
9.	,,	,,	Labrum of the species, from the specimen figured in Pl. IX, fig. 2. (Mus. Pract. Geology.)
10.	,,	,,	Very young Dudley specimen (*C. pulchella*, Dalman ?), from Dudley. In the Gray collection, Brit. Museum.
11.	,,	,,	Young Dudley specimen, same collection.
12.	,,	,,	Ordinary half-grown specimen, Dudley. (E. Hollier, Esq., junr.)
13 *a, b.*	,,	,,	Under view and side view of a fine specimen in Prof. Tennant's cabinet. Dudley.
14.	,,	,,	Specimen with coarse granulation. (Mus. Pract. Geology.)
15.	,,	,,	Large granulated specimen of the full size. (Cabinet of E. Hollier, Esq., junr.) Dudley.
16 *a, b.*	,,	,,	Two views of very large coiled specimen, the granules much worn off. (Cabinet of E. Hollier, junr.)

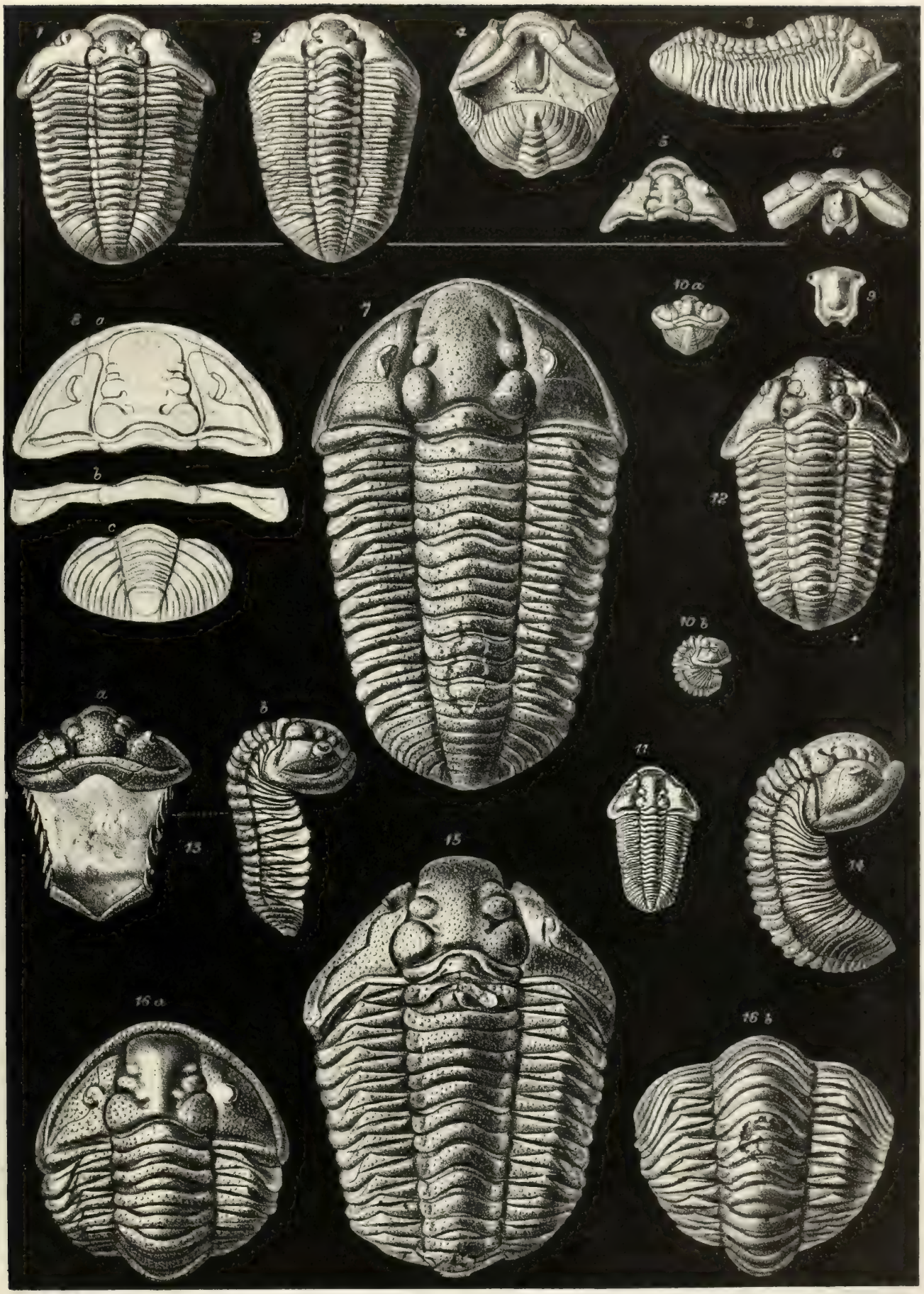

1
2
4
3
5
6
8 a
b
c
7
10 a
9
12
10 b
a
b
13
11
14
15
16 a
16 b

PLATE IX.

MIDDLE AND LOWER SILURIAN.

Figs. 1—5.

1. *Calymene Blumenbachii*, BRONGN, var. α, *auctorum*. Interior cast, from the Woolhope or Lower Wenlock Grits of Bogmine, Shelve, Shropshire. (Mus. Prac. Geology.) The crust of this specimen is much thickened.

2. „ Same species and variety. Llandovery Rock, Mullock, near Girvan, Ayrshire. (Mus. Pract. Geology.) [The labrum figured in Pl. VIII, fig. 9, is from the same locality.]

3. „ var. *Caractaci*. Fine specimen from a large slab in the Geological Society's Museum. Acton Scott, Shropshire.

4. „ Do. A head from Shropshire. (Mr. Edgell's cabinet.)

5. „ The same variety, from Gen. Portlock's collection in Mus. Pract. Geology. (*C. brevicapitata*, Portl., in part.)

Figs. 6—11. „ *senaria*, CONRAD.

6, 7. „ „ (Original figured specimens of *Calym. brevicapitata*, Portl.) from Caradoc Rocks, Tyrone. Interior cast. (Mus. Pract. Geol.)

8. „ „ A head of same species from Caradoc Rocks of Dolbenmaen, near Pwllheli, Caernarvonshire. Interior cast. (Mus. Pract. Geol.)

9. „ „ [A specimen with external crust from the blue Trenton Limestone of Ohio, N. America. (Mus. Pract. Geology.)]

10. „ „ Young, perfect (the specimen figured in the Memoirs of the Geol. Survey, vol. ii, plate 1, plate 11). 10 *a*. Tail magnified. Bala, N. Wales.

11. „ „ Head from same locality. (Mus. Pract. Geol.)

Figs. 12—14. „ *Cambrensis*, SALTER.

12. „ „ Interior cast of glabella, Llandeilo Flags, Lann Mill, Narberth.

13. „ „ Cast of exterior of perfect specimen. Near Llandeilo, in Llandeilo flags. (In the cabinet of J. E. Lee, Esq., Caerleon.)

14. „ „ Same species. (M'Coy's figured specimen of *C. brevicapitata*. Woodwardian Museum.)

Figs. 15—18. „ *Tristani*, BRONGN.

15, 16. „ „ Llandeilo or Arenig Rocks; Gorran Haven, Cornwall. (Mr. Edgell's cabinet.)

17. „ „ Tail of same species, from the Budleigh Salterton pebble-bed. (See Quart. Geol. Journ. for 1864, vol. xx, pl. xv, fig. 5, where the same specimen is figured.)

18. „ „ [Outline head from Nehou, Normandy, for comparison.]

Figs. 19—24. „ *duplicata*, MURCHISON. 19. Small specimen, var. α (*mas*), Pen Cerrig, Builth. (Mus. Pract. Geology.) 20. Dissected head, same locality and collection. 21. Large tail, same locality. (Mr. Griffith Davies's cabinet.) 22. Labrum, natural size and twice magnified; Builth. (Mus. Pract. Geology.) 23. Nearly complete specimen from Builth (Mr. Edgell's cabinet); the front of the head is added in outline from other specimens. 24. Variety (*fœmina*), probably the ♀ form. Trecoed, Builth. (Mus. Pract. Geology.)

Fig. 25. „ *parvifrons*, SALTER. Arenig group (Lower Llandeilo). Tai Hirion, Bala (Woodw. Museum).

Figs. 26—28. „ *id.* VAR. *Murchisoni*. Same formation, west of Stiper Stones, Shropshire. Fig. 28 is partly restored in shaded outline, derived from several specimens, to show the probable shape of the entire tail.

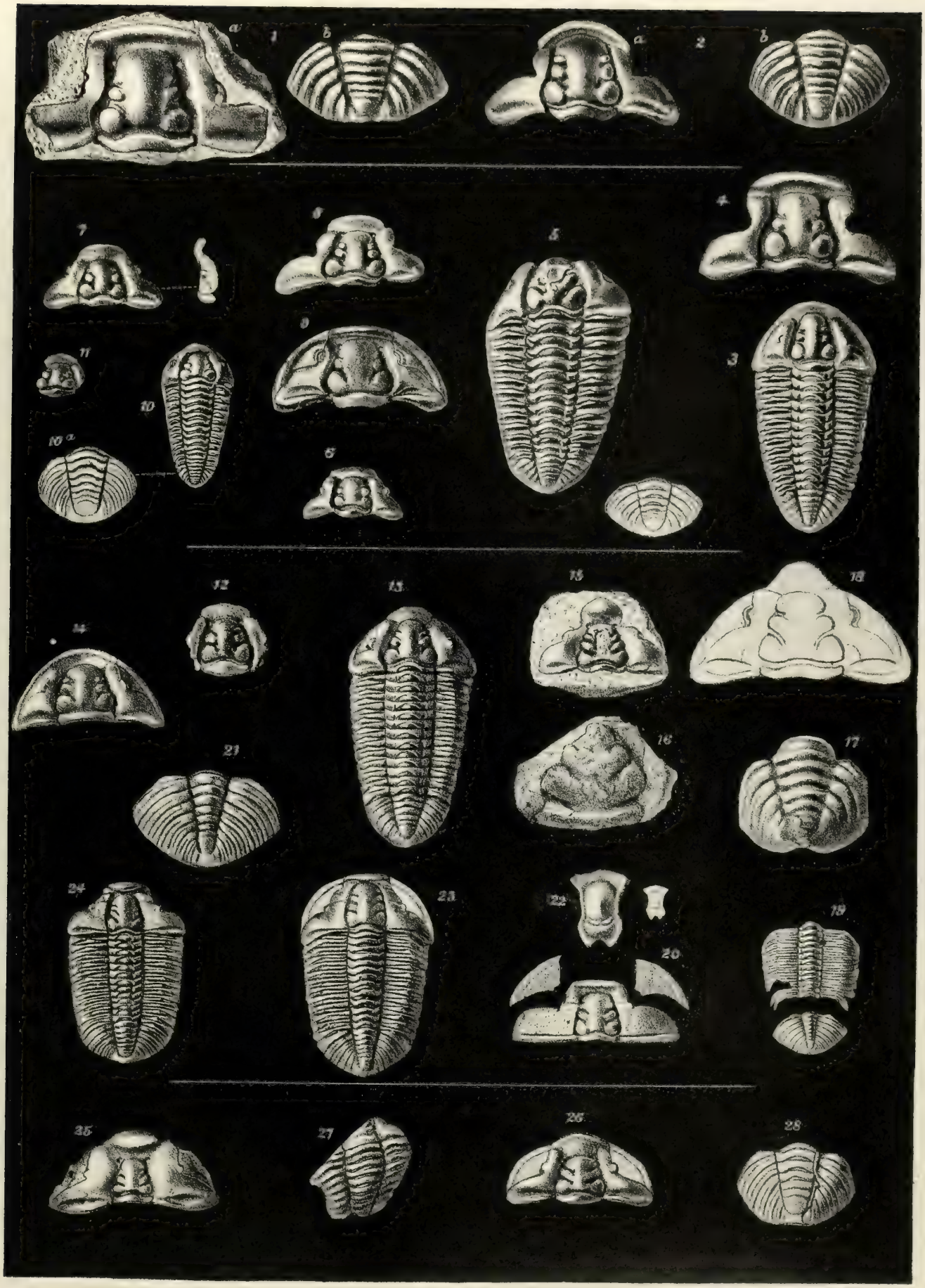

a
1
b
a
2
b
7
9
5
4
11
10
10 a
8
3
12
13
15
18
14
21
16
17
24
23
22
20
19
25
27
26
28

PLATE X.

LOWER DEVONIAN.

Figs. 1, 2. *Homalonotus elongatus*, SALTER. Front and side views of a unique specimen in the cabinet of Mr. Townshend Hall, of Pilton Rectory, N. Devon. Lowest Devonian; Meadsfoot, Torquay.

LOWER SILURIAN.

Figs. 3—10.[1]	,,	*bisulcatus*, SALTER.	From the Caradoc of Shropshire.
3.	,,	,,	Tail, from Wittingslow, Shropshire. (Museum of the Geological Society.)
4.	,,	,,	Body and tail. Same locality and museum.
5.	,,	,,	Choice young specimen. Acton Scott. (Mr. Edgell's cabinet.)
6.	,,	,,	Specimen from Bala, N. Wales, elongated by cleavage. (Mus. Pract. Geology.)
7, 8.	,,	,,	Young specimens. North Wales. Showing a more conical glabella than the adult. (Woodwardian Museum.)
9.	,,	,,	Fine head. (Mr. Lightbody's cabinet.) Onny River.
10.	,,	,,	Very young head (possibly of the next species.) Horderly. Mr. Edgell's cabinet.
Fig. 11.	,,	*Edgelli*, SALTER.	Tail from Acton Scott. (Same cabinet.)
Figs. 12—14.	,,	*rudis*, SALTER.	CARADOC of North Wales and Shropshire.
12.	,,	,,	Giant specimen. Nantyr, near Llanarmon, in the Berwyn Mountains, N. Wales. (Mus. Pract. Geology.)
13.	,,	,,	Probably same species, showing nodular rings to the axis. Caradoc Grits of Cressage, Shropshire. (Mus. Pract. Geology.)
14.	,,	,,	Coiled body (*a*), and tail (*b*), from Cader Dinmael, Denbighshire. (Mus. Pract. Geology.)
Figs. 15—17.	,,	*Brongniartii*, DESLONGSCHAMPS.	From the Lower Silurian pebbles, Budleigh Salterton, S. Devon. (Mr. Vicary's cabinet.) 15. Head, wanting the free cheeks. 16, *a*, *b*. Body ring; *a* shows the blunt end of the pleura, *b* the axal point. 16. Is an edge view of the ring. 17. Tail, with serrate edges.
Fig. 18.	.	— *sp.*	Same locality and cabinet. The last two are also figured in the Quart. Geol. Journ., vol. xx.

[1] Wrongly 2—10 at bottom of plate.

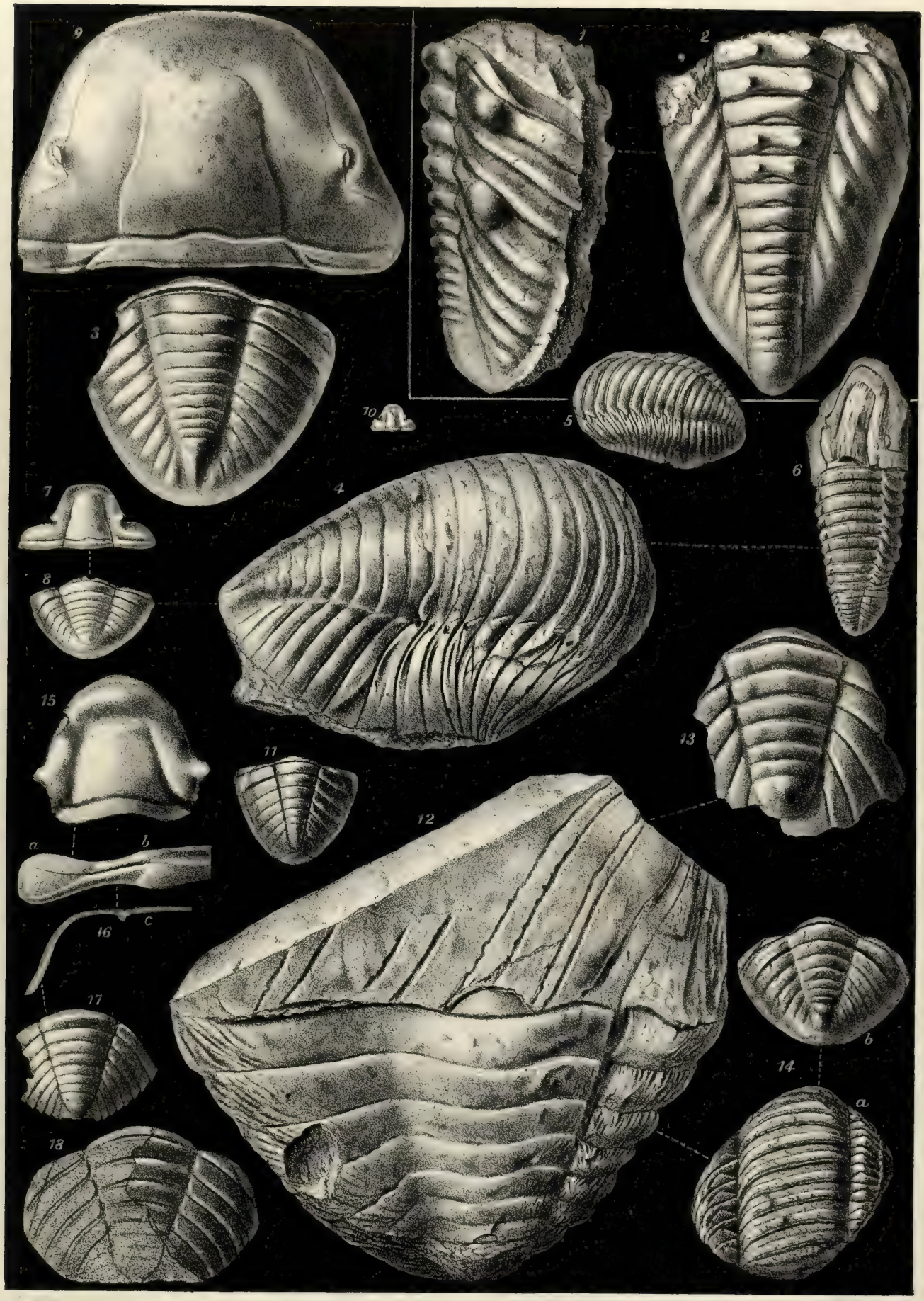

9
1
2
3
10
5
6
7
4
8
15
13
11
12
a
b
c
16
17
b
14
a
18

PLATE XI.

UPPER SILURIAN (WENLOCK).

Figs. 1—11.	*Homalonotus delphinocephalus*, GREEN.		
1.	,,	,,	From Dudley: the finest known. This is the specimen figured in the 'Silurian System,' and is in Mr. Blackwell's possession. 1 *a*. Is a side view of the same.
2.	,,	,,	A smaller specimen. (Mr. E. Hollier's collection.)
3.	,,	,,	A very young one. (Mr. Edgell's cabinet.) Invaluable, as showing the eyes. 3 *a*. The same, magnified. Fig. 6. The magnified eye. Dudley.
4.	,,	,,	Somewhat older, and also showing the lentiferous surface perfectly. (From the cabinet of Mr. E. Hollier, junr.)
5.	,,	,,	The angle of the cheek, with the squamate granules. (From Mr. Blackwell's specimen.)
6.	,,	,,	Eye and free cheek of fig. 3, magnified, to show the eye-lenses.
7.	,,	,,	Labrum, interior view. (Mr. E. Hollier, junr.)
8.	,,	,,	A thorax-ring, the fulcrum close to the puncta which mark out the axis.
9, 10.	,,	,,	Pleuræ enlarged, to show the squamate character of the granulation.
11.	,,	,,	Tail from large specimen. (E. Hollier, junr.)

All the above are from the Dudley Limestone.

Fig. 12. *Homalonotus cylindricus*, SALTER. See p. 116, figs. 27, 28 (woodcuts), for a more complete specimen. Woolhope Limestone, Woolhope. (Cabinet of Mr. H. Edgell.)

UPPER SILURIAN.

J. W. Salter & A. Gawan lith. W. Wr. imp.

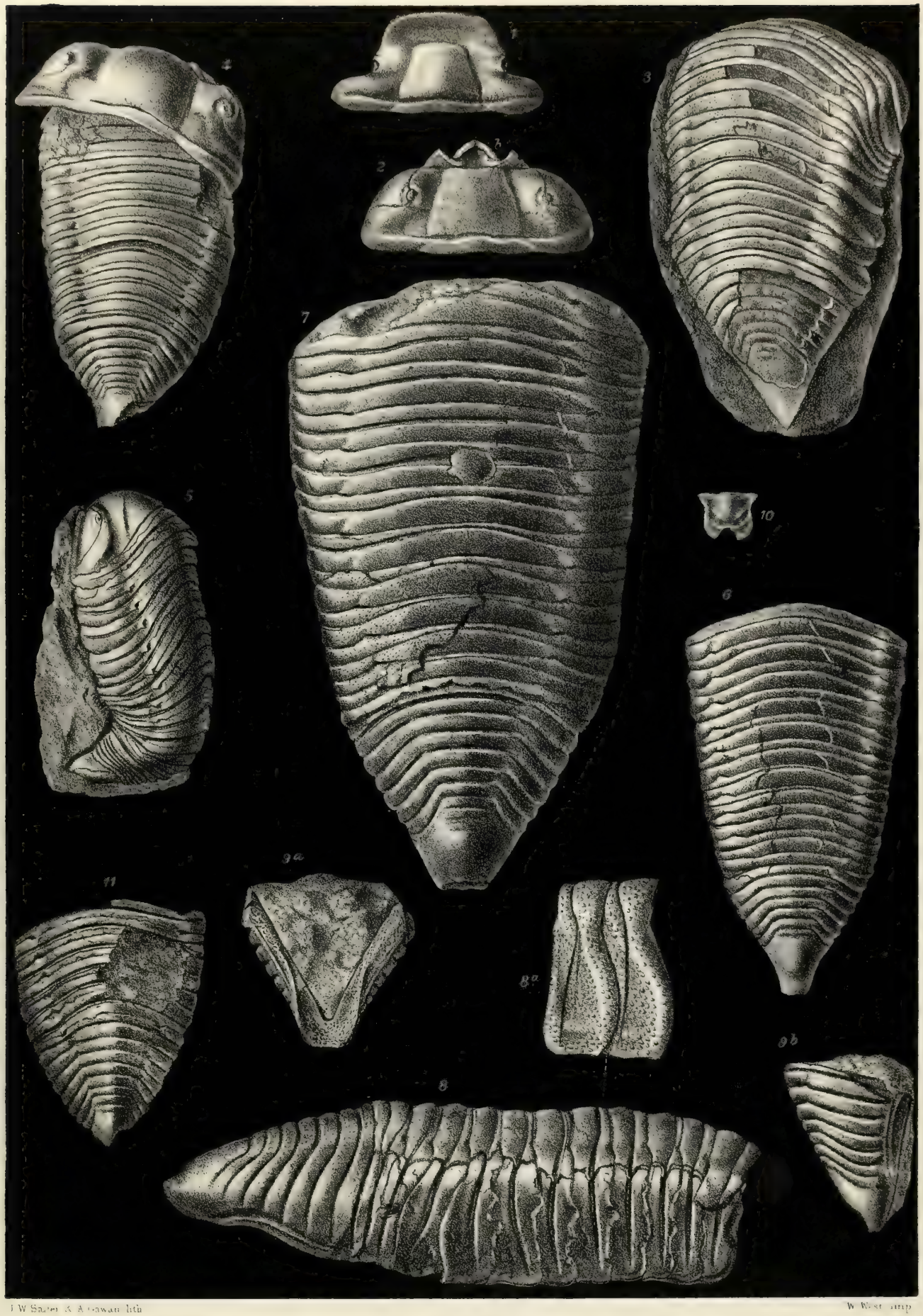
1. H. Homalonotus delphinocephalus. 1a. H. exhumatus.

PLATE XII.

UPPER SILURIAN (LUDLOW ROCK.)

Fig. 1.	*Homalonotus* (*Koenigia*) *ludensis*, SALTER, (not of 'Sil. System'). Nat. size. So far as known, a unique specimen. (Mr. Edgell's cabinet.)		
Figs. 2—10.	,,	*Knightii*, KOENIG.	
2.	,,	,,	Perfect head, showing the sinuated front; at *b*, the attachment for the labrum. (Mr. G. Cocking's collection.)
3.	,,	,,	Fine specimen, from Ludlow Museum, with the crust preserved (all the others are casts).
4.	,,	,,	Interior cast, showing the depressed spaces at the base of the cheeks.
5.	,,	,,	Half-coiled specimen, copied from the 'Silurian System.' Ludlow.
6.	,,	,,	Half-grown specimen, the original from which Dr. Koenig's figure in the 'Icones Sectiles' was taken. Probably from Radnorshire.
7.	,,	,,	The largest specimen known: from the Upper Ludlow Rock of Malvern. (Dr. Grindrod's cabinet.)
8, 8 *a*.	,,	,,	Side view of the same. 8 *a*. Two of the pleuræ magnified, to show the granules (not squamæ) in this species.
9.	,,	,,	Side view and underside of tail; showing the strong broad fascia, granulated and angularly bent along its middle. Ludlow. (Mr. Cocking's cabinet.)
10.	,,	,,	Labrum of an Upper Ludlow specimen. Ludlow Museum. (Mr. Edgell's cabinet.)
Fig. 11.	,,	*Johannis*, SALTER (see also Pl. XIII). Wenlock Rocks of Carmarthenshire. (Mus. Pract. Geology.)	

UPPER SILURIAN



J. W. Salter & A. Gawan lith. W. West imp.

1. *Homalonotus Iudensis*. 2. 10. *H. Knighti*. 11. *H. Johnsonii*.

PLATE XIII.

UPPER SILURIAN.

Figs. 1—7. *Homalonotus Johannis*, SALTER. A new species, from the Wenlock Shale of Usk. (Cabinet of Mr. John E. Lee, Caerleon.)

1. „ „ Largest head known, interior cast. The oval spaces at the base of the cheeks are well seen.
2. „ „ Showing the rostral shield, and the granular cheek-border—interior cast.
3. „ „ Imperfect body, and pointed tail, interior.
4. „ „ Exterior cast, in gutta-percha, of the body-rings.
5. „ „ The pleuræ from fig. 7, enlarged, to show the emarginate tips, and the spinose granules on the border.
6. „ „ Large but less perfect specimen. Same cabinet.
7. „ „ Most complete one known, showing the rostral shield, and the deep circumscription of the glabella and axis of the tail. The crust is preserved in part, and is magnified in fig. 5.

Fig. 8. „ *Knightii*, MURCHISON. The original specimen figured in the 'Silurian System.' (Mus. Geol. Society.)

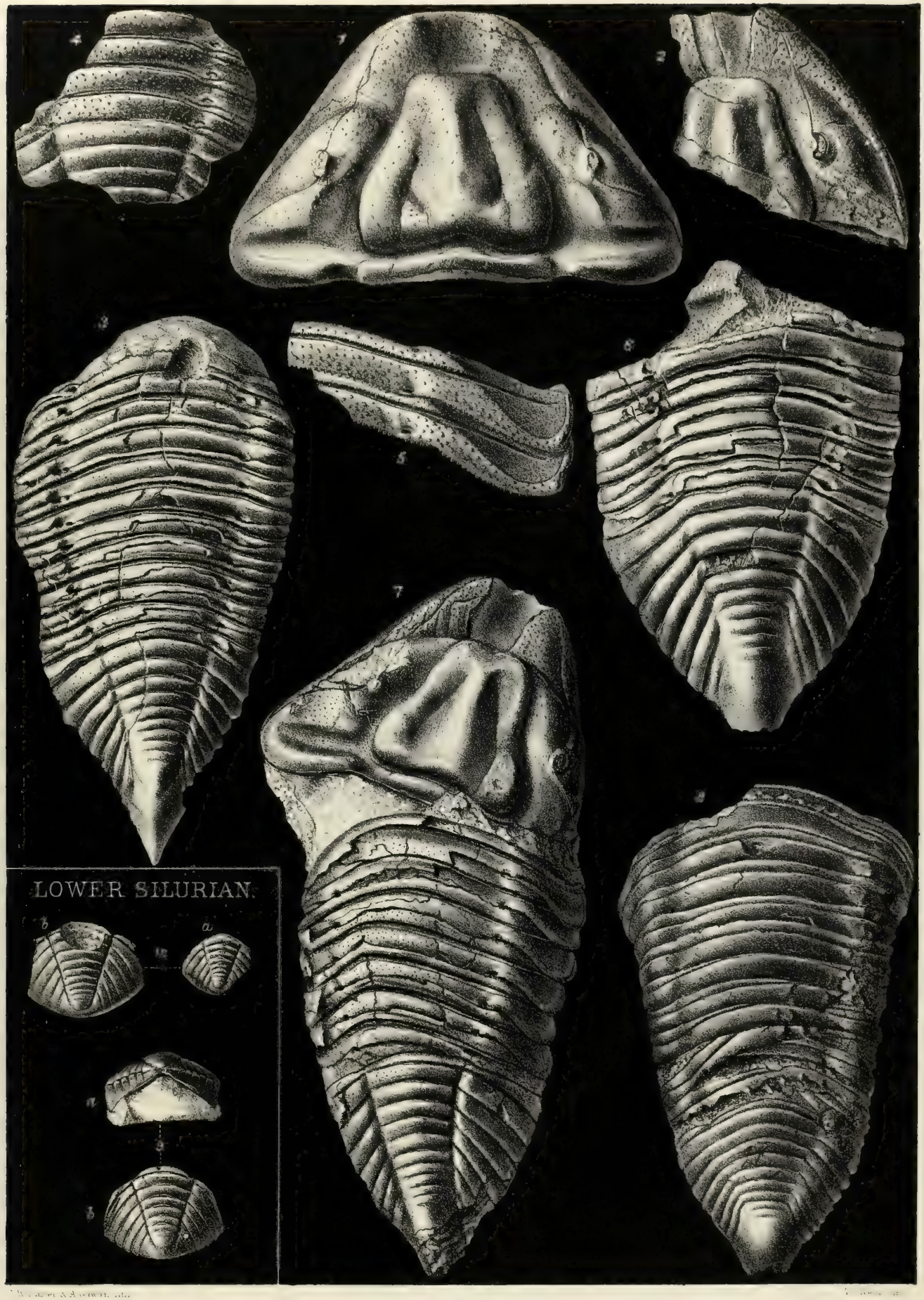
LOWER SILURIAN.

The following are from the Budleigh Salterton pebbles in Mr. Vicary's cabinet.

Fig. 9. *Homalonotus Brongniartii* (see Pl. X), showing the serrated border and vertical margin. Nat. size.

Fig. 10. „ *Vicaryi*, n. sp. 10 *a* (marked *H. Winwoodii* on plate). A small Budleigh specimen. [10 *b*. A Normandy specimen for illustration. Mus. Geol. Soc.]

All the figures except fig. 5 are of natural size.

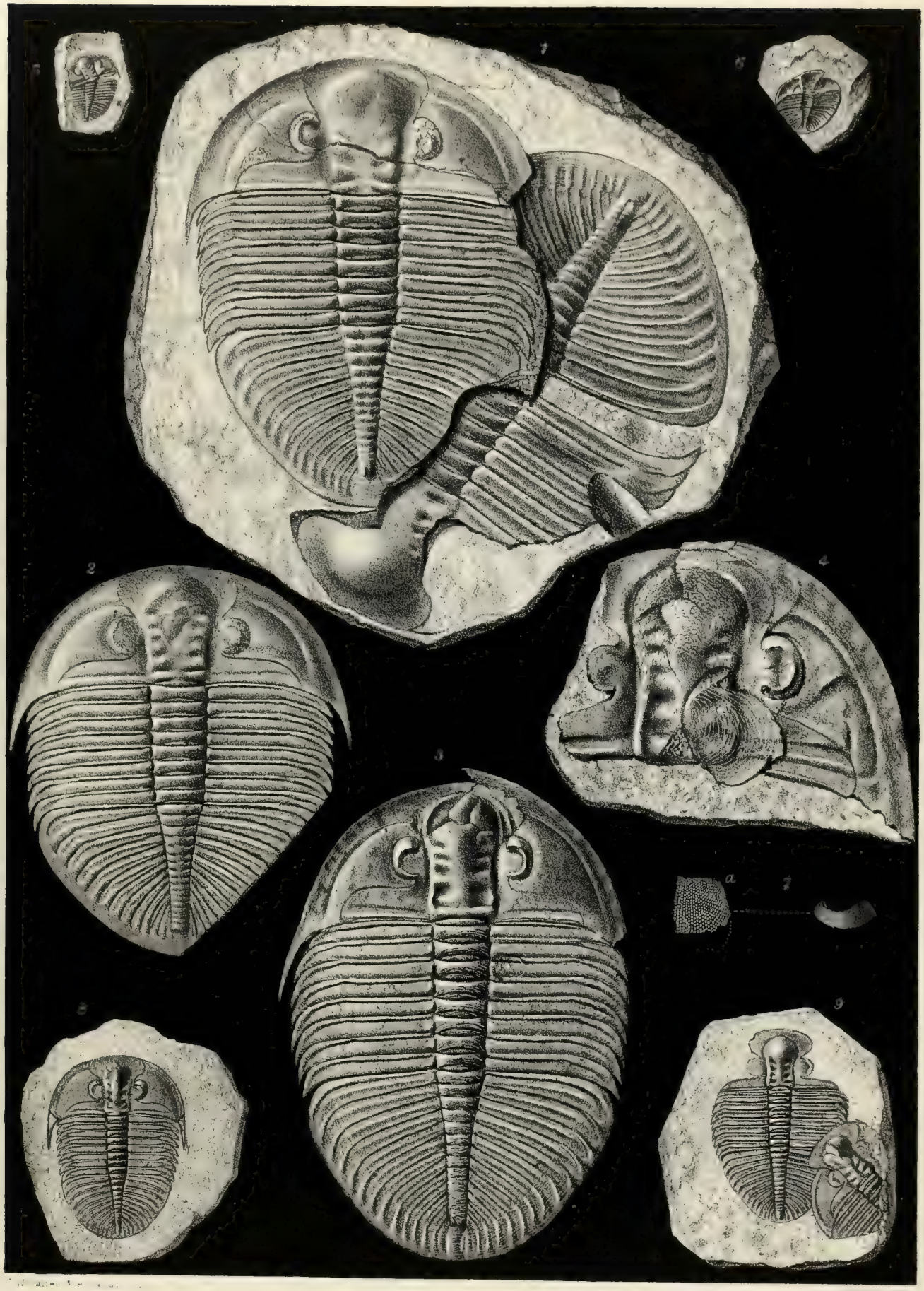


1 7 Homoraspis Johannis. 8 H Knightii 9 H Evangelinae
10 H Winwoodii

PLATE XIV.

LLANDEILO FLAGS.

Figs. 1—7.	*Ogygia Buchii*, Brongniart.		A series of fine specimens from Builth, in the cabinet of Mr. Griffith Davies, Cloudesley Street, Islington.
1.	,,	,,	Group of the female form, not fully grown.
2.	,,	,,	The same variety, or ♀ form.
3.	,,	,,	Large head of the ♂ form, showing the lineation of the surface, and the labrum shifted from its natural place.
4.	,,	,,	♂ form, not fully grown; the glabella-furrows strongly marked.
5.	,,	,,	Young specimen.
6.	,,	,,	Young specimen; the original of *Trinucleus asaphoides* figured in the 'Sil. System.'
7.	,,	,,	Eye, natural size. *a*. Lenses of the same, magnified.
Figs. 8, 9.	*Ogygia angustissima*, Salter.		From the same cabinet and locality.



1, 2 *Cryptolithus Bucklandi*

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLXV.

A MONOGRAPH

OF

BRITISH

DEVONIAN BRACHIOPODA.

BY

THOMAS DAVIDSON, F.R.S., F.G.S.,

ETC.

PART VI.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1864—1865.

A MONOGRAPH

OF

BRITISH

DEVONIAN BRACHIOPODA.

BY

THOMAS DAVIDSON, F.R.S., F.G.S.,

ETC.

PART VI.

SECOND PORTION.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1865.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

Var. ASPERA, *Schloth.* Pl. X, figs. 5—8.

TEREBRATULA ASPERA, *Schlotheim.* Leonhard's Taschenbuch, p. 74, tab. i, fig. 7, 1813; and Petrf., Part I, 263, Part II, 68, tab. xviii, fig. 3.

ATRYPA ASPERA, *Dalman.* Uppställring och Beskrifning af de i Sverige funne Terebratuliter; Kongl. Vetenskaps Academiens Handlingar für an 1827, p. 128, tab. iv, fig. 3.

TEREBRATULA ASPERA, *Def.* Dict. liii, p. 164, 1828.

— RETICULARIS, *Bronn* (in part). Index Palæontologicus, p. 1249, 1848.

ATRYPA SQUAMOSA, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. lvii, fig. 1.

TEREBRATULA (ATRYPA) ASPERA, *Phillips.* Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 81, pl. xxxiii, fig. 114, 1841.

SPIRIFERINA RETICULARIS, var. ASPERA, *M'Coy.* British Palæozoic Fossils, p. 379.

Although I quite admit with Prof. Phillips that the distinctiveness of some specimens of this shell, even of equal size when compared to typical ones of *A. reticularis* or *prisca,* is great, still as the difference, which consists in the paucity of ribs in extreme forms of *Aspera,* and the many smaller ones in *Reticularis,* is not a persistent character, to the generality of specimens of both, each extreme being connected and linked together by every gradation in shape and number of ribs, I dare not venture to look upon *A. aspera* as more than a well-marked variety of *A. reticularis.* This view has also been taken by Bronn, M'Coy, and several other palæontologists. *A. aspera* is always found in the same beds and localities where *A. reticularis* occurs and abounds, and possesses similar external shapes.

The only difference or character I can perceive by which this variety may be distinguished is when its ribs are few in number, and consequently proportionably larger, the concentric laminæ being in such specimens wider apart, but similar in character to those of *A. reticularis.* Schlotheim's original figure of *A. aspera* is just one of those intermediate links connecting the two, while those given by Phillips are extreme conditions of the shell under description. Phillips describes *A. aspera* as "generally wider than long, lenticular, with slightly prominent beak, minutely perforated below" (the foramen being almost surrounded by a well defined deltidium, a small flattened space usually intervening between the beak-ridges and the hinge-line, which distinguishes it again a little from *A. reticularis,* although I have seen some specimens of the Linnæan shell showing the same character), "front raised in a gentle curve, surface radiated with from twelve to twenty broad rounded ribs" (which increase in number at variable distances from the beaks, as in *A. reticularis*) "crossed by projecting concentric fringed laminæ of growth."[1]

[1] When describing *Spiriferina reticularis,* var. *β aspera* (Schloth. sp.), Prof. M'Coy observes: "This variety, which is at first sight so extremely different from the ordinary Silurian type, by its few very

Localities.—The same as those already given for *A. reticularis*, and in addition to which Prof. M'Coy adds Pridmouth, Menabilly, and Fowey in Cornwall, but from these places I have not seen specimens.

ATRYPA DESQUAMATA, *Sow.* Pl. X, figs. 9—13; Pl. XI, figs. 1—9.

ATRYPA DESQUAMATA, *Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. lvi, figs. 19, 20.
— — var. *compressa.* Ibid., figs. 21, 22.
SPIRIGERINA DESQUAMATA, *M'Coy.* British Pal. Foss., p. 378, 1852.
ATRYPA — *Murchison.* Siluria, 2nd ed., p. 298, fig. 5, 1859.

Spec. Char. Shell of a transverse oval shape, sometimes somewhat subquadrate, straight or rounded in front, or broadly raised at the edge of the ventral valve without elevating the surface of the opposite one. When young the shell is much compressed, with almost equally deep valves, but with age the ventral valve becomes uniformly convex, and even at times ventricose, especially along the middle, while the dorsal valve is convex, but less so than the opposite one, and slightly concave towards the front and lateral margins of the valve. The front margin of this valve forms an upward curve, while that of the dorsal valve is concave. Beak more or less produced and angular, but slightly incurved; foramen circular, close under the pointed beak, and completed or almost entirely surrounded by a wide deltidium in two pieces, and thus separated more or less from the hinge-line, a flattened space or false area existing between the beak-ridges and the hinge-line. Surface of both valves ornamented with numerous small rounded sub-equal radiating ribs, with interspaces of equal width, the ribs augmenting in number at variable distances from the beaks by the means of bifurcated or interpolated ribs. The surface is also traversed by numerous concentric lines or slightly projecting laminæ. Proportions variable, a large specimen measured 2 inches 7 lines in length, 2 inches 4 lines in width, and 1 inch 2 lines in depth; but the generality of specimens are smaller.

thick rounded ribs, with comparatively few branches, and distant, strong, concentric scales of growth, passes by the most insensible gradations into that species, when a large series either from the Eifel or Devon is examined. The most marked types of this peculiar form are nearly orbicular; the length and breadth equal; length about one inch, the depth half the length; the entering valve moderately convex along the middle, raised into a small rounded sinus at the margin, receiving valve slightly convex at the sides and near the beak, becoming depressed in the middle towards the margin; about sixteen thick, rounded, radiating ribs, two or three only of which dichotomise, (occupying a space of two lines at six lines from the beak, and the concentric laminæ nearly a line apart at the same distance). This highly typical form of the var. *aspera* is common in the Devonian limestone of Plymouth, and not uncommon in the Eifel; but with these in both localities occur specimens in which the depth in proportion to the length is $\frac{60}{100}$; the ridges become gradually smaller, more numerous, and more often branched, and the concentric laminæ of growth become more crowded, so that no character can be assigned, so far as my observations go, which would serve to separate specifically the intermediate varieties."

Obs. I am very uncertain whether *Atrypa desquamata* be really more than a variety of *A. reticularis,* but since Sowerby, Phillips, M'Coy, Salter, and several other palæontologists have considered it different, I have described it under a separate head. The chief difference consists in the beak of the shell under description possessing a well-marked area and exposed foraminal aperture, this last being usually concealed in *A. reticularis* from the great incurvation of the beak; it is also usually less ventricose than the Linnæan shell, and the concentric lines of growth or laminæ are obscurely marked on the greater number of specimens I have been able to examine; but this may be due to fossilization. Prof. Phillips states that "the analogy of this beautiful fossil to *Atrypa prisca* (*reticularis*) is considerable, but that the species are totally distinct." Prof. M'Coy observes likewise, that "by cautiously breaking a specimen in the right direction he had the pleasure of ascertaining the existence of the spiral appendages in this beautiful fossil, and to demontrate their spiral convolutions in the plane of the lateral margins, instead of at right angles thereto, as in different groups of Spirifera; that they are of rather small size, the diameter of the spires not exceeding half the width of the shell, so that they are not placed one behind the other, but each occupies its own side of the median line. The pallial vessels are large, composed of three or four main trunks on each side, branching once or twice to the margin."

Atrypa desquamata occurs abundantly in the Middle Devonian of Woolborough Quarry, Ogwell, Chircombe Bridge, &c.; at Barton, Lummaton, and Hope's Nose, near Torquay; in the Plymouth limestone, at Datington, near Totness, and in several other Devonshire localities.

ATRYPA FLABELLATA, *Goldf.* MS. Pl. XI, figs. 11, 12.

TEREBRATULA PRISCA, var. FLABELLATA, *Roemer.* Rheinisch. Uebergangsgeb. p. 66, pl. v, fig, 4, 1844.

— INSQUAMOSA, var. FLABELLATA (partim), *Schnur.* in Dunker und von Meyer's Palæontographica, p. 182, pl. xxiv, fig. 5, *c d e*, 1852.

Spec. Char. Shell ovate, sometimes circular; dorsal valve uniformly convex, deeper than the opposite one, at times ventricose. Ventral valve moderately convex; beak incurved, with a circular foramen placed under its angular extremity, and almost entirely surrounded by a deltidium, a flattened space or area existing between the beak-ridges and hinge-line. Surface of each valve ornamented with from eighteen to twenty-four rounded ribs, of which very few are due to bifurcation or interpolation. The surface is also marked by a small number of concentric lines of growth.

Length 13, width 11, depth 7 lines.

Obs. *Atrypa flabellata* of Goldfuss has been considered by Bronn and F. Roemer to

be nothing more than a variety of *Atrypa reticularis* or *prisca*, and they may probably be correct in the view they have taken of the matter. *A. flabellata*, as far as my observations go, would however differ from the Linnean form by the greater convexity of its dorsal valve, by its more simple ribs, indistinct concentric lines of growth, as well as by the shape of its beak and exposed foramen, but these are perhaps varietal differences only, and it may be desirable to consider them as such. While comparing the British specimens figured in our plate with another series from Gerolstein in the Eifel, which I had received some years ago from F. Roemer, I could perceive no difference in the larger number of specimens, although in one or two, being adult individuals, the dorsal valve was exceedingly ventricose, while the ventral one was convex. It may therefore be as well to provisionally retain the term *flabellata* for the shell under description.

A. flabellata occurs in the Middle Devonian limestone of Woolborough quarry, near Newton Abbot.

Family—RHYNCHONELLIDÆ.

Genus—Rhynchonella, *Fischer.*

Rhynchonella acuminata, *Martin* (sp.). Pl. XIII, figs. 1—4; 5 ?.

Conchyliolithus anomites acuminatus, *Martin.* Petrif. Derb., pl. xxxii, figs. 7, 8; and pl. xxxiii, figs. 5, 6, 1809.

Terebratula acuminata, *Phillips.* Pal. Foss. of Devon, &c., p. 88, pl. xxxv, fig. 159, 1841.

Hemithyris — *M'Coy.* British Palæozoic Fossils, p. 380, 1852.

Rhynchonella pugnus, *Sandberger* (not of *Martin*). Die Brachiopoden des Rheinischen Schichtensystems in Nassau, p. 42, pl. xxxiii, fig. 6, 1855.

This species being fully described at p. 93 of our Monograph of 'British Carboniferous Brachiopoda,' it will not be necessary to reproduce the details there given, and all we need now mention is that the species with its characteristic shapes occurs in the Middle Devonian limestone at Woolborough quarry, near Newton Abbot, as well as in that from the neighbourhood of Torquay, &c. *Rhynchonella acuminata* has also been found in beds of a similar age in Nassau, and in one or two other localities. The presence of this shell in the Devonian limestone of Devonshire has been recorded by Phillips, and admitted to be Devonian as well as Carboniferous by M. de Verneuil in his descriptions of the fossils in the older deposits of the Rhenish Provinces, p. 391. In addition to the above-named localities, Prof. M'Coy states that the shell is not uncommon in the Middle Devonian limestone of Plymouth, and that the *Atrypa triangularis* of Sowerby ('Geol. Trans.,' 2nd ser., vol. v, t. 54, fig. 9) is a synonym of the var. *Mesogonia*, " has the apex of the sinus

bifid, and traces of two minute lateral plaits, the form and other characters exactly as in the type var. *acuminata*, but the width less than an inch."

I cannot, however, offer an opinion concerning *A. triangularis*, not having been able to procure a sight of the original specimen, and since the figure is drawn in such a position as not to convey a sufficient idea of the real shape and character of the shell.

I have not yet been able to find specimens of *Rh. acuminata* in our British "Upper Devonian" strata, but it has been mentioned by Professor M'Coy as having been found, although rarely, in the slate of Petherwin (?).

RHYNCHONELLA LATICOSTA, *Phillips* (sp.). Pl. XIV, figs. 1—3.

TEREBRATULA LATICOSTA, *Phillips*. Pal. Foss. of Devon, &c., p. 85, pl. xxxiv, fig. 153, 1841.

Spec. Char. Shell transversely oval, wider than long; dorsal valve regularly convex, with about twenty-two large simple radiating ribs, which extend from the umbone to the margin; of these five or six compose a very slightly elevated, flattened fold. Ventral valve rather deeper than the opposite one, with a shallow sinus. The surface of this valve is ornamented with from twenty-one to twenty-three radiating ribs, which in both valves are crossed by numerous lines of growth; proportions variable; length 15, width 18 lines.

Obs. Although casts of this Rhynchonella are very abundant in grey impure Upper Devonian limestone at Baggy Point and in some other North Devon localities, not a single specimen could be found in anything like perfect condition, all the examples being more or less crushed and contorted, so much so, indeed, that it was difficult to determine the exact form, no specimen with the shell preserved having been discovered. Professor Phillips mentions that the resemblance of this fossil with Von Buch's figure and description of *Terebratula amphitoma* is very great, but that it differs in several particulars, and with which last statement I entirely coincide. It appears to resemble nearer to the Carboniferous *Rhynchonella Carringtoniana* than with any other species with which I am acquainted. Prof. Phillips' figured specimens are preserved in the Museum of the Geological Survey, and were obtained from Baggy Point.

RHYNCHONELLA PENGELLIANA, *Davidson*. Pl. XII, figs. 8, 9.

Flattened and otherwise distorted external impressions and internal casts of a very large Rhynchonella occur abundantly in an ochreous yellow friable sandy rock at Looe, in Cornwall. None of the specimens were, however, perfect enough to admit of a complete diagnostic description.

The shell appears to have been, when perfect, transversely oval, or wider than long;

and each valve was ornamented with from thirty-two to thirty-four large simple radiating ribs, of which eight or nine formed a slightly elevated mesial fold.

The dimensions of the most complete internal cast I have yet seen measured two inches four lines in length, by two inches eleven lines in width. It is larger than any other Devonian Rhynchonella with which I am at present acquainted, and approaches to *Rh. pleioplena* from the Oriskany Sandstone of the United States, but the ribs are not so large in this last as in the British species.

RHYNCHONELLA PLEURODON, *Phillips*. Pl. XIII, figs. 12, 13.

TEREBRATULA PLEURODON, *Phillips*. Geol. of York., vol. ii, p. 222, pl. xii, figs. 25—30 (but not 16), 1836.
— — Ibid. Pal. Foss. of Devon, &c., p. 86, pl. xxxv, fig. 155, 1841.
RHYNCHONELLA — *Dav*. Mon. British Carb. Brach., vol. ii, p. 101, pl. xxiii, figs. 1—15, &c.

This species having already been fully described in another portion of the present work, all we need mention is that the shell occurs in great abundance in the Marwood and Pilton "Upper Devonian" beds at Marwood, Baggy Point, Barnstaple, Braunton, &c., in North Devon, as well as in those of Petherwin and Landlake, in Cornwall. Some specimens have also been found in the Middle Devonian limestone of Woolborough quarry, near Newton Abbot.

RHYNCHONELLA RENIFORMIS, *Sowerby*. Pl. XIII, figs. 6, 7.

TEREBRATULA RENIFORMIS, *Sow*. Min. Con., pl. ccccxcvi, figs. 1—4, 1825.
— — *Phillips*. Pal. Foss. of Devon, &c., p. 88, pl. xxxv, fig. 157, 1841.
RHYNCHONELLA — *Dav*. Mon. Carb. Brach., p. 90, pl. xix, figs. 1—7.

A complete description of this species will be found in the second volume of the present work. I can discover no difference between the Carboniferous and the Devonian specimens. In Devonshire it occurs in the Middle Devonian limestone of Lummaton, near Torquay, as well as at Woolborough quarry, near Newton Abbot.

Terebratula subdentata, Phillips (Pal. Foss. of Devon, Pl. 35, fig. 164), is drawn from an imperfect specimen of what I take to be an example of *Rh. reniformis*. Professor Phillips states that Sowerby's figure of *Atrypa subdentata* represents a smaller specimen, but that he is not at all in doubt as to its identity with the one he has described and illustrated from the Upper Devonian of Petherwin. I have not, however, been able to

find Sowerby's original specimen, and feel somewhat uncertain as to the value of the species as well as of its identification.[1]

RHYNCHONELLA PUGNUS, *Martin.* Pl. XII, figs. 12—14, and Pl. XIII, figs. 8, 9, 10.

CONCHYLIOLITHUS ANOMITES PUGNUS, *Martin.* Petrificata Derbensia, tab. xxii, figs. 4, 5, 1805.
ATRYPA PUGNUS, *Sow.* Geol. Trans., 2nd ser., vol. v, pl. lvi, figs. 15—18.
TEREBRATULA PUGNUS, *Phillips.* Palæozoic Fossils of Devon, &c., p. 87, pl. xxxv, fig. 156, 1841.
— ANISODONTA, *Phillips.* Ibid., p. 86, pl. xxxiv, fig. 154, 1841.
RHYNCHONELLA PUGNUS, *Dav.* Mon. British Carb. Brach., p. 97, pl. xxii, figs. 1—15.

This well-known Carboniferous species has been fully described in the second volume of the present work. It occurs, but not abundantly, in the Upper Devonian limestone of Petherwin, and Landlake, in Cornwall, and in the Middle Devonian limestone of Woolborough quarry, near Newton Abbot; at Barton, near Torquay, and Plymouth, in Devonshire.

Rhyn. pugnus varies exceedingly in shape and character, both in the Carboniferous and Devonian formations, and among its varieties may, I think, be placed *Rhynchonella* (*Terebratula*) *anisodonta* of Phillips, which the author last named describes as "transversely elliptical, depressed; the front straight, the beak rather prominent. Front large and angularly raised to a straight mesial edge, deeply indented by six intervening narrow rounded ridges: sides rather reflected towards the deep valve, and very deeply and broadly notched by short acute bold ridges."

As is the case with the greater number of specimens of *Rh. pugnus*, the ribs become apparent only near the margin, and do not usually extend over what corresponds to the visceral portion of the shell; their number is also very variable in different specimens, those on the fold numbering three, four, five, and six in different examples.

Prof. Phillips states that, on comparing his specimens of *R. anisodonta* with some of the numerous and apparently distinct varieties of *Rh. pleurodon* alluded to in his work 'On the Geology of Yorkshire,' he finds it difficult to doubt their close affinity. I am, however, more disposed to consider their affinity to be much closer to *Rh. pugnus* than to *Rh. pleurodon*, considering that in this last-named species the ribs radiate from the beak and umbone to the margin, while in *Rh. anisodonta*, as in *Rh. pugnus*, they become apparent only in the proximity of the margin, the remainder of the shell being smooth. The var. *anisodonta* occurs along with true *Rh. pugnus* in the Middle Devonian limestone

[1] ATRYPA SUBDENTATA, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. liv, fig. 7.
"Orbicular, slightly convex, rather longer than wide, with a pointed three-plaited raised front: beak minute. Loc. Petherwin."

of Woolborough quarry, near Newton Abbot, as well as in the limestone of Barton and Lummaton, near Torquay. It has also been found at Dartington, near Totness and at Mount Wise, near Plymouth, &c.

RHYNCHONELLA TRILOBA, *Sowerby*. Pl. XII, figs. 1—7.

ATRYPA TRILOBA, *Sow*. Trans. Geol. Soc., 2nd ser., vol. v, pl. lvi, fig. 14.
— LATISSIMA, *Sow*. Ibid., pl. lvi, fig. 25 (not *T. latissima* of the Min. Con.).

Spec. Char. Tetrahedral, rather wider than long, with rounded angles; dorsal valve, when adult, very gibbous and trilobed, the median lobe forming an elevated mesial fold. Surface ornamented with numerous radiating ribs. Ventral valve convex, but much less so than the opposite one, with a very wide concave sinus: lateral margins sigmoid, front margin abruptly arched upwards into a sinus; beak small, and so much incurved as to conceal the foraminal aperture. Surface ornamented with numerous radiating angular ribs. Proportions very variable: two specimens measured—

Length	1 inch	9 lines,	width	2 inches,	depth,	1 inch	9 lines.
„	1	0	„	1 6 lines	„	0	8

Obs. This is an exceedingly variable shell, being at times and especially up to a certain age comparatively flattened, the trilobation of the valve being more often apparent with age. *Rh. triloba* therefore passes through the same kind of variation as has already been described in my 'Monograph of British Carboniferous Species,' with reference to *Rh. acuminata*, but with this difference, that the surface of *Rh. triloba* is always covered with radiating ribs, while these are the exception in *Rh. acuminata*. Some examples of the shell under description bear resemblance to the Jurassic *Rh. trilobata*, but are nevertheless specifically different. *Atrypa latissima*, Sowerby, from the Middle Devonian limestone, has the appearance of being nothing more than a compressed variation in shape of *Rh. triloba*, but is very different from *Rh. latissima* of the Cretaceous formation. *Rh. triloba* is a common shell in the Middle Devonian limestone of Woolborough quarry, near Newton Abbot. It occurs also at Barton, near Torquay; and at Plymouth, from whence Sowerby's figured specimens, now in the museum of the Geological Society, were obtained.

RHYNCHONELLA BIFERA, *Phillips*. Pl. XII, figs. 10, 11.

TEREBRATULA BIFERA, *Phillips*. Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 84, pl. xxxiv, fig. 151, 1841.

Spec. Char. Tetrahedral, wider than long: dorsal valve moderately convex and trilobed, the central lobe being formed by the mesial fold, which commences to become defined and moderately elevated towards the middle of the valve, and from whence it

extends to the front. Ventral valve moderately convex, with a wide deep sinus; beak acute, incurved, and showing under its angular extremity a small circular foramen surrounded by a deltidium. The surface of each valve is covered with numerous fine striæ, which bifurcate at various distances from the beak and umbone, and particularly so towards the margins, where from fifty to sixty may be counted. Proportions variable: two specimens measured—

Length 9, width $12\frac{1}{2}$, depth 4 lines.
„ 7, „ 8 „ $3\frac{1}{2}$

Obs. This species is well characterised, and occurs in the Middle Devonian limestone of Hope's Nose, near Torquay; Phillips's original example is preserved in the Museum of the Geological Survey.

RHYNCHONELLA CUBOIDES, *Sowerby*. Pl. XIII, fig. 17—21.

ATRYPA CUBOIDES, *Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. lvi, fig. 24.
— CRENULATA, *Sow.* Ibid., fig. 17.
— IMPLETA, *Sow.* Ibid., pl. lvii, fig. 2.
TEREBRATULA CUBOIDES, *De Kon.* Animaux Fossiles de Belgique, p. 285, tab. xix, fig. 3.
ATRYPA — *Phillips.* Palæozoic Fossils of Devon, &c., p. 84, pl. xxxiv, fig. 150, 1841.
TEREBRATULA — *A. Roemer.* Dei Versteinerungen des Harzgebirges, vol. v, fig. 2.
— — *Bronn.* Index Palæontologicus, p. 1233, 1848.
HEMITHYRIS — *M'Coy.* British Palæozoic Fossils, p. 381, 1852.
TEREBRATULA — *F. Roemer.* Rheinisch. Uebergangsgeb., p. 65, 1844.
— — *J. Steinenger.* Geog. Beschreibung der Eifel, p. 60, 1853.

Sp. Char. Subglobose, subcuboidal, wider than long; dorsal valve longitudinally very convex, but sloping rapidly on either side; mesial fold wide, more or less elevated. Ventral valve much less deep or convex than the opposite one; lateral margins slightly sigmoid, front margin much elevated, forming a wide shallow square or parallel-sided sinus; beak small, and so much incurved that the foraminal aperture is usually concealed: surface of both valves covered with numerous small radiating striæ or small ribs, which are split or grooved near the margin. Proportions very variable: two specimens measured—

Length 11, width $12\frac{1}{2}$, depth 10 lines.
„ 10, „ 11, „ 5

Obs. I quite coincide in the view taken by Professor Bronn, that *A. crenulata*, Sowerby, is nothing more than a synonym or variation in shape and age of *Rh. cuboides*, and am also imbued with the idea that *A. impleta* of the same author is also

another variation in shape, wherein the ribs are larger than in typical specimens of the species under description. The number of ribs is very variable in some specimens, as many as eighty may be counted round the margin, and of which twenty or twenty-two compose the mesial fold and sinus. Professor M'Coy observes, that "the margins are much sharper and more angular than in the Silurian *Rh. Wilsoni*, and the ribs simple; another difference is the small size at which the deflection of the margin begins in that species; there is no trace of it in the present one, which never acquires the great semi-cylindrical extension of the Silurian shell."

Rh. cuboides is a common Middle Devonian species, and occurs in the limestone of Woolborough quarry, near Newton Abbot; also in a yellow limestone at Ramsleugh quarry, near Ogwell; at Bradley, North Down; at Barton, Lummaton, and Hope's Nose, near Torquay. It is also common in the Plymouth limestone, from which the original examples of *Rh. crenulata* were obtained. On the Continent it occurs in the Eifel, &c.

RHYNCHONELLA SPHÆRICA, *Sow.* Pl. XIII, fig. 14.

ATRYPA SPHÆRICA, *Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. lvii, fig. 3, 1840.

The original example on which this species has been established is now in the Museum of the Geological Society; and, although described and figured by Sowerby as from the Devonian Limestone of Plymouth, has all the appearance of a *Silurian* specimen, which by some chance may have become mixed up with other Devonian shells while in the collection of the Rev. W. V. Hannah. Sowerby decribes his *A. sphærica* as "spherical or rather ovate, transverse, ventricose, plaited; ribs of the front deeply sinuated, with five elevated ribs; beak small, adpressed, rather wider than long. Loc. Plymouth." It is very doubtful whether this is in reality a British Devonian species.

RHYNCHONELLA PRIMIPILARIS, *von Buch.* Pl. XIV, figs. 4—6.

TEREBRATULA PRIMIPILARIS, *von Buch.* Ueber Terebrateln, p. 68, tab. xi, fig. 29, *a*, *b*, 1834.
ATRYPA PRIMIPILARIS, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. lvii, figs. 5, 6.
SPIRIFER PENTAGONUS, *Sow.* Encyclop. Metrop.
TEREBRATULA PRIMIPILARIS, *D'Archiac* et *de Verneuil.* Desc. of the Fossils of the Older Rhenish Provinces; Trans. Geol. Soc., 2nd series, vol. vi, p. 392, read May 1840.
— — *Schnur*, in Dunker und v. Meyer's Palæontographica, vol. ii, pl. xxvi, fig. 3.
— ANGULOSA, *Schnur.* Ibid., pl. xxv, fig. 5.

TEREBRATULA PARALLELIPIPEDA, *Bronn.* Leth. Geog., p. 71 (non *T. Wilsoni*, var.).
RHYNCHONELLA — *Sandberger.* Die Brachiopoden Rheinischen Schichtensystems in Nassau, p. 43, pl. xxxiii, fig. 12, 1852.

Spec. Char. Shell of a nearly equilateral pentagonal shape, wider than long; dorsal valve moderately convex and divided into three lobes of almost equal width; the central lobe forms a well-marked, elevated, mesial fold, but at a short distance from the margin the valve is suddenly bent down at right angles to meet the similarly bent margin of the opposite one. Ventral valve less convex than the opposite one, with a deep mesial sinus bounded by two angular ridges; beak prominent but small, much incurved, and exhibiting under its angular extremity a small circular foramen, surrounded by a deltidium. Surface of each valve covered with a great number of fine radiating striæ or ribs, which are split, or grooved, in their proximity to the margin.

Proportions very variable; a well-shaped specimen measured—length 8, width $9\frac{1}{2}$, depth $5\frac{1}{2}$ lines.

Obs. Some difference of opinion appears to exist with reference to the name this species should retain. Baron von Buch, Sowerby, and the generality of naturalists, have, since 1834, made use of the term *primipilaris* for the Eifel and English Devonian shell. At page 1247 of Bronn's 'Index Palæontologicus' we find *P. primipilaris*, v. Buch, considered a synonym of *T. marginalis*, Dalman; but on reading Von Buch's description of *T. primipilaris* I find that he distinctly refers his type to the limestone of Gerolstein, in the Eifel, and afterwards merely alludes to a specimen from Gothland, which in Schlotheim's collection, so named, bears some resemblance to the Devonian species. Schlotheim's is only a catalogue name, and consequently cannot claim priority over Von Buch's, since the last palæontologist has both figured and described his species, which Schlotheim has not done. I am therefore of opinion that the term *primipilaris* should be made use of in the sense proposed by Von Buch, Sowerby, and others. *Rh. primipilaris* is a very remarkable species, and so variable that several so-termed species have evidently been fabricated out of some of its variations in shape, and we will now allude to the principal ones which occur in Great Britain.

The typical form, that agreeing with Von Buch's figures (figs. 4, 5, 6, of our plate), has been already described; it is the prevalent and most characteristic shape assumed by the species. Next comes the—

RHYNCHONELLA (ATRYPA) IMPLEXA, *Sowerby.* Pl. XIV, figs. 7—10; *Atrypa implexa*, Sow., Trans. Geol. Soc., 2nd series, vol. v, Pl. lvii, fig. 4, and of which *Rhynchonella* (*Terebratula*) *compta* of Phillips, Pal. Foss. of Devon, at p. 89, pl. 35, fig. 161, is only a synonym, being a more elongated variety of the same form.

Sowerby describes his *Atrypa implexa* as "Obovate transversely plaited. Front

straight, flat; margin of the front and sides broad; the toothed edges of the valves deeply locked into each other; plaits numerous, acute."

Having obtained a great number of specimens of this small shell, and of the typical *Rh. primipilaris* from a single bed and quarry (Lammaton) near Torquay, I was enabled to trace every variation connecting the two. The characters brought forward in order to establish a distinction between the typical specimens of *Rh. implexa*, or *compta*, and *R. primipilaris* is the absence of any fold or sinus in the first-named shell; but this feature will not hold good in all specimens, since in some the tendency to the production of a fold and sinus is more or less evident; in fact, *Rh. implexa* appears to me to be a young condition of the full-grown *Rh. primipilaris*. *Rh. primipilaris*, and its varieties *Rh. implexa* and *compta*, occur plentifully in the Middle Devonian limestone of Barton, Lummaton, and Hope's Nose, near Torquay; of Dartington, near Totness; Woolborough quarry, near Newton Abbot, as well as those of Dock-yard and Mount Wise, near Plymouth, all in Devonshire. It is also a common species in the Eifel, and I have picked up a great number of examples of larger dimensions than any hitherto found in Great Britain, at Reffrath, near Cologne.

RHYNCHONELLA ANGULARIS, *Phillips*. Pl. XIV, figs. 11—13.

TEREBRATULA ANGULARIS, *Phillips*. Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 89, pl. xxxv, fig. 162, 1841.

Spec. Char. Shell small, pentagonal; valves moderately convex and almost equally deep; beak small, with a minute circular foramen under its angular extremity; surface of each valve ornamented with from ten to fifteen angular ribs, of which a few are due to bifurcation, while three or four in the dorsal valve compose a slightly produced, sharply margined mesial fold and shallow sinus, with projecting edges in the ventral one.

Proportions variable; length 3, width $3\frac{1}{2}$, depth 2 lines.

Obs. Some uncertainty may exist with reference to the specific claims of the shell under description, and which has been supposed by some palæontologists to be a young condition or variation of *Rh. primipilaris*. I will not assert that such a view might not prove correct, but must observe that the very few specimens of *Rh. angularis* I have been able to examine differed in several particulars from Von Buch's species, and therefore, for the present at least, have preferred to retain Phillips's denomination for the shell under description. In *Rh. primipilaris*, and its young state or variation *Rh. implexa*, the ribs are comparatively much more numerous and smaller; they are, also, in each valve bent suddenly downwards towards the margin, with a small longitudinal groove in the middle, while nothing of the kind could be noticed in the few examples of *Rh. angularis* that have fallen under my observation, and where the ribs are larger, of irregular width, few in number, and going straight to the margin without being bent. *Rhynchonella angularis*

has been found in the same beds and localities with *Rh. primipilaris;* Phillips's original term being preserved in the collection of Mr. Lee.

RHYNCHONELLA ? PROTRACTA, *Sow.* Pl. XIV, figs. 27, 28, 29.

ATRYPA PROTRACTA, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. lvi, fig. 16, 1840.
TEREBRATULA PROBOSCIDIALIS, *Phillips.* Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 84, 1841.

Spec. Char. Shell small, longitudinally oval; valves moderately convex, and smooth to within a short distance of the frontal and lateral margins, where a few small ribs originate, and extend to the margin; about four or six of these ornament a small fold and sinus, which become apparent only near the front, the remaining portions of the valves being uniformly convex; a dark line (indicating the presence of a longitudinal septum in the interior) is likewise observable along the centre of the dorsal valve, and which extends from the umbone to two thirds the length of the valve. The beak is of moderate size, much incurved, and showing under its angular extremity a small circular foramen surrounded by a deltidium. The ribs on the lateral portions of the valves are usually seven or eight on each side, and exist only near the margin. Proportions variable; two specimens measured—

Length $7\frac{1}{2}$, width 7, depth 5 lines.
„ 6, „ $5\frac{1}{2}$, „ 4 „

Obs. After having compared the original example of *Atrypa protracta*, Sowerby, now in the Museum of the Geological Society, with *Terebratula proboscidalis*, Phillips, of which the type forms part of the Museum of the Geological Survey, I arrived at the conclusion that they both belonged to a single species, but I felt some uncertainty whether the species should be referred to the genus *Rhynchonella* or *Camarophoria.* The specimens were not sufficiently perfect; or rather I could not examine the interior, whereby the genus could be satisfactorily determined.

Rhynchonella (?) *protracta* was discovered for the first time in the Middle Devonian limestone, at the north side of Stone House Hill, near Plymouth, and afterwards in that of Hope's Nose, near Torquay.

RHYNCHONELLA (?) OGWELLIENSIS, *Dav.* Pl. XIV, figs. 23—26.

Spec. Char. Shell small, pentagonal, valves moderately convex, with or without a more or less distinctly marked biplication or triplication at or close to the front; a small rib is likewise present in some specimens on each of the lateral portions of the valve close to the biplicated fold; beak incurved. Proportions variable: length 3, width 3, depth 2 lines.

Obs. This small shell is abundant in the Middle Devonian limestone of Ramsleugh quarry, near Ogwell, in Devonshire. It is exceedingly variable in shape, certain examples approaching in form to some varieties of Schlotheim's *Camarophoria globulina,* but two diverging lines departing from the extremity of the beak seem to indicate that the shell under description would belong to the genus Rhynchonella.

RHYNCHONELLA (?) LUMMATONIENSIS, *Dav.* Pl. XIV, figs. 14—18.

Spec. Char. Shell small, somewhat pentagonal, slightly transverse or as broad as long. Valves moderately convex; in the dorsal one a fold of moderate elevation, commencing at about the middle of the shell, extends to the front, while in the ventral one there exists a sinus of variable depth: beak small and incurved. Surface of both valves smooth from the umbone to about half the length of the valve, the remaining portion being ornamented with a variable number of small ribs, of which two, three, four, or five compose the fold; one, two, three, and four the sinus; on the lateral portions of the valve the number varies from two to four on each side, but are visible only in the vicinity of the margin. Proportions variable: two specimens measured—

Length $5\frac{1}{2}$, width 6, depth $4\frac{1}{2}$ lines.
„ 4, „ 4, „ 3.

Obs. This small species is common in the Middle Devonian limestone of Lummaton, near Torquay, and has been found by Mr. Champernowne at Dartington, near Totness. By its exterior shapes it nearly resembles *Camarophoria globulina,* so much so, indeed, that I was long uncertain whether it might not belong to that species, but after an attentive examination of many examples I could not detect in any of them, or of their internal casts, the peculiar features or characters of the genus Camarophoria; nor did any of them show a trace of the median line which is often seen through the transparency of the shell, and which, in the genus Camarophoria, extends from the extremity of the beak to about a third of the length of the valve, and indicates the presence of a central median septum. The larger number of specimens possess three or four small ribs in the fold, but this variability is common to the generality of species of the genus *Rhynchonella* as well as of *Camarophoria.*

Genus—CAMAROPHORIA, *King.*

CAMAROPHORIA RHOMBOIDEA, *Phillips* (? GLOBULINA var.). Pl. XIV, figs. 19—22.

TEREBRATULA RHOMBOIDEA, *Phillips.* Pal. Fossils of Cornwall, Devon, and West Somerset, p. 88, pl. xxxv, fig. 158, 1841.

Spec. Char. Sub-pentagonal, rather depressed; almost circular, transverse, or slightly elongated; surface smooth, dorsal valve rather deeper and more convex than the opposite one, with a mesial fold of moderate elevation, which, commencing at about the middle of the shell, extends to the front. This fold is either entirely smooth and evenly rounded, or divided near the front into two or three small ribs. The lateral portions of the valves are smooth, and usually without any rib. Dorsal valve moderately convex, the sinus being either entirely smooth or divided close to the front by one or two small ribs: beak small, incurved. Proportions variable: two specimens measured—

Length $7\frac{1}{2}$, width $7\frac{1}{2}$, depth 5 lines.
„ 6 „ 7 „ 4 „

Obs. I have not been able to examine the interior of this shell, but the single median line, which can be observed through the transparency of the shell, and which extends for a short distance along the back of the beak, leaves no doubt as to this species being a *Camarophoria*. It is the same as described and figured by Phillips under the designation of *Terebratula rhomboidea,* at p. 88 of his 'Palæozoic Fossils of Cornwall, Devon, &c.,' and this distinguished palæontologist is quite correct, I think, in stating that there appears no important difference between this Devonian shell and that so-named Yorkshire Carboniferous species.

In his 'Geology of Yorkshire,' Phillips's *Terebratula rhomboidea* is described as having no lateral plaits; and although this observation is correct for the greater number of specimens, it is not so for other examples, which possess two or three small ribs close to the margin on the lateral portions of the shell, as may be seen in one of Phillips's own typical examples, and in this last condition exactly resembles *Camarophoria globulina* of Schlotheim.

The Permian shell, it is true, does not attain (so far as my knowledge goes) a third of the size of the largest Carboniferous specimens, or a fourth or fifth of the Devonian examples; still, I cannot divest from my mind the intimate relationship which seems to exist between the shells in question from the three formations, and it appears to me probable or possible that the small Permian *C. globulina* is merely a small race derived in natural succession from the Devonian and Carboniferous species, which has been described by Phillips under the denomination of "*rhomboidea.*" It is also true that in the Permian *C. globulina* one or two small angular ribs are usually present near the margin on each of the lateral portions of the valve, while in general the lateral portions of the valves remain smooth and without ribs in the Devonian and Carboniferous types; but there are likewise specimens of the Permian shell which are similarly constructed, and it is therefore evident that neither the presence nor absence of these lateral ribs can be brought forward as an essential character of the species. However, as I may after all be mistaken in my judgment in this matter, and in consideration of the much larger dimensions of the Devonian shell, as well as of its exact similarity to Phillips's Carboniferous specimens, which do not show any lateral ribs, it may be best to retain (pro-

visionally at least) the distinctive denomination of *rhomboidea* until a large number of Devonian and Carboniferous specimens can be compared.

Camarophoria rhomboidea occurs in the Middle Devonian limestone at Barton and Lummaton, near Torquay; also in that of Woolborough, near Newton Abbot. On the Continent it has been found at Gerolstein, in the Eifel, and where it has attained even larger proportions than in Great Britain.

Genus—Pentamerus, *Sowerby.*

Pentamerus brevirostris, *Phillips* (sp.). Pl. XV, figs. 1—14.

Stringocephalus brevirostris, *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 80, pl. xxxii, fig. 143, 1841.

Terebratula (Atrypa) cassidea, *Phillips* (not of *Dalman*) ed. p. 83, pl. xxxiv, fig. 148, 1841.

Pentamerus brevirostris, *M'Coy.* British Palæozoic Fossils, p. 384, 1852.

— globus (*Bronn*, in Collect.), *Schnur*, in Palæontographica, vol. iii, p. 197, tab. xxxi, fig. 4.

— brevirostris, *Geinitz.* Grauwackenform. in Sachsen, vol. ii, p. 59, tab. xv, figs. 1-3.

— — *Sandberger.* Die Brachiopoden Rheinischen Schichtensystems in Nassau, p. 48, pl. xxxi, fig. 6, *b.*

— globus, *Sandberger.* Ibid., p. 48, pl. xxxiv, fig. 1.

Spec. Char. Very variable in shape; sub-orbicular, nearly circular, or broad-ovate, usually longer than wide, and more or less globose. Dorsal valve moderately and evenly convex, with or without a slight rounded mesial elevation, or more or less depressed along the middle in the shape of a sinus, which is either entirely smooth or marked with two or three longitudinal rounded ribs, which commencing at about the middle of the shell extend to the front. Ventral valve gibbous, evenly convex, or presenting a slightly elevated mesial fold ornamented with four or five longitudinal ribs. Beak obtuse, incurved; fissure triangular. In the interior of the ventral valve the dental plates converge and form a small trough-like chamber supported on a median septum, while in the dorsal valve there exists a long narrow trough-like process supported likewise by a single low septum. Two specimens measured—

Length 1 inch 11 lines, width 1 inch 7 lines, depth 1 inch 2 lines.
„ 1 „ 6 „ , „ 1 „ 7 „ , „ 1 „ 3 „ .

Obs. After having assembled and studied a great many specimens of the shell under description, I became convinced of its extreme variability as well as of the necessity of uniting under the single name of "*brevirostris*" several so-termed species which had been fabricated out of some of its variations in shape. Prof. M'Coy has shown that Phillips's

Stringocephalus brevirostris belonged to the genus Pentamerus, but one of the most remarkable features of this curious species is that, in certain individuals, both valves are almost equally and evenly convex (figs. 7, 10, 11), and in this shape they would constitute Phillips's so-termed *Ter. cassidea*, but not the species so named by Dalman. In some examples, such as in fig. 9, there exists a slightly raised mesial fold in the dorsal valve, but which in other examples is replaced by a depression or sinus of greater or lesser depth (figs. 1, 5, 6), and I believe that such examples as fig. 1 have been termed *Pent. globus* by Bronn and Sandberger. Another peculiarity consists in the presence or absence of longitudinal ribs in the sinus of the dorsal valve, or on the fold of the ventral one. The specimen fig. 5, for instance, has no ribs in either valve, while these are present in such specimens as fig. 4, and indeed, had space permitted, we could have given drawings of every stage or passage in shape uniting the extreme conditions above described.

Pentamerus brevirostris occurs plentifully in the Middle Devonian limestone of Woolborough quarry, near Newton Abbot; near Chircombe Bridge, West Ogwell, and Bradley, North Devon; Barton, Lummaton, and Hope's Nose, near Torquay; at Dartington, near Totness; and, according to Professor M'Coy, at Plymouth in Devonshire. On the Continent it has been found in the Eifel, and Nassau, also at Ferques in the Boulonnais, and in several other Devonian localities.

PENTAMERUS BIPLICATUS, *Schnur*. Pl. XIV, figs. 31, 32.

PENTAMERUS BIPLICATUS, *Schnur*. Programm der vereinigten höhern Bürger und Provinzial-Gewerbeschule zu Trier für das Schuljahr., p. 8, 1851; and in Dunker und von Meyer's Palæontographica, vol. iii, p. 196, pl. xxxi, fig. 3, 1853.

Spec. Char. Pentagonal, transverse or slightly elongated, globose. Dorsal valve evenly convex to within a short distance of the front, where a shallow sinus is produced with a small rib in its centre. Ventral valve deeper and more convex than the opposite one, with a short biplicated fold apparent only near the front; two or three short ribs exist also in some specimens close to the margin on each of the lateral portions of the valves. Beak incurved; fissure triangular, margins of the valves deeply sinuated and biplicated in front; proportions variable; two specimens measured—

Length $7\frac{1}{2}$, width $6\frac{1}{2}$, depth 7 lines.
„ 7, „ 8, „ 6 „

Obs. This species does not appear to have attained the dimensions of the preceding one, although some examples described by Professor Schnur from Prüm in the Eifel have exceeded by two or three lines the largest specimens hitherto observed in Great Britain; it is also easily distinguished from *P. brevirostris* by its general shape as well as by the biplication of its front and lateral ribs.

Pentamerus biplicatus occurs in the Middle Devonian limestone of Barton and Lummaton, near Torquay, and has been found by Mr. Champernowne in that of Dartington, near Totness.

Genus Davidsonia, *Bouchard*, 1849.

Davidsonia Verneuilii, *Bouchard.* Pl. XI, figs. 13, 16, and Pl. XV, fig. 18.

Thecidea prisca, *Goldfuss*, MS. Mus. of Bonn.
Leptæna? *De Verneuil.* Geol. of Russia and the Ural, vol. ii, p. 227, pl. xv, fig. 9; (mala), 1845.
Davidsonia Verneuilii, *Bouchard.* Ann. des Sc. Nat., 3e. sér., vol. xii, p. 92, pl. i, figs. 2 et 2a, 1849.
— — *De Koninck.* Note sur le Genre Davidsonia et sur le Genre Hypodema, Annales de la Société Roy. de Liége, vol. viii, p. 149, pl. i, figs. 1, *a* — 4, and pl. ii, fig. 1, *a*, *b*, 1852.
— — *Davidson.* Introduction, vol. i, p. 110, pl. viii, figs. 186—193, 1853.
— — *Schnur*, in W. Dunker und H. von Meyer's Palæontographica, vol. iii, p. 219, pl. xxxix, fig. 4, 1853.
— — *De Koninck.* Notice sur une Nouvelle Espèce de Davidsonia; Annales de la Soc. Roy. de Liége, 1855.
— — *Davidson.* Palæontological Notes; The Geologist, No. XI, pl. xii, fig. 33—34, Nov., 1858.

Spec. Char. Shell transversely oval, with thick unequal valves, fixed to marine objects by a portion of the surface of the back of the ventral valve, filling outward irregularities, but not reproducing them interiorly; the unattached portion of the ventral valve rises abruptly, especially in front; hinge-line straight, area more or less defined, and divided by a convex triangular pseudo-deltidium. Dorsal valve slightly convex; external surface smooth, and marked by concentric lines of growth, which extend uninterruptedly over the rudimentary area. In the interior of the ventral or attached valve, between and below the dental projections, are situated the muscular scars left by the adductor or occlusor muscle, and on either side of these are visible the larger impressions produced by the cardinal or divaricator muscles. In the interior of the dorsal or smaller valve, between the largely developed socket-walls and close to the hinge-line, a small cardinal process is observable, which served for the attachment of the cardinal or divaricator muscles, and under this, on the bottom of the valve, is seen the quadruple impression of the adductor or anterior and posterior occlusors. Proportions variable; the largest British example yet discovered measured—

Length 6, width 8 lines.

Obs. From the above it has been seen that we have two sets of muscles for the opening and closing of the valves. No trace of adjustor muscles could be ascertained, and these

may or may not have existed in those unforaminated species which were provided with a straight hinge-line, but I have observed imprints of adjustor muscles in those Strophomena-shaped species which were up to a certain age provided with a foraminal aperture for the passage of a pedicle, as in *Strophomena analoga*, &c. The most important character of *Davidsonia* resides in the greater portion of the interior of the ventral valve being occupied by two conical elevations projecting more or less beyond the level of the valve, the lateral and frontal portions of these exhibiting five or six semicircular or spiral projecting ridges, which diminish in surface and width as they approach the summit of the cone. In the interior of the smaller valve Prof. de Koninck found two conical hollows which correspond with the cones of the attached valve, and were separated by a rounded mesial ridge.

Various interpretations have been advanced as to the use of these cones, but the most probable one was that they were produced by the mantle, which, pressing on the spiral arms, retained some impressions of their coils, which were transmitted to the shell it was secreting. This view was expressed in the English, French, and German editions of my General Introduction, but I then supposed that the spiral arms were free and unsupported, as in *Productus*, *Strophalosia*, &c.; since that period Prof. de Koninck has discovered two spiral lamellæ, which were fixed to the socket-margins of the smaller valve, and formed a few vertical convolutions towards the bottom of the valve, having a somewhat similar appearance to what we perceive in *Atrypa*, only the two spirals in *Davidsonia* were not so closely adpressed as in Dalman's genus.[1] The first British example of this genus and species was noticed by myself adhering to a valve of *Atrypa aspera* in the Jermyn Street Museum, and which had been collected many years ago by Mr. Godwin-Austen in the Middle Devonian limestone of the neighbourhood of Newton Abbot. Subsequently, a much larger specimen, attached to *Stringocephalus Burtini*, was found by Mr. Vicary in Woolborough quarry, and another by Mr. Champernowne at Dartington, near Totness, Devonshire, where also it occurs attached to corals, &c. On the Continent the shell is very common in the horizon characterized by *Calceola sandalina*, or Middle Devonian limestone of the Eifel. It occurs also at Chimay in Belgium.

[1] These observations were published by myself in the XIth number of the 'Geologist' for November, 1858, and subsequently translated and published by Prof. de Koninck in the 'Transactions of the Royal Society of Liége, in Belgium, for 1859.'

Genus Strophomena, *Rafinesque.*

Strophomena rhomboidalis, *Wahlenberg*, var. analoga, *Phillips.* Pl. XV, figs. 15—17.

Producta analoga, *Phillips*, in The Geol. of Yorkshire, vol. ii, pl. vii, fig. 10.
Leptæna — *Phillips.* Palæozoic Fossils of Cornwall, Devon, and West Somerset, p. 56, pl. xxiv, fig. 93, 1841.
— nodulosa, Ibid., pl. xxiv, fig. 94.
— rugosa, Ibid., pl. xxiv, fig. 95.
— analoga et rugosa, *Sow.* Trans. Geol. Soc., 2nd series, vol. v, pl. lvi, figs. 1 and 2.
— — *M'Coy.* British Pal. Foss., p. 389, 1852.
— depressa, *Schnur*, in Dunker und v. Meyer's Palæontographica, vol. iii, pl. xlii, fig. 3, and pl. xlv, fig. 2, 1853.
— — *Sandberger.* Die Brachiopoden Rheinischen Schichtensystems in Nassau, pl. xxxiv, fig. 9, 1855.
Strophomena rhomboidalis, var. analoga, *Dav.* British Carboniferous Brachiopoda, p. 119, pl. xxviii, figs. 1—13.

This important recurrent form has been fully described at p. 119—123 of my 'Monograph of British Carboniferous Brachiopoda,' and is again alluded to by myself at p. 427 of Sir Charles Lyell's valuable work on the 'Geological Evidences of the Antiquity of Man' (1863). We will, therefore, merely mention that it is a common fossil, in the state of casts, in the *Upper Devonian* grits of Marwood, Braunton, Barnstaple, &c., in Devonshire, as well as in a coarse gray limestone at Hagginton Hill, near Ilfracombe. It occurs also in the *Middle Devonian* limestone of Barton, Lummaton, and Hope's Nose, near Torquay; at Dartington and Black Hall, near Totness; Roster Bridge, near Harberton Ford; Woolborough quarry, near Newton Abbot, Plymouth, &c.

On the Continent it occurs in the Eifel, Nassau, &c., and in many other European and American "Devonian" districts.

Genus Streptorhynchus, *King.*

Streptorhynchus umbraculum, *Schlot.* Pl. XVI, fig. 6; and Pl. XVIII, figs. 1—5.

Terebratulites umbraculum, *Schlotheim.* Die Petrefactenkunde, &c., p. 256, 1820. (for figure and reference); Hüpsch., Naturgesch., vol. i, p. 12, tab. i, figs. 1, 2, 1781.
Orthis umbraculum, *Buch.* Ueber Delthyris oder Spirifer und Orthis. Akad. der Wiessenschaften, p. 69, pl. i, fig. 5, 1837.

SPIRIFER ? CRENISTRIA, *Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. lvii, fig. 7 (read in 1840).

ORTHIS TENUISTRIATA, *Sowerby.* Trans. Geol. Soc., 2nd series, vol. v, pl. lvii, fig. 12, 1840.

— UMBRACULUM, *De Vern.* Bull. Soc. Géol. de France, vol. xi, p. 253, 1840.

— — *De Vern.* et *D'Archiac.* Trans. Geol. Soc., 2nd series, vol. vi, p. 396, 1841.

SPIRIFER (?) CRENISTRIA (?) *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 66, pl. xxvii, fig. 113, 1841.

ORTHIS CRENISTRIA, *De Verneuil* et *De Keyserling.* Russia and the Ural Mountains, vol. ii, p. 185, pl. xi, fig. 4, 1845; and De Keyserling, Petschoraland, p. 221, pl. vii, fig. 7.

— UMBRACULUM, *Bronn.* Index Pal., vol. ii, p. 861, 1848.

LEPTÆNA — *M'Coy.* British Pal. Foss., p. 388, 1852.

— — *Morris.* Catalogue of British Fossils, p. 137, 1845.

ORTHISINA CRENISTRIA, *Sandb.* Die Brach. des Rheinischen Schichtensystems in Nassau, p. 61, 1855.

Spec. Char. Variable in shape, but usually transversely semicircular; hinge-line straight, nearly equal or slightly exceeding the width of the shell; cardinal angles slightly rounded or somewhat prolonged, with acute terminations; area of the ventral valve variable in its width, but divided by a convex pseudo-deltidium; area of the dorsal valve linear. Dorsal valve moderately convex, with sometimes a small mesial depression. Ventral valve slightly convex, or so only near the beak, becoming gradually concave towards the margins, the greatest width of the shell being about the middle. Surface of both valves covered with numerous straight, radiating, slender, thread-like ribs, separated by slightly wider concave interspaces, in the centre of which a shorter and smaller rib begins at variable distances from the beaks, and extends to the front. The surface of the striæ are more or less coarsely and closely intersected with scale-like projections, while the interspaces are crossed by finer and more numerous transverse lines of growth. Proportions variable—

Length 1 inch 9 lines, width 3 inches 4 lines, depth 5 lines.

Obs. The interior details of the Devonian shell being similar to those of *Str. crenistria*, as described at p. 125 of my 'Monograph of British Carboniferous Brachiopoda,'[1] it will not be necessary to again repeat what has been already published. Much uncertainty has, however, been entertained and expressed by several distinguished palæontologists, with reference to the specific value of *Str. umbraculum* and *Str. crenistria*, which some would retain as separate species, but which others would combine under a single denomination; we will therefore enter upon some details, in order that the reader may be able to form his own opinion on a question which may, perhaps, still claim a verdict of "not proven."

In rocks of the Silurian age we find a shell with shapes and striation bearing resem-

[1] Figures of the interior of *Streptorhynchus Devonicus*, which agree in every particular with those of *St. umbraculum*, may be seen in p. 29 of my 'Monograph of British Permian Brachiopoda.'

blance to some variations in shape of the shell under description, and to which Linnæus applied the denomination of *Anomia pecten* ('Syst. Nat.,' 12th ed., p. 163, 1768); it is the same shell as was subsequently published by Wahlenberg, Dalman, Hisinger, myself, and others, under the same specific denomination, although some few authors have erroneously supposed that the *Anomia pecten* of Linnæus is specifically different from that subsequently so named by Dalman, Hisinger, and others.[1] Our present purpose is simply to notice the general resemblance of the Linnæan shell to some varieties of the Devonian and Carboniferous *Str. umbraculum* and *crenistria,* and to mention that hitherto, with but few exceptions, palæontologists have considered the Silurian *A. pecten* to be specifically distinct from the two species above recorded.

While describing the Carboniferous *Str. crenistria,* we enumerated a certain number of its synonyms, as well as of its variations in shape, and were able, I trust, to show that this variable shell had passed insensibly through every variation connecting the concavo-convex shapes with the bi-convex ones, and were also able to demonstrate how variable was the striation in different examples of the same species.

We will now consider the Devonian form which Prof. M'Coy states to be "distinguishable from *O. crenistria* by the greater convexity of the entering (dorsal) valve, with its slight mesial depression, also by the thicker, closer, and more equal striæ, the narrow spaces between which are either quite smooth or only marked by regular transverse lines of growth totally different from the deep, minute, irregular wrinkles of the Carboniferous species."

The first figure of the Devonian shell with which I am acquainted was that published by Hüpsch in 1711, but it was only in 1820 that the species received from Schlotheim the denomination of *umbraculum;* and therefore, should the Carboniferous and Devonian forms prove identical, Schlotheim's name would hold priority over that proposed by Phillips in 1836. Schlotheim considered his *Terebratulites umbraculum* to be distinct from the *Anomia pecten* of Linnæus, which also he describes at p. 255 of his 'Petrefactenkunde.'

In 1837 Baron von Buch figured and described Schlotheim's species under the denomination of *Orthis umbraculum*, and mentioned *Sp. crenistria* as a synonym; he also stated

[1] At p. 125 of Hanley's 'Ipsa Linnæi Conchylia' (1855), Mr. Sharpe has stated, "The only specimen in the Linnæan collection which at all answers to the description is the *Strophomena* (*Orthis*) *pecten* (Dalman, Vet. Act. Hand., 1827, pl. i, fig. 6—Hising. Lethæa Suec., pl. xx, fig. 6) is still preserved in the box so marked in the cabinet. Dalman's figures and description prove that the Swedish naturalists have kept up the knowledge of the species. The shell to which Sowerby has given the name of *Orthis pecten* (Sil. Syst., p. 21, fig. 9) is very different, and may be readily distinguished by its finer and more numerous striæ and by its greater length. *O. expansa* of Sow. (Sil. Syst., pl. xx, fig. 4), appears to be the cast of the same shell, and consequently may be retained for the Sowerbian shell." In p. 251, fig. 3, of the 2nd ed. of Sir R. Murchison's 'Siluria,' a good figure of the true *Anomia pecten* of Linnæus may be seen.

that the shell had been found in the Devonian rocks of Gerolstein in the Eifel, as well as in the Carboniferous limestone of Bolland, in Yorkshire; while *O. pecten* he considers to be a distinct species. About the same period Sowerby published a description of the British Devonian form, under the designation of *Spirifera* (?) *crenistria* (Phillips), and adds, that his own *Sp. reticulata* ('Encyclop. Metrop.,' art. Geology) is a synonym.

In 1840 M. de Verneuil described *Orthis umbraculum*, from Ferques, and considered Phillips's *Sp. crenistria* a synonym. In 1841 the same author again, in the 'Trans. of the Geol. Soc. of London,' made use of the term *umbraculum* for the Devonian as well as for the Carboniferous shell, adding, at the same time, that *Strophomena pileopsis*, Rafinesque, must be numbered among the synonyms of *umbraculum*. In 1845 (at p. 188 of vol. ii, of the 'Geology of Russia') M. de Verneuil recalls his former statements, and is of opinion that the Carboniferous and Devonian shells may be distinct, and he therefore adopts both Schlotheim's and Phillips's denomination, but adds, "Nevertheless, we must confess that it is not always an easy matter to distinguish these two species, especially when one has before one's eyes only figures and descriptions."

In 1841, while describing the fossils of Cornwall, Devon, and West Somerset, Professor Phillips applied the term *Spirifer* (?) *crenistria* to the Devonian shell, but interrogated at the same time whether it might not be the same as the *Orthis umbraculum* (?) of Von Buch.

In 1843, Portlock makes use of the name *Orthis umbraculum* for the Carboniferous species; and in the same year Professor L. de Koninck likewise adopts the term *umbraculum* for the Carboniferous shell; but at p. 655 of the Supplement to his 'Description des Animaux Fossiles de la Belgique,' published in 1851, he recalls his former statement, and expresses the opinion that *O. crenistria*, Phillips, is distinct from *O. umbraculum* of the Devonian period, adding at the same time that the two species are very well distinguished by the shape of their areas, and by that of their ornaments.

In 1848, in his Index Palæontologicus, Bronn considers *O. umbraculum*, *O. crenistria*, and *O. pecten* (Dalman) to be distinct species, with the following synonyma—

1. ORTHIS UMBRACULUM, *Buch* = *An. pecten*, Linn. Syst., xiii, 1152 = *Stroph. pileopsis*, Raf.
2. — CRENISTRIA, *Phil.* = *Sp. senilis*, Phil = *Orthis umbraculum*, var. *senilis*, De Kon = ? *Sp. reticulata*, J. Sow., Geol. Trans.
3. — PECTEN, *Dalman* (not *A. pecten*, Lin.) = *An. pecten*, Wahlb., Schlotheim, &c.

From the above it is evident that Bronn was not well acquainted with the *An. pecten* of Linnæus, which is the same as that subsequently described and figured by Dalman. His synonyma are also, in other respects, defective.

In 1853, Professor Schnur makes use of the term *Orthis umbraculum* for the Devonian form.

In 1854, at p. 137 of his 'Catalogue of British Fossils,' Professor Morris adopts—

1. *Str. arachnoidea*, Phil. = *sub-arachnoidea*, Vern. 2. *Str. crenistria*, Phil. = *O. pecten*, M'Coy. 3. *Str. senilis*, Phil. = *O. umbraculum*, De Kon. 4. *Str. Sharpei*, = *O. umbraculum*, Portlock. 5. *Str. umbraculum*, Schloth., as distinct species; but I cannot myself admit so great a number, and it must remain a question for further research, whether even two of these (*Str. umbraculum* and *Str. crenistria*) may be retained as distinct species.

In 1855, Dr. Sandberger (in his work on the Devonian Fossils of Nassau) makes use of the designation *Orthisina crenistria* for the Devonian as well as the Carboniferous shell.

From the above, and from several other authors' statements, it will be seen that some palæontologists have considered *Str. crenistria* a synonym of *Str. umbraculum*, while others would retain the two as distinct species; and it was while labouring under this uncertainty that in my description of the Carboniferous form I made use of the designation *crenistria*, and am still undecided whether the Devonian form is in reality a distinct species. *Str. umbraculum*, as found in the Devonian rocks, is very variable in its shapes, just as is the case with the Carboniferous *Strept. crenistria*. It has been affirmed by some palæontologists that in *Str. umbraculum* the shell is always concavo-convex, while the ventral one is slightly concave near the margin in all fully developed or adult individuals, and that on both valves the striæ are strongly indented; the area always regular and narrow; and it was subsequently proposed by MM. A. D'Orbigny, Bouchard, and others, to distinguish, by the designation of *Strep. Devonicus*,[1] those bi-convex specimens, which are, on the contrary, very inconstant in their external form, both valves being convex, their striæ smooth and not strongly marked, while the area assumes every kind of shape, both in height and width, being often irregularly twisted, and wider than long on one side than on the other; the beak curved backwards or inclined to one or to the other side, while nothing appears regular in the shell. *Str. Devonicus* occurs in the Upper Devonian limestone of Ferques, in France, but has by some palæontologists been considered a mere variety of the shell under description, and which they have at times designated by the name of *Orthis umbraculum*, var. *senilis*.

The minute examination I made of a multitude of specimens of *Str. crenistria* and *Str. senilis* led me to the conclusion that both forms passed by insensible gradation into one another, and consequently belonged to a single species; a view subsequently corroborated by several local observers who had been able to study *in sitû* a great many specimens derived from the same bed and locality; but not having been able to assemble a sufficient number of examples of the Devonian *Str. umbraculum* and *Devonicus*, I cannot give out any positive opinion as to their distinctiveness, or to assert that they are mere varieties of a single species.

A great difference is also observable in the respective number and strength of the striæ

[1] *Leptæna Devonica*, d'Orb. Prodrome, vol. i, p. 90, 1849 = *Orthis crenistria*, var. *Devonica*, &c., Keyserling. Geognost Beobacht, p. 221, pl. vii, fig. 7, 1849. Russie Septentrionale, Ishma; France, Ferques.

in different examples of *Str. umbraculum*, as well as of the Carboniferous *Str. crenistria*. In some specimens the intermediate space between each of the two larger ribs is partly occupied by a smaller rib, which, commencing to appear at variable distances from the beaks, extend to the front; while in other examples the intervening ribs are irregular in their respective widths, and can hardly be distinguished from the principal ones.

It appears to be very difficult to obtain from our British Devonian rocks specimens of *Str. umbraculum* with the shell-surface perfectly preserved; but when so, and as is often visible on those from the Eifel, the ribs are ornamented, as we have already described, while the intervening spaces are more or less finely transversely striated; but when the outer shell-surface has not been preserved, the ribs and the interspaces appear smooth.

In our Upper Devonian rocks of North Devon we unfortunately meet with but impressions and internal casts, and these certainly appear undistinguishable from similar Carboniferous casts and impressions of *Strept. crenistria* and its variety *arachnoideus;* and it is only in the Middle Devonian limestones of Lummaton and Hope's Nose, near Torquay; East Ogwell, and Woolborough quarry, near Newton Abbot; or in the neighbourhood, that we occasionally meet with specimens sufficiently perfect to be identified with *Strept. umbraculum* of the Eifel.

The so-termed *Orthis tenuistriata*, Sowerby, pl. XIX, fig. 3, was established on a single specimen from Moreback, now in the collection of the Geological Society, and which, to my eye, has all the appearance of a small individual of *Str. umbraculum*. In shape it is semicircular, with a straight hinge-line equal to the width of the shell. The dorsal valve is convex, while the ventral one is slightly so only at the beak, becoming afterwards flattened and slightly concave at the margins. The surface of the valves is striated in the manner we have described for *Str. umbraculum*. The area in the specimen is obscured by matrix.

STREPTORHYNCHUS CRENISTRIA, et var. ARACHNOIDEUS, *Phillips*. Pl. XVIII, figs. 4 and 7.

SPIRIFERA CRENISTRIA, *Phillips*. Geology of Yorkshire, vol. ii, p. 216, pl. 9, fig. 6, 1836.

STREPTORHYNCHUS — *Dav*. Mon. Brit. Carb. Brach., p. 125, pl. xxvi, figs. 1—6, pl. xxvii, figs. 1—5, and pl. xxx, figs. 14—16, 1861.

SPIRIFERA ARACHNOIDEA, *Phillips*. Geology of Yorkshire, vol. ii, p. 220, pl. 11, fig. 4, 1836.

As already observed, casts and impressions agreeing with the Carboniferous form occur plentifully in the Upper Devonian grits of many localities in North Devon, as well as of Cornwall, such as at Braunton; Upscott, parish of Pilton; the neighbourhood of Barnstaple, and in Middle Devonian at Ilfracombe, &c.

In these same North Devon grits occur many undeterminable casts and impressions, out of which several so-termed species have been proposed, but some of these are evidently referable to *Str. crenistria* or *Str. umbraculum;* but as I cannot venture to express any decided opinion from such imperfect material, I will content myself by simply recording their presence, and reproducing the original figures published by their respective makers.

A. Strept.? compressus, *Phillips.* Pl. XVIII, figs. 7, 8, 9.
Orthis compressa, *Phillips.* Pal. Foss., p. 66, pl. xxv, fig. 112—*a, b, c, d, e, f,* 1841.

The imperfect and incomplete casts and impressions referred by Phillips to *O. compressa,* Sowerby ('Sil. Syst.,' pl. xxii, fig. 12), appear referable to two distinct species, but in no case to *O. compressa* of the 'Silurian System.' Phillips's fig. 112 *a* (fig. 8 of my Plate) may perhaps belong to *Chonetes Hardrensis,* while some of the others, and in particular his fig. 112 *e* (fig. 7 of my Plate) (of which the original example is in the collection of the Geological Society), is evidently a cast of *Strept. crenistria.* The so-termed *O. compressa,* Phillips, will therefore have to be erased from the list of British Devonian species.

B. Strept. calcar, *Phillips.* Pl. XVII, fig. 11.
Orthis calcar, *Phillips.* Pal. Foss., p. 230, pl. lviii, fig. 112** (upper figure), 1841.

This looks like the cast of a young specimen of *Str. crenistria. Loc.* Upper Devonian. Pilton.

C. Strept.? semicircularis, *Phillips.* Pl. XVIII, fig. 10.
Orthis — *Phillips.* Pal. Foss., p. 65, pl. lviii, fig. 112* (lower figure), 1841.

This impression or internal cast is so very imperfect, that I cannot venture upon any positive identification or opinion. It is referred by Phillips to *Orthis semicircularis;* Sow. ('Sil. Syst.,' pl. xxi, fig. 7). Professor Phillips states to have found one specimen only at Pilton, in North Devon.

D. Strept.? plicata, *Sow.* Pl. XVIII, fig. 12.
Orthis — *Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. liii, fig. 10, 1840.

I am very uncertain with reference to this so-termed species, which is founded on one specimen of an obscure small internal cast of a single valve which Sowerby describes as "transversely elongated, depressed, plaited; plaits numerous, sharp; width twice the length. *Loc.* Barnstaple, North Devon." At page 64 of his 'Pal. Foss. of Devon,

&c.,' Professor Phillips redescribes and figures (pl. xxvi, fig. 108) what he takes to be Sowerby's so-termed species, but which appear to me (in part at least) to be small imperfect distorted casts or impressions of *Str. crenistria.*

STREPTORHYNCHUS GIGAS, *M'Coy* (sp.). Pl. XVI, figs. 1—3.

LEPTÆNA (STROPHOMENA) GIGAS, *M'Coy*. British Pal. Foss., pl. ii A, fig. 7, 1852.
? LEPTÆNA SPATHULATA, *F. Roemer*, in Dunker und v. Meyer's Palæontographica, vol. v, p. 98, pl. xv, fig. 2, 1852.

Spec. Char. Elongated, elliptical, truncated by a straight hinge-line, which is equal to the width of the shell. Ventral valve much depressed, and slightly convex near the margin. Surface radiated with very numerous fine, close, obtuse striæ, separated by numerous fine, finely punctured impressed lines, every fifth, seventh, or ninth of which seems larger than the rest; about sixteen striæ in two lines at an inch from the beak, fifteen in the same space at the margin three inches from the beak; cardinal area broad. Proportions variable.

Length $3\frac{1}{4}$ inches, width $2\frac{1}{2}$ inches.

Obs. Of this large species (?) I have seen several internal casts of the ventral valve from the Devonian shales or brown grits of Looe and Polruan, in Cornwall, and from whence the specimen showing traces of the shell-surface or sculpture was described and figured by M'Coy. Internal casts of the ventral valve in Mr. Pengelly's collection show two large pyriform muscular scars (in relief on the cast), which are due to the divaricator, and perhaps ventral adjustors of Hancock, while in the centre between these large scars may be seen an elongated oval one referable to the adductor or occlusor muscle. Professor M'Coy states that "this gigantic species in its elongated, elliptical, or sub-trigonal form arising from the narrow rounded front, precisely agrees with *Orthis subarachnoidea* of MM. d'Archiac and De Verneuil (Geol. Trans., 2nd series, vol. vi, p. 36, fig. 3), but differs from it in the larger striæ at sub-regular intervals, between the groups of smaller, as well as in its greater size." He adds, also, that he has seen and made drawings of a large number of specimens in private collections of persons at or near Looe, although there is but one poor specimen in the Cambridge Museum, and is therefore better prepared to decide on the character of the species than he should otherwise have been. I have never seen any specimen with the shell preserved, so that the above description is principally taken from that published by Professor M'Coy; but a fragment of a specimen, closely agreeing with Professor M'Coy's species, was figured by Roemer in the same year under the name of *O. spathutala.* The search for better material, with reference to both M'Coy's and Roemer's species, will be very desirable.

STREPTORHYNCHUS ? PERSARMENTOSUS, *M'Coy* (sp.). Pl. XVI, fig. 5.

ORTHIS PERSARMENTOSA, *M'Coy*. British Pal. Fossils, p. 385, pl. ii A, fig. 9, 1852.

Spec. Char. "Transversely oblong, hinge-line nearly as wide as the shell, ends obtusely sub-truncated, slightly rounded; surface covered with thick rugged, rounded, flexuous, radiating ridges, about half their thickness apart; about five in three lines in the middle of the shell at six lines from the beak, branching four or five times between the beaks and margin, counting about 130 at the margin of a large specimen: those towards the sides straighter and finer than those in the middle. Average width three inches, length probably one third of the width, but cannot be stated accurately, owing to the distortion of all the specimens. This species very closely resembles *O. sarmentosa* (M'Coy) of the older rocks in form, and the peculiar twig-like mode of branching of the ribs on the middle of the shell, and the straighter and finer ones of the sides; but is distinguished by the very much greater number of the ridges, as in the case of that species, the distortion is usually such, that I can make no probable approximation of the proportional length. The coarseness of the ridging separates the present species from the American *Stroph. nervosa* and *S. bifurcata* (Hall) of the Chemung group."

Position and Locality. Common in the Devonian shale of Polruan, Cornwall; in the reddish Devonian schists of East Looe; and schists of Fowey.

Obs. I have reproduced Prof. M'Coy's description, because, feeling exceedingly uncertain as to the specific value of this so-termed species, of which I have not been able to procure satisfactory material, I do not desire to express any opinion upon the subject further than to say, that it appears to me to belong to *Streptorhynchus* and not to *Orthis*. It is always most hazardous to propose new species on such imperfect, shortened, and otherwise distorted specimens as those that have served for *C. persarmentosa*.

Sub-genus—LEPTÆNA, *Dalman*.

LEPTÆNA ? Pl. XVIII, figs. 13, 14.

Spec. Char. Transversely semicircular, hinge-line straight, nearly equal, or slightly exceeding the width of the shell. Dorsal valve almost flat to within a short distance of the front, when the valve becomes slightly curved or convex. External surface ornamented with from forty to fifty radiating angular ribs, but of which about one third are due to bifurcation. Proportions variable.

Length $11\frac{1}{2}$, width 18 lines.

Obs. As we cannot offer a complete or even satisfactory description of this shell, which occurs in the state of imperfect casts or impressions in brown grits at Looe in Cornwall, it will be preferable for the present not to give it a specific denomination.

LEPTÆNA INTERSTRIALIS, *Phil.* Pl. XVIII, figs. 15—18.

ORTHIS INTERSTRIALIS, *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 61, pl. xxv, fig. 103, 1841.

LEPTÆNA — *Schnur*, in Dunker und v. Meyer's Palæontographica, vol. iii, p. 222, pl. xli, fig. 2, 1853.

Spec. Char. Transversely semicircular, concavo-convex, wider than long; cardinal edge and hinge-line equal to the width of the shell, extremities angular and slightly projecting; ventral valve uniformly convex; dorsal valve concave, following the curves of the opposite one; ventral area rather narrow, but wider in the middle under the extremity of the beak, and divided by a small pseudo-deltidium; dorsal area linear, and of almost equal width along its entire length; surfaces of both valves ornamented by from twelve to twenty or more simple striæ of about equal thickness throughout, which originating at the beak extend to the margin, and leaving a wide interspace between them. In the centre of these interspaces and at about the middle of the shell a smaller rib is observable, and which extends to the margin, while the whole surface of each interspace is marked by five, seven, or eight fine, longitudinal, thread-like striæ. Proportions variable.

Length 11, width 15 lines.

Obs. This shell is very variable in the degree of convexity of its ventral valve; the ears, or cardinal angles, are also more or less produced, and the striation is slightly variable in different examples, but still always assuming the same character. In some specimens, as in fig. 17, there exists, to a certain distance from the beak, slightly marked concentric wrinkles in the interspaces.

Prof. Phillips observes, that in general appearance *Lept. interstrialis* resembles *L. sericea* or *L. transversalis*, but that it is distinct from both.

L. interstrialis occurs in the Middle Devonian Limestone of Woolborough quarry, near Newton Abbot; Bradley; Barton and Lummaton, near Torquay; Dartington and Black Hall, near Totness; Plymouth, &c.

On the Continent it occurs at Gerolstein, in the Eifel.

LEPTÆNA (?) NOBILIS, *M'Coy*. Pl. XVIII, figs. 19—21.

LEPTÆNA (STROPHOMENA) NOBILIS, *M'Coy*. British Palæozoic Fossils, p. 386, pl. ii A, fig. 8, 1852.

Spec. Char. Transversely semicircular, usually wider than long; hinge-line equal to the width of the shell; ventral valve uniformly convex and strongly arched; ears slightly projecting, rounded, and more or less sharply defined; beak rounded; surface ornamented with twenty or more straight or somewhat flexuous narrow ridges or ribs, of about equal thickness throughout, which radiate, and extend from the beak to the margin, leaving wide interspaces between them, in the middle of which, and at variable distances from the beaks, shorter ridges, but similar to the larger ones, are developed. The intervening spaces are slightly concave, and crossed in a more or less zig-zag manner by deep; strong, irregularly curved, concentric wrinkles, but not crossing the ridges, scarcely four in a longitudinal space of three lines; surface of ridges and furrows marked by very fine, slightly irregular, longitudinal, distinct striæ, nine in the space of one line; area of moderate width. Dorsal valve concave, following the curves of the opposite one, and similarly sculptured. Dimensions variable.

Length 2 inches, width 3 inches.

Obs. I have not been so fortunate as to procure perfectly preserved examples of this fine shell, and therefore have taken some of the details of my description from those published by Prof. M'Coy. The specimens which I have been able to examine were not (as is the one figured by M'Coy) put out of shape by pressure, and showed that the shell was regularly semicircular, and nearly resembling *Leptæna interstrialis*. I cannot go as far as does Prof. M'Coy, when he affirms that "this fine species is so completely unlike any other, that it is unnecessary to point out the distinctions." On the contrary, it will require to be made certain whether *L. nobilis* might not be a full-grown condition of *L. interstrialis*. The material at hand will not, however, enable me to determine this point. It is also uncertain whether this shell should remain in the sub-genus *Leptæna*, the muscular arrangement of the ventral valve leading one to surmise the possibility of its belonging to *Strophomena* or *Streptorynchus*. The ribs appear to be much coarser in some specimens than in others; and in certain examples not only are the interspaces smaller, but one, two, and even occasionally three new ridges, equal in width to the primary ones, are developed between the original ones.

Lept. nobilis occurs in the Middle Devonian Limestone of Woolborough quarry, near Newton Abbot, and, according to Prof. M'Coy, in that of Teignmouth.

LEPTÆNA (?) LATICOSTA, *Conrad.* Pl. XVII, figs. 1, 2, 3.

LEPTÆNA LATICOSTA, *Conrad;—de Verneuil*, Bull. Soc. Géol. France, 2nd series, vol. iv, p. 705, 1847.
— — *Schnur*, in v. Meyer und Dunker's Palæontographica, vol. iii, p. 220, pl. xl, fig. 2, 1853.
STROPHOMENA LATICOSTA, *Sandberger.* Die Brachiopoden des Rheinischen Schichtensystems in Nassau, p. 66, pl. xxxiv, fig. 8, 1855.

Spec. Char. Transversely semicircular, and slightly indented in front; wider than long; hinge-line a little less than the width of the shell; ventral valve moderately convex; cardinal line almost straight; beak small, and but slightly produced; surface marked by about thirty-one or more simple radiating ribs, the central one being wider than any of the others; area narrow, and divided in the middle by a small fissure arched over by a pseudo-deltidium; dorsal valve slightly convex at the beak, and gently concave near the margin; exterior surface ornamented by a similar number of ribs as in the opposite valve, but along the centre there exists a wider and deeper furrow, which corresponds with the median rib of the opposite valve; area linear. Proportions variable—

Length 9, width 12 lines.

Obs. Of this species I am acquainted only with impressions of the exterior and internal casts which occur at Meadfoot, near Torquay, as well as in the brown sandy grits or slates of Looe, in Cornwall. The muscular and other impressions on the surface of the internal casts were not sufficiently defined to admit of an accurate description, and I am consequently uncertain whether this species should be retained in the sub-genus *Leptæna.*

On the Continent, and especially in the Eifel, where it likewise occurs in the state of impressions and internal casts, the shell appears to have attained larger proportions. M. de Verneuil observes, in his paper already mentioned, that this species in America is found in the Hamilton group of Hamilton County, New York; also at Daun, in the lower schists or limestone of the Eifel, as well as in the Devonian limestone of Gahard, in Brittany.

Genus ORTHIS, *Dalman.*

ORTHIS STRIATULA, *Schloth.* Pl. XVII, figs. 4—7.

HYSTEROLITES, *Linnæus.* Mus. Tessinianum, p. 90, pl. v, fig. 2, A, B, C, D, 1755; id. Baumer—Naturges. des Mineralsreiches, 2nd part, fig. 28, 1764; id. Walch and Knorr.—Die Naturg. der Verst., pl. B, figs. 5, 6, 1768, and of several other old authors who designated internal casts of *O. striatula* by the term *Hysterolites.*

TEREBRATULÆ MINUTISSIMÈ STRIATÆ, *Schroter.* Abh. Naturg., pl. iv, fig. 24, 1777.

ANOMIA TEREBRATULITES STRIATULUS, *Schlotheim.* Min. Taschenbuch, viii, pl. i, fig. 6, 1813.

HYSTEROLITES VULVARIUS, *Schloth.* Petrefactenkunde, p. 247, 1820.

TEREBRATULITES STRIATULUS, *Schloth.* Nachträge zu Petrefactenkunde, pl. xv, fig. 4, 1822.

— EXCISUS. Ibid., fig. 3.

TEREBRATULA HYSTEROLITHA, *Hön.* Ibid., p. 231, 1830.

SPIRIFER STRIATULUS, *v. Buch.* Uber Delthyris und Orthis, &c., p. 231, 1837.

— CONNIVENS, *De Vern.* Bull. Soc. Géol. de France, vol. xi, p. 255, 1840.

ATRYPA STRIATULA, *Sow.* Trans. Geol. Soc., 2nd ser., vol. v, pl. liv, fig. 10, 1840.

ORTHIS CONNIVENS, *D'Archiac* et *De Vern.* Trans. Geol. Soc., 2nd ser., vol. vi, p. 371, 1841.

— STRIATULA, *De Kon.* Anim. Carb. Belg., pl. xii, bis., fig. 6, 1844.

SPIRIFER STRIATULUS, *F. Roemer.* Rheinish Uebergansgsgeb., p. 73, pl. i, fig. 4, 1844.

ORTHIS RESUPINATA, var. STRIATULA, *De Verneuil* et *De Key.* Geol. of Russia and the Ural Mountains, pl. xii, fig. 6, 1845.

— STRIATULA, *De Verneuil.* Bull. Soc. Géol. France, 2nd ser., vol. iv, 1847.

— RESUPINATA, *Bronn.* Index Palæontologicus, p. 858, 1848.

— STRIATULA, *D'Orb.* Prodrome, vol. i, p. 90, 1849.

— — *De Vern.* Bull. Soc. Géol. France, 2nd ser., vol. vii, 1850.

HYSTERIOLITHES VULVARIUS, *Quenstedt.* Handb. der Petrefact., p. 484, pl. xxxix, fig. 2, 1851.

ORTHIS STRIATULA, *Schnur*, in Dunker und v. Meyer's Palæontographica, vol. iii, p. 215, pl. xxxviii, fig. 1, 1853.

— — *Steininger.* Geol. Beschreibung der Eifel, p. 81, 1853.

— — *Dav.* British Foss. Brach. Introduction, vol. i, pl. vii, fig. 128—133, 1855.

— RESUPINATA, *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 67, pl. xxvii, fig. 115, 1841.

— — *Morris.* Catalogue of British Fossils, p. 141, 1854.

— STRIATULA, *Woodward.* Manual of the Mollusca, p. 229, fig. 147, 1854.

— — *Sandberger.* Die Brach. Rheinischen Schichtensystems in Nassau, p. 39, pl. xxxiv, fig. 4, 1855.

Spec. Char. Shell variable, usually transversely oval or elliptical, but at times the length is equal to, or slightly exceeds, the width; hinge-line straight, much shorter than the width of the shell; dorsal valve deeper than the ventral one, uniformly convex, most prominent and even gibbous at and near the beak, which is more or less incurved, while the half of the valve towards the front is either evenly convex or slightly depressed; area narrow; ventral valve moderately convex, with a wide depression or sinus at and near the front; beak either inconspicuous or but slightly incurved; area triangular, with an open fissure in the middle; the frontal margin presents a convex curve, while that of the dorsal one is concave. The beaks of both valves are at times so much incurved as to almost

touch each other, but are in general moderately separate. Exteriorly, both valves are closely covered with numerous fine, thread-like, rounded, radiating striæ, which increase in number by interstriation and bifurcation, at variable distances from the beaks, and at intervals the striæ themselves slightly augment in thickness and prominence, producing small, hollow, thread-like, tubular spines, which become more numerous towards the margin. The intimate shell-structure is perforated by innumerable canals, of which the exterior orifices, in the shape of minute punctures, cover the entire surface of the valves. In the interior of the ventral valve the teeth are prominent, and the dental plates extend to some distance along the bottom of the shell; the muscular impressions occupy an elongated oval or saucer-shaped cavity with raised margin; this cavity is divided along the middle by a small, rounded, or angular ridge. The adductor or occlusor muscle is central, and leaves a small but not always clearly defined depression on either side of the mesial ridge, while it is probable that each of the larger cavities (on either side of the mesial ridge and adductor impression) may have been formed by, or afforded attachment to, the cardinal or divaricator and the ventral adjustor muscles of Hancock; the last-named muscular impression being indistinct, but situated close to the outer margin of the saucer-shaped cavity above described. The small triangular scar at the bottom of the fissure I am inclined to attribute to the pedicle-muscles. In the *dorsal valve* the fissure is partly occupied or divided by a moderately produced shelly prominence or cardinal process, to which were, in all probability, attached the divaricator muscular fibres. The inner socket-walls are prolonged to some distance into the cavity of the shell, and form two curved blade-like brachial processes, to which the spiral arms may in all probability have been attached, and to the inner surface of these blade-like processes the dorsal adductor was in all probability fixed, while under the cardinal process above described a rounded central ridge separates the quadruple adductor or occlusor impressions. The vascular impressions are more or less observable, and consist of six principal trunks in the dorsal valve, two in the ventral, the external branches turned outwards and backwards, inclosing the ovarian spaces. Proportions variable; two specimens measured—

Length 14, width 17, depth $9\frac{1}{2}$ lines.
„ 15 „ 16 „ 11 „

Obs. The same uncertainty already expressed with reference to the specific value of *Strept. umbraculum* and *St. crenistria* may be here repeated in connection with *Orthis resupinata* and *O. striatula*. The greater number of palæontologists (as may be seen from our list of synonyms and references, and which might have been made still more numerous) would maintain the Devonian *O. striatula* as a distinct species, while Bronn, Phillips, and Morris, would place the term *O. striatula* among the synonyms of *O. resupinata*. Any how, if *O. striatula* is to be considered distinct from *O. resupinata* it cannot, as some have proposed, retain the specific denomination of *O. connivens* (Phillips), since this last designation was made use of in 1836, while the name *striatula* dates as far back as 1813.

In 1840, 1841, and 1845, M. de Verneuil adopted the terms *O. connivens,* and that of *O. resupinata* var. *striatula,* for the Devonian form, but in 1847 and 1850 preferred the name *striatula*, and consequently considered the Carboniferous and Devonian forms to be distinct. The Devonian species does not appear to have attained anywhere the proportions of the Carboniferous *O. resupinata,* but examples of the same dimensions of both forms cannot be distinguished; thus, for example, if the reader will compare our illustrations of *O. striatula* with that of *O. resupinata* in Pl. XXX, fig. 1, of my 'Carboniferous Monograph,' the external resemblance or identity will appear to him undisputable. More difference may, however, be perhaps observable in the details of the interior arrangement of both forms. Thus, if the reader will refer to Pl. VII, figs. 131 and 135, of my 'General Introduction,' which represent the interior of the dorsal valves of *O. resupinata* and *O. striatula*, he may, perhaps, perceive sufficient difference to warrant him in at least provisionally retaining the two names for the shells under consideration, and until it can be clearly ascertained whether those differences are constant. It is, however, very possible and probable that *O. striatula* is a smaller variety of *O. resupinata;* or, in other words, that the last-named shell is only a more fully developed variation of the Devonian form. *O. striatula* occurs in the shape of internal casts in the Middle Devonian at Hagginton Hill, near Ilfracombe, also in the Limestone of Woolborough quarry, near Newton Abbot; at Barton, Lummaton, and Hope's Nose, near Torquay. It has also been noticed in the Upper Devonian of South Petherwin, in Cornwall. *O. striatula* is a common Devonian shell on the Continent, it occurs in various Russian and Ural localities; in the Eifel, at Bensberg, Paffrath, and Ratingen in Prussia; at Ferques, Néhou, Viré, and Arnao, in France; in the Hartz; the Asturias, &c., in Spain; in Nassau, &c. It has also been found in Persia; the United States, &c.

ORTHIS HIPPARIONIX, *Vanuxem* (?). Pl. XVII, figs. 8—11.

HIPPARIONYX PROXIMUS, *Vanuxem.* Nat. Hist. N. York; Geol. Report of the Third District, p. 124, fig. 4, 1843, and *Orthis hipparionix,* Vanuxem.
ORTHIS HIPPARIONYX, *Schnur.* in Meyer und Dunker's Palæontographica, vol. iii, p. 217, pl. xl. fig. 1, 1853.
— — *J. Hall.* Nat. Hist. of New York; Palæontology, vol. iii, p. 407, pl. lxxxix, figs. 1—4; pl. xc, figs. 1—7; pl. xci, figs. 4 and 5, and pl. xciv, fig. 4, 1859.

In the Lower Devonian slates and grits of Looe, in Cornwall, we very commonly meet with large internal casts, which resemble much in shape and character those of *Orthis hipparionyx* of American authors; but as the shell itself no longer exists in our rocks, and as only small portions showing impressions of the external surface could be obtained, we cannot feel quite certain as to our identification. These casts are also much put out of shape by

pressure, so that it is difficult to determine the shell's exact form. When about in their normal condition these casts are sub-orbicular, the length and width being nearly equal. The dorsal valve is convex, and deeper than the opposite one; muscular scars large and in relief. The external surface of the shell appears to have been marked by fine, sub-equal, radiating striæ, which increase in number by numerous intercalations. The beak of the ventral valve was incurved, the area of moderate width, and divided in the middle by a pseudo-deltidium. Dorsal area narrow; proportions variable; length and breadth about two and a half inches.

In America *O. hipparionyx* occurs in the Oriskany Sandstone, from which horizon, perhaps, the Looe beds may not be far removed. It is found at Albany and Schoharie Counties (New York); at Cumberland (Maryland), and other places. Prof. Schnur figures it from the Grauwackenschichten of Prüm, in the Eifel.

ORTHIS INTERLINEATA. Pl. XVII, figs. 18—23.

ORTHIS INTERLINEATA, *Sow.* Geol. Trans., 2nd series, vol. v, pl. liii, fig. 11; pl. liv, fig. 14, 1840.
— — *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 63, pl. xxvi, fig. 106, 1841.
— PARALLELA, *Ibid.* Pal. Foss., p. 64, pl. xxvi, fig. 109.

Spec. Char. Shell transversely elliptical, sub-orbicular, or slightly rotundato-quadrate, compressed; hinge-line less than the width of the shell; cardinal angles obtuse; ventral valve slightly convex, but deeper than the dorsal one; area narrow; deltidium small; beak inconspicuous; dorsal valve very gently convex and depressed; area linear. Surface of both valves marked with numerous small, radiating, thread-like striæ, which extend from the beak to the margin, with wide interspaces between them, in the middle of which a smaller rib commences at variable distances from the beaks and extends to the margin, the whole interspaces being also marked by six or seven smaller striæ. A few concentric lines of growth are visible on both valves. In the interior of the ventral valve the teeth are prominent, the dental plates extending to some distance along the bottom of the valve, and forming an elongated oval depression with raised margin; this cavity is divided in the middle by an angular ridge; the occlusor or adductor muscle forms a small, central, oval scar, but not very apparent, while the larger elongated depressions on either side are formed of two parts, the anterior or one close to the occlusor and lowest down being due to the cardinal or divaricator, while the other, the posterior or lateral, which is parallel but higher up, may have been formed by the ventral adjustor (?). In the interior of the dorsal valve the cardinal process is situated between two projecting laminæ (which perhaps afforded attachments to the spiral arms). These laminæ curve on either side and partly

enclose the dental sockets; under the cardinal process a convex ridge of moderate width separates the quadruple impressions of the adductor or occlusor muscle, these last producing two oval-shaped depressions, one placed above the other and separated by lateral elevations branching from the central ridge.

Dimensions variable; length 7, width 9, depth 4 lines.

Obs. All the specimens I have been able to examine of this species were in the condition of internal casts and external impressions, but which being sharply marked, it was possible to reproduce the surface of the shell by the means of gutta-percha. By this medium we have also the exact external shape as well as of the interior details of the valves, in as complete a condition as if we had the shell itself before us.

Some palæontologists have considered, but with a mark of interrogation, *O. operculans*, De Verneuil, and *O. orbicularis*, of the same author, as synonyms of *O. interlineata;* but I have not been able, as yet, to feel quite certain with reference to these identifications. As observed by Prof. M'Coy, *O. interlineata* varies considerably in proportionate width, but this is principally owing to pressure. It occurs abundantly in the Upper Devonian shales of Landlake, near S. Petherwin, and Launceston, in Cornwall; and in the brown grits of North Devon, such as near Barnstaple, Croyde, Marwood, &c.; and, according to Mr. Valpy, in the Middle Devonian at Hagginton Hill, near Ilfracombe.

ORTHIS GRANULOSA, *Phillips.* Pl. XVII, fig. 24.

ORTHIS GRANULOSA, *Phil.* Pal. Foss. Devon, &c., p. 65, pl. xxvi, fig. 111, 1841.

Spec. Char. "Orbicular, very depressed, lenticular. The hinge-line above half the width of the shell. Surface radiated, with numerous fine, granulated striæ, of unequal length, doubled in number and diminished in prominence towards the margin, so as to give it rather a bordered appearance. *Loc.* In North Devon, Woodabay. In South Devon, Meadsfoot Sands." (*Phillips.*)

Obs. I have been able to examine only two or three incomplete valves of this species, and therefore have preferred to reproduce Phillips's description, which conveys all the information we at present possess. Mr. Pengelly has found in the Middle Devonian Limestone of Woolborough quarry a valve (the one figured in our plate) which quite agrees with Phillips's description and figures. In this specimen forty-five small ribs may be counted round the margin, the valve being slightly convex and measuring five lines in length by five and a half in width, and which is also about the proportion of Phillips's figure. From such imperfect and insufficient material one can say but little as to the specific value of this form, and it is to be hoped that further search may bring to light some examples showing both valves, area, &c.

ORTHIS ARCUATA, *Phillips*. Pl. XVII, figs. 13, 14.

ORTHIS ARCUATA, *Phillips*. Pal. Foss. of Cornwall, Devon, and West Somerset, p. 64, pl. xxvi, fig. 107, 1841.
— — *M'Coy*. British Pal. Foss., p. 384, 1852.
? — LONGISULCATA, *Phil*. Pal. Foss., p. 64, pl. xxvi, fig. 105 (?), 1841.

Spec. Char. Depressed, transversely elliptical, wider than long; hinge-line much less than the width of the shell. Dorsal valve gently convex, ventral one very slightly convex or nearly flat; areas narrow. Surface of both valves marked by numerous radiating striæ, or minute, thread-like ribs, which commence to bifurcate at variable distances from the beaks.

Dimensions. Two specimens measured—

Length 7, width 11, depth 2 lines.
,, 6 ,, 8 ,, 3 ,,

Obs. It is not an easy matter to obtain complete and satisfactory examples of this species; the greater number of specimens obtainable from the Middle Devonian beds of Hope's Nose, near Torquay, being much out of shape from the effects of pressure; nor is the dorsal valve always flat and hollowed along the middle, as is described and figured in one of Phillips's specimens.

I am not quite certain that I am justified in considering *O. longisulcata* (Phillips) as a synonym of *O. arcuata*, but must observe that the last-named author's *O. longisulcata* was described from casts and impressions so entirely out of shape from the effects of pressure, that it was not possible to ascertain the shell's true character. What has tempted me to provisionally locate *O. longisulcata* with *O. arcuata* is, that many examples of *O. arcuata* from Hope's Nose entirely resembled in shape some of Phillips's specimens of *O. longisulcata*; we will, however, here append Phillips's description, and I have reproduced one of that author's illustrations (fig. 17 of our Plate).

"*Orthis longisulcata*, Phillips, Pal. Foss., p. 62, pl. 26, fig. 105. *Character.* Transversely elliptical, depressed, radiatingly striated, with numerous imbrications; striæ very numerous, fine, devaricating; internal plates near the beak of the lower valve, long, diverging. If my views be correct, the sides of this species are rounded so as to make the whole contour elliptical, as in *O. lata* (Sil. Researches). The long, straight, subrostral plates appear to be constant. I have seen innumerable specimens at Watersmeet, Linton, and Woodabay, but almost always obliquely crushed. The striæ are much finer than in the elliptical species from Petherwin (*O. interlineata*), to be noticed next. *Loc.* In North Devon. Linton, Watersmeet, Woodabay, West Lee."

Family—PRODUCTIDÆ.

Genus—Chonetes, *Fischer.*

?Chonetes Hardrensis, *Phillips.* Pl. XIX, figs. 6—9; and Chonetes (Leptæna) sordida, *Sow.* Pl. XIX, figs. 4, 5.

Orthis Hardrensis, *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 138, pl. lviii, fig. 104, *a, b, c, d, e,* and pl. lx, fig. 104, 1841.
Leptæna convoluta, *Ibid.* Ibid., pl. xxiv, fig. 96.
? — sordida, *Sowerby.* Trans. Geol. Soc., 2nd ser., vol. v, pl. liii, figs. 5 and 16, 1840.
?Chonetes sarcinulata, *De Kon.* Mon. Productus et Chonetes, p. 210, 1847.
— — *Sandberger.* Die Brachiopoden Rheinischen des Schystensystems in Nassau, p. 71, pl. xxxiv, fig. 14, 1855.
— Hardrensis, *Davidson.* Monog. British Carb. Brach., p. 186, pl. xlvii, figs. 12—16, 1861.

Spec. Char. Shell marginally semicircular, wider than long, concavo-convex; hinge-line straight, and either a little shorter or somewhat longer than the width of the shell, with rounded or angular terminations; each valve is provided with a sub-parallel area, which is widest, however, in the ventral one, and divided in the middle by a small fissure, partially covered by a pseudo-deltidium; ventral valve moderately convex, sometimes slightly depressed along the middle and flattened towards its auriculate cardinal extremities; the beak, which is small and incurved, does not overlie the hinge-line, while the dorsal valve assumes in different specimens a greater or lesser degree of concavity, with, at times, a slight longitudinal elevation along the middle, and flatness near the cardinal extremity. The surface of both valves is covered with numerous thread-like, radiating, and often bifurcating striæ, which increase in number by the interpolation of striæ at various distances from the beak and umbo, so that as many as 120 striæ may in some examples be counted round the margin, while at irregular distances small spines rise from their rounded surface in addition to those on each side of the beak; in adult examples there exist along the cardinal edge from five to nine slanting, tubular spines, which become longer and larger as they approach the extremities of the cardinal edge. Dimensions variable; an average-sized specimen has measured—

Length 7, width 11, greatest depth $1\frac{1}{2}$ lines.

Obs. The above description is taken from that published at page 186 of our 'Monograph of British Carboniferous Brachiopoda,' and we must likewise refer the reader to the observations therein appended. The identity of the Carboniferous species with that

published under the denomination of *C. Hardrensis* cannot be doubted, and the only question upon which some uncertainty might prevail is whether *C. Hardrensis* might not be a synonym of *C. sordida,* or even of *C. sarcinulata,* of the Silurian period. Phillips, in his work on the Pal. Foss. of Devon, &c., describes *C. sordida* and *C. Hardrensis* as distinct species. De Koninck places both these so-termed species under *C. sarcinulata,* and Dr. Sandberger follows in the same track. In their 'Memoir on the Fossils of the Older Deposits of the Rhenish Provinces,' published in vol. vi, of the Transactions of the Geological Society, Messrs. d'Archiac and de Verneuil have retained *C. sordida* and *C. Hardrensis* as distinct species, and Prof. M'Coy, at p. 386 of his 'British Palæozoic Fossils,' describes *C. sordida,* without announcing any synonyms, under the designation of *Leptæna* (*Strophomena*) *sordida* (Sow.), and concludes by stating that he suspects the Linton shell referred by Prof. Phillips (Pal. Foss.) to the Silurian *O. compressa* to belong to the present species. I have already had occasion to observe that this view may be partly correct, for some of Phillips's figures of *O. compressa* do, in all probability, belong to *C. sordida* or *Hardrensis,* and one or two of them to *Strep. crenistra.* One of the original specimens of Sowerby's *Leptæna sordida* may be seen in the Museum of the Geological Society, and without doubt must be referred to the genus *Chonetes,* and not to *Leptæna;* but they are, as remarked by Sowerby, very imperfect specimens, and their exterior badly preserved, so that from the typical examples no very satisfactory description could be given.[1] I prefer, therefore, to retain the name *Hardrensis* in preference to that of *sordida* (supposing the two names to be synonymous), because Phillips's description and figures leave no uncertainty as to the species he intended to describe. *Leptæna convoluta,* Phillips, appears to be nothing more than a somewhat deformed specimen of *C. Hardrensis.*

C. Hardrensis is exceedingly common in the Upper Devonian Grits and Shales of North Devon. At Marwood and Braunton it is very abundant, but the specimens are usually small. It occurs also in several localities in the neighbourhood of Barnstaple; at Linton, and in other localities. Mr. Pengelly has found the shell in dark grey slate at Black Hall, near Totness. It has now been obtained from dark shales in the Eifel, in Nassau, and several other localities.

[1] Sowerby describes his *Leptæna sordida* with the following words: "Transversely elongated, rather convex, irregularly striated, hispid? Muscular impressions occupying half the internal area; hinge-line nearly as long as the width of the shell, its angles rounded. Width variable, sometimes nearly double the length (*Loc.* Linton)." We have also in our Pl. XIX reproduced the original figures.

? CHONETES MINUTA, *Goldf.* Pl. XIX, figs. 10—12.

ORTHIS MINUTA, *Goldfuss*, Von Buch., Abhandl. der Königl. Akad. der Wissens. zu Berlin, p. 68, 1836.
— — *Goldfuss.* Von Buch., Mém. de la Soc. Géol. de France, vol. iv, p. 217, 1840.
— — *d'Archiac* and *De Verneuil.* Desc. of the Fossils of the Rhenish Provinces. Trans. Géol. Soc., 2nd ser., vol. vi, pl. xxxvi, fig. 5, 1841.
CHONOTES MINUTA, *de Koninck.* Mon. des genres Productus et Chonetes, p. 219, pl. xx, fig. 18, 1847.

Spec. Char. Sub-hemispherical, or transversely oval; hinge-line straight, shorter than the width of the shell; cardinal angles rounded; ventral valve uniformly convex; beak small, incurved, and more or less conspicuous; area narrow, but broader than that of the dorsal valve, and divided in the middle by a small fissure arched over with a pseudo-deltidium. Dorsal valve concave, and particularly so under the beak; area narrow. Surface of both valves marked with from twenty-two to thirty distinct, radiating, rounded ribs, separated by interspaces of rather less width. The valves are also crossed by numerous concentric lines of growth. The ribs are simple, and rarely bifurcate or increase in number by interpolation. Proportions variable; two specimens measured—

Length 5, width 7 lines.
,, 5 ,, 6 ,,

Obs. The nearest described species of Chonetes with which we can compare the shell under description is the *C. minuta* of Goldfuss; indeed, an example from Dartington was very similar in shape and character to the one from the Eifel, which was described and figured by M. de Verneuil. Some of our specimens were, however, a little more transverse, but any one who has seen a number of individuals of any species of Chonetes will be aware of the great variability to which it is liable. It differs, also, from *C. Hardrensis* by its fewer and comparatively stronger ribs, for a specimen of *C. minuta* on which I counted about thirty ribs, one of *C. Hardrensis*, of about the same dimensions, would number not less than seventy.

C. minuta (if I am not mistaken in identifying our British specimens with that species) occurs in the Middle Devonian Limestone of Dartington, near Totness, as well as at Hope's Nose, near Torquay. On the Continent it occurs in the Devonian Limestone of Blankenheim in the Eifel.

Sub-Genus—STROPHALOSIA, *King*.

STROPHALOSIA PRODUCTOIDES, *Murch*. Pl. XIX, figs. 13—21.

ORTHIS PRODUCTOIDES, *Murch*. Bull. Soc. Géol. de France, vol. xi, p. 254, pl. ii, fig. 7, 1840.

PRODUCTUS SPINULOSUS, *V. Buch*. Archiv für Mineral. &c., vol. xv, p. 38, non *Sow.*, 1840.

— — *D'Eichwald*. Bull. Sc. de l'Academie des Sciences de St. Petersb., p. 86, 1840.

LEPTÆNA CAPERATA, *J. de C. Sow*. Trans. of the Geol. Soc. of London, 2nd ser. vol. v, p. 704, pl. liii, fig. 4, pl. liv, fig. 3, 1840.

— — *Phillips*. Pal. Fossils of Cornwall, Devon, &c., p. 58, pl. xxv, fig. 98, 1841.

— LAXISPINA, *Phillips*. Ibid., p. 59. pl. xxv, fig. 99.

— MEMBRANACEA, *Phillips*. Ibid., p. 60, pl. xxv, fig. 101.

PRODUCTUS SPINULOSUS, *V. Buch*. Abhandl. der Königl. Akad. der Wissens. zu Berlin, Theil. i, p. 27, pl. ii, fig. 16, non *Sow.*, 1841.

— — *De Kon*. Desc. des An. Foss. du Terrain Carb. de Belgique, p. 183, pl. xiii bis, fig. 4 (not *Sow.*), 1843.

— PRODUCTOIDES, *De Verneuil*. Russia and the Ural Mount., vol. ii, p. 283, pl. xviii, fig. 4, 1845.

— MEMBRANACEUS, *De Verneuil*. Ibid., p. 285, pl. xv, fig. 11.

— SUBACULEATUS (partim) *De Keyserl*. Reise in das Petschora-land, p. 199, pl. iv, figs. 1, 2, 1846.

— MURCHISONIANUS, *De Kon*. (part). Mon. du Genre Productus, t. iv, des Mémoires de la Soc. Royale des Sciences de Liége, p. 245, pl. xvi, fig. 3_f (not fig. $3^{a,b,c,d,e}$), 1847; Monographe des Genres Productus et Chonetes, p. 138, pl. xvi, fig. 3_f, 1847.

LEPTÆNA CAPERATA, *M'Coy*. Brit. Pal. Foss., p. 388, 1852.

Spec. Char. Shell sub-orbicular, or transversely semicircular; hinge-line somewhat shorter than the width of the shell; ventral valve moderately and evenly convex, regularly arched, without sinus; beak very small, hardly conspicuous; area triangular, flat, rather narrow, and divided in the middle by a small pseudo-deltidium. Dorsal valve concave, following the curves of the opposite one; hinge-area almost linear, and much narrower than that of the dorsal valve. Surface of ventral valve marked by fine, contiguous, concentric, undulating, irregular, and interrupted wrinkles, as well as numerous spine tubercles, or long, slender, sloping spines, arranged somewhat in quincunx. A row of erect spines are situated close to the cardinal edge. The surface of the dorsal valve is also marked with wrinkles and small pits. Interior unknown.

Length 1 inch; width 1 inch 1 line; depth 2 lines.

Obs. This interesting species was, by Sir R. Murchison, published on the 6th of

April, 1840, under the denomination of *Orthis productoides*, and on the 30th of May of the same year, by Sowerby, as *Leptæna caperata*. It has also received several other designations; to imperfectly preserved flattened casts showing only the zigzag concentric markings Phillips applied the denomination *membranacea*, and one of De Koninck's figures of *P. Murchisonianus* undoubtedly belongs to the species under description. It is not an *Orthis*, nor can it be classed under *Leptæna*, but was, in 1846, correctly located by Prof. King in his genus or sub-genus *Strophalosia*,[1] but I hardly consider the last-named author equally fortunate while placing *Prod. subaculeatus* in the same sub-genus. Sir R. Murchison states that he gave the name *Orthis productoides* to this shell because, in his opinion, it appeared to establish a passage from *Orthis* to *Productus* and *Leptæna*, but at that period the sub-genus *Strophalosia* had not been established. Prof. de Koninck thinks Sir R. Murchison right when considering the species under description to be situated on the limits of the genera *Productus* and *Chonetes*, and the learned Belgian palæontologist places the shell in the genus *Productus*. He also states to have been mistaken when he united *St. productoides* with Sowerby's *P. spinulosus*, but from which it is at once distinguished by its well-marked double area, a character never seen in the Carboniferous *P. spinulosus*. M. de Koninck observes, moreover, relative to the surface of the dorsal valve, that it is marked with irregular concentric wrinkles, similar to those of the opposite valve, but generally more lamellar; that the spines are more often wanting, and are replaced by small pits corresponding to the tubercles or spines of the opposite one. None of the specimens I have been able to procure showed spines in this valve, and I therefore mention their existence solely on the authority of Prof. L. de Koninck, for they are seen only on the dorsal valve of those specimens of his *P. Murchisonianus* which do not, I consider, belong to the species under description. I am at a loss to understand why some palæontologists should have considered it difficult to distinguish this shell from *Productus subaculeatus*, for they appear to me perfectly distinct, as a reference to figures will easily explain. Prof. M'Coy states that all the specimens which he has examined of the species, named by Sowerby himself, were certainly specifically identical with *L. membranacea* of Phillips, and that it is only the dorsal valve of typical examples of that species that are nearly flat; that the species varies greatly in the proportional strength of the two kinds or ornaments, and when the beautiful concentric zigzag wrinkling is very strongly marked, the elongated tubercles can scarcely be seen; and that, on the other hand, when the quincuncial spine-tubercles are strongly marked, the transverse wrinkling cannot be so distinctly seen; and that this has perhaps given rise to the two species distinguished by Mr. Phillips, although, from examination of Sowerby's types and numerous specimens on the spot when they were first found, and where they abound, he readily traced every gradation between the supposed different types; lastly that none of the published figures do justice to the singular beauty and regularity of the minute, transverse wrinkling.

[1] Annals and Mag. of Nat. Hist., vol. xviii, July and August, 1846.

M. de Verneuil does not appear to have recognised the identity of *St. productoides* and *St. carepata*, since in his description of the fossils of the older deposits of the Rhenish Provinces he refers to the two as distinct species.

Strophalosia productoides is exceedingly abundant in the state of casts in the Upper Devonian Grits and Shales of North Devon—such as at Braunton ; near Orchard quarry, parish of Pilton, &c. ; it is also very common at Petherwin, in Cornwall. On the Continent it is not abundant at Ferques, in the Bas Boulonnais, and from whence I obtained three or four perfect specimens, with part of the long slender spines still adhering. It occurs, also, at Couvin, in Belgium; Gerolstein, in the Eifel; and M. de Verneuil mentions Volkof, Bouregi, Lake Ilmen, Voroneye, Lebedian, Zadonsk, &c. ; but I am not quite certain whether the shell has in reality been obtained from all the localities recorded by various authors, and I am almost inclined to believe that Prof. de Koninck may have combined two species under the denomination of *P. Murchisonianus*.

Genus—Productus.

Productus subaculeatus, *Murch.* Pl. XX, figs. 1, 2.

Productus subaculeatus, *Murch.* Bull. Soc. Géol. de France, vol. xi, p. 255, pl. ii, fig. 9, 1840.

Leptæna fragaria, *J. de C. Sowerby.* Trans. of the Geol. Soc. of London, 2nd ser., vol. v, p. 704, pl. lvi, fig. 5, 1840.

— — *Phillips.* Pal. Foss. of Cornwall, Devon, and West Somerset, p. 59, pl. xxv, fig. 100, 1841.

Productus spinulosus (partim), *De Kon.* Desc. des Anim. Foss. du Terr. Carb. de Belgique (figuris exclusis), non *Sow.*, 1843.

— subaculeatus (partim), *De Verneuil.* Russia and the Ural Mount., vol. ii, p. 282, pl. xvi, fig. 9, 1845.

— — (partim), *De Keyserling.* Reise in das Petschora-land, p. 199 (figuris exclusis), 1846.

— — *De Kon.* Mon. du Genre Productus, Mém. de la Soc. Royale de Liége, vol. iv, p. 249, pl. xiv, fig. 4, 1847, et Monographe des Genres Productus et Chonetes, p. 142, pl. xvi, fig. 4, 1847.

— — *De Verneuil.* Bull. Soc. Géol. de France, 2nd ser., vol. iv, p. 705, pl. lx, 1847.

— — (partim), *Bronn.* Index Palæontologicus, p. 1043, 1848 (not *P. productoides*, Murch.).

— — *De Verneuil.* Bull. Soc. Géol. de France, 2nd ser., vol. vii, p. 362, 1850.

— (strophalosia) subaculeata, *M'Coy.* British Pal. Foss., p. 308, 1852.

PRODUCTUS SUBACULEATUS, *Schnurr*, in v. Meyer and Dunker's Palæontographica, Band ii, p. 228, pl. xliii, fig. 4 *a*, 1853.
— — *Davidson*. Quarterly Journ. of the Geol. Soc., p. 336, pl. xv, fig. 12, 1853.
— — *Steininger*. Geogn. Beschreibung der Eifel, p. 86, 1853.
— — *Sandberger*. Dei Brach. Rheinischen Schichtensystems in Nassau, p. 75, pl. xxxiv, fig. 17, 1855.

Spec. Char. Shell sub-hemispherical, transversely semicircular, sometimes as broad as long; hinge-line straight, usually about equal to, or a little less than the width of the shell. Ventral valve pretty regularly vaulted and very gibbous, without sinus; beak small, prominent, and incurved, but overlying very slightly the hinge-line; ears small, gradually flattened; hinge-area linear, with a small fissure in the middle. Dorsal valve very concave, following closely the curves of the opposite one. Surface of the ventral valve marked with numerous concentric lines or wrinkles of growth, as well as with irregularly scattered projecting tubercles, or cylindrical, curved, hollow spines. These spines are very irregularly scattered over the surface of the valve, and appear at greater or lesser intervals from each other; they are also more numerous on the ears. Surface of dorsal valve marked with concentric lines and wrinkles on the auriculate portions of the valve; small circular pits exist likewise, here and there, over its surface. Proportions variable—

Length 18, width 21 lines.
,, 11 ,, 11 ,,

Obs. This is a common and well-known Devonian fossil, named *subaculeatus*, by Sir R. Murchison, on the 6th of April, 1840, and *fragaria*, by Sowerby, on the 30th of May of the same year, and it is much to be regretted that Sir R. Murchison had not submitted to Mr. Sowerby the specimens he had collected at Ferques, since that gentleman was at the time describing for Sir Roderick those he had picked up in beds of a similar age in Devonshire. Had this been done, a number of synonyms and a certain amount of confusion in the nomenclature would have been avoided.[1]

Sir R. Murchison remarks that his *Productus subaculeatus* approaches nearly to Martin's *Productus* (*Anomites*) *aculeatus*, but that it differs from that species by the manner in which the spines rise from the surface of the valve, those in the Devonian form being stated to rise perpendicularly to the surface of the valve. Prof. M'Coy has likewise observed that the elongation of the tubercles in Sowerby's figures were produced by mechanical compression in the rock, the part of the specimen not crushed having them round. It is, however, very difficult to procure from our Devonian rocks uninjured specimens, with the shell itself well preserved, but I was able to obtain the communication of

[1] From having unfortunately overlooked the fact of Murchison's paper in the 'Bulletin' having been read twenty-three or twenty-four days sooner than that of Sowerby, published in the 'Transactions of the Geol. Soc.,' I adopted at p. 23 of this Monograph the term *Spirifer disjunctus*, Sow., while that of *Sp. Verneuilli* has a claim to priority.

two or three such specimens, one of which (fig. 2) will be found represented in our plate; but at Ferques, near Boulogne-sur-mer, in France, the shell is often found in a very complete state of preservation. It differs, also, from *P. aculeatus* by the presence of a narrow hinge-area, first noticed by M. Bouchard-Chantereaux from specimens found at Ferques.[1] Some palæontologists have supposed that *Strophalosia* (*Orthis*) *productoides* of Murchison might be a synonym of the shell under description, and Prof. L. de Koninck has suggested that *P. subaculeatus* might possibly be a constant and well-marked variety of *Strophalosia productoides*, but I believe both forms to be not only specifically distinct, but that they belong to a distinct section of the genus *Productus*, i. e. *Strophalosia*, King. *P. subaculeatus* varies considerably in the number of spines which are scattered over the surface of its ventral valve. In some examples they are much nearer to each other than in other individuals, and Prof. M'Coy observes that the young specimens rarely show any of the obsolete concentric wrinkles, and in them also the spine-bases are more nearly round; that "they are fewer, more distant, and less regular than in *P. spinulosus* (Sow.), and the peculiar form of the tubercles, their number, and tuberculation of the ventral valve, as well as a less gibbosity, separate it from *P. aculeatus*." In none of the British specimens I have been able to see were the spines in place, but some of the French examples still preserved their spines, which were slender, and sometimes exceeding half an inch in length; some may even have attained an inch, and many of our British examples of *P. subaculeatus* have exceeded in dimensions those I have seen from the Continent. I have not been able to obtain any British or foreign specimen in which the interior of the valves could be studied, but examples of the dorsal valve showing the cardinal process have been figured by M. Bouchard.

Locality. In England, *P. subaculeatus* is common in the Middle Devonian Limestone of Woolborough quarry, near Newton Abbot; at Barton, Lummaton, and Hope's Nose, near Torquay; and Plymouth. But I have seen no examples from any of our Upper Devonian beds, where it ought to have occurred, but it is stated by Prof. M'Coy and Mr. Salter to have been found abundantly in the Upper Devonian beds of Petherwin and Landlake, in Cornwall.

On the Continent it is abundant at Ferques, in the Bas Boulonnais; at Gahard, in Brittany (M. Rouault); also at Chimay and Couvin, in Belgium; also in the Eifel; at Zadosk, on the Don; and in the neighbourhood of Voronege, in Russia. I have described and figured it from China; and it occurs likewise in America, &c.[2]

[1] "Note sur le Genre Productus;" 'Annales des Sciences Naturelles,' Sept., 1842.

[2] In the fourth vol., 2nd series, of the 'Bulletin de la Soc. Géol. de France' (1847), M. de Verneuil remarks, "*Productus subaculeatus*, Murch. (*Strophomena lacrymosa*, Conrad); a small species proper to the Devonian system, and which has never been found lower down. In America, it appears for the first time, in the *Corniferous Limestone* of Charleston Landing and Lewis's Creek (Indiana), where it is associated with the fine fish described by Mr. Norwood, under the name of *Macropetalichthys rapheidolabis*: it is found to go through all the Devonian stages, such as those of Hamilton, Portage, and Chemung.

PRODUCTUS PRÆLONGUS, *Sow.* (sp.). Pl. XIX, figs. 22—25.

LEPTÆNA PRÆLONGA, *Sow.* Trans. Geol. Soc., vol. v, tab. liii, fig. 29, May 30, 1840.
PRODUCTA — *M'Coy.* British Pal. Foss., p. 390, 1852.

Spec. Char. Shell known only in the state of casts of an elongated oval or subcylindrical shape; hinge-line usually not quite so long as the width of the shell. Ventral valve gibbous, with depressed rectangular ears; beak incurved. Surface longitudinally divided by a slight median depression, or small ridge, from which rise at variable intervals four or five long spines. The surface, in the casts, is even as well as irregularly and finely striated. Dorsal valve concave, following the curves of the opposite one, and similarly marked. A few concentric wrinkles exist also on the ears and lateral portions of the beaks. Proportions variable—

Length 1 inch 3 lines, width 1 inch 2 lines.

Obs. It is not always possible to describe completely a shell of which we possess only imperfect casts and impressions. Still they are so exceedingly abundant in the brown grits and grey shales of the Marwood and Pilton beds of North Devon and West Somerset, that it becomes one of its most important species. It is there likewise associated with *Strophalosia productoides,* which appear to be equally abundant. Professor M'Coy observes, at p. 390 of his work on British Palæozoic fossils, that he "was greatly surprised to find, on examining the unique specimens of this species in the Cambridge collection, originally figured and described by Sowerby, that the impression of the ventral valve (not figured) shows a strong, narrow, rounded mesial ridge of exactly the size and shape of that in *P. mesolobus* (a very slight indication of which may be now recognised in a notch in the lower margin of Sowerby's end view); and further, that along the corresponding line on the middle of the dorsal valve, there was a narrow, rough, abraded space, from which there could be no doubt the narrow ridge had been either broken in extracting the specimen from the matrix, or had been worn off from the soft sandstone in the carriage." The distinctness (he adds) of the mesial fold in the mould of the ventral valve would cause the specimens to be referred to *P. mesoloba,* were it not for the distinct longitudinal striation; and as this is also the distinguishing character of *P. Christiani* of de Koninck, he has little doubt of the identity of the species, allowance being made for difference in size, and the spines being rather more numerous than in the example figured by Koninck. I cannot, however, upon such imperfect material, identify with any degree

. . . . *P. subaculeatus* is one of the most far-spread fossils of the northern hemisphere; we know it in Russia, from the Government of Novogorod, as far as the Rivers Wol and Uchta, affluents of the Petchora, on the north, and as far as Voronèje, on the south; we also possess a specimen from the Altai. Everywhere in Russia, as well as in Belgium, in France, and in England, this species is Devonian."

of certainty the shell, or casts under description, with *P. sub-lævis*, De Kon., of which we have already shown *P. Christiani* to be a synonym. The difference in the size of the two (?) species is so great and so constant, that upon that ground alone we would feel warranted in expressing some uncertainty as to the identity. It will, therefore, I think, be desirable, for the present at least, to retain for the Upper Devonian shell the designation of *prælongus*, as given by Sowerby in the 'Transactions of the Geol. Soc. of London.'—*P. prælongus* occurs at Croyde Bay; also in brown grits at the top of Orchard quarry, parish of Pilton; at Braunton; and in the lower Marwood beds, near Marwood in North Devon, &c.

PRODUCTUS SCABRICULUS, *Martin*. Pl. XX, figs. 3, 4, 5.

PRODUCTUS SCABRICULUS, *Martin*. Petrif. Derb. p. 8, pl. xxxvi, fig. 5, 1809.
LEPTÆNA SCABRICULA, pl. 24, fig. 97, 1841.
PRODUCTUS SCABRICULUS, *Dav*. A Monograph of British Carboniferous Brachiopoda, p. 169, plate xlii, figs. 5—8, 1861.

Internal casts and impressions, exactly resembling those of the Carboniferous species, have been mentioned by Phillips as having been found in the Pilton and Marwood beds of North Devon. It will not be necessary to re-describe this shell, since full details will be found in our 'Carboniferous Monograph.' In the Museum of the Geol. Survey may be seen impressions of the interior of the dorsal valve, which are, to all appearance, identical in character with some from the Carboniferous shales of Lanarkshire.

PRODUCTUS LONGISPINUS? *Sow*. Pl. XX, fig. 7.

PRODUCTUS LONGISPINUS, *Sow*. Min. Conch. vol. 1, p. 154, pl. lxviii, fig. 1, 1814.

Imperfect casts of a small *Productus* bearing much resemblance to certain examples of *P. longispinus*, occur in the Upper Devonian grits at the top of Orchard quarry, near Pilton in North Devon, but it is impossible from the material in our present possession to be quite certain of the identification. These casts are subcylindrical, slightly transverse: ventral valve gibbous, evenly convex, but slightly depressed along the middle; ears small; beak incurved; dorsal valve concave, following the curves of the opposite one. Surface marked with numerous small longitudinal striæ, tolerably regular in their course.

Length 6, width 7 lines.

In the 'Transactions of the Geol. Soc.,' vol. v, 2nd series, pl. lvi, fig. 7, Sowerby describes and figures under the designation of *P. interruptus* a small *Productus*,

which appears exceedingly like a small example of the Carboniferous *P. fimbriatus*, Sow., or *P. laxispinus*, M'Coy, but which may have got accidentally mixed up among the Rev. W. V. Hennah's Plymouth specimens. The original example is now in the collection of the Geol. Soc.; but we will not include it without further proof in our list of British Devonian species. A figure of the shell will be found in Pl. XX of our Monograph.

Family—DISCINIDÆ.

Genus—Discina, *Lamarck.*

Discina nitida, *Phillips.* Pl. XX, figs. 9, 10.

Orbicula nitida, *Phillips.* Geol. of York., vol. ii, p. 221, pl. ix, figs. 10—13, 1836.
Discina — *Dav.* A Mon. of British Carboniferous Brachiopoda, p. 197, pl. xlviii, figs. 18—25, 1863.

Spec. Char. Shell marginally circular or elongated oval, the posterior portion being rather narrower than the anterior one. Large or free valve limpet-like, the pointed apex being situated at variable distances between the centre and the posterior margin: surface covered with numerous small, irregular, concentric wrinkles or striæ. The smaller, or lower valve is somewhat flattened, or slightly concave towards its anterior margin, with an oval-shaped foramen, surrounded by an elevated, convex margin, which extends from near the centre of the valve to a variable distance from the posterior edge. This valve is likewise ornamented with numerous concentric ridges or wrinkles, with small, flattened interspaces. Dimensions variable—

Length 8, width 7 lines.

Obs. This species occurs in the Upper Devonian, Carboniferous, and Permian formations of Great Britain. It has been found in greenish shales, or silty bed, of the Marwood group at Muddiford, about six or seven miles from Ilfracombe, on the Barnstaple road, also at Sloly or Plaistow Mill quarry, parish of Shirwell. Mr. Salter has also found a fine example in a dark grey limestone, which he attributes to the Marwood beds of West Angle, south side; this specimen can be seen in the Museum of the Geol. Survey.

Genus Lingula.

Lingula squamiformis, *Phillips.* Pl. XX, figs. 11, 12.

Lingula squamiformis, *Phillips.* Geol. of Yorkshire, vol. ii, pl. ix, fig. 14, 1836.
— — *Dav.* A Monograph of British Carboniferous Brachiopoda, &c., p. 205, pl. xlix, figs. 1—10, 1863.
— mola, *Salter.* Quarterly Journal of the Geol. Soc., vol. xix, p. 480, 1863.

Spec. Char. Shell longitudinally oblong, one third or less longer than wide, with sub-parallel sides, the broadest towards the anterior extremity. The anterior portion is gradually curved on either side, the beak being slightly angular at its extremity in the dorsal valve. The valves are slightly convex, but somewhat depressed along the middle. The external surface in both valves is covered with numerous fine concentric striæ or lines of growth. Dimensions variable—

Length 9, width 5 lines.

Obs. This shell, which I cannot distinguish, when well-shaped, from the Carboniferous *Lingula squamiformis* occurs in vast numbers, together with *Discina nitida*, in the greenish shales of Sloly or Plaistow Mill quarry, parish of Shirwell, in North Devon. It is, however, difficult to obtain specimens preserving their natural shape, almost every example being deformed, or put out of shape from the effects of pressure or cleavage.

Genus Calceola, *Lamarck.*

Calceola sandalina, *Linn.* (sp.) Pl. XX, fig. 13.

Anomia sandalium, *Linn.* Gmel. Syst., p. 3349, 1788.
Calceolites sandalinus, *Schlot.* Petrif., i, p. 173, 1820.
Calceola sandalina, *Lam.* Syst., p. 139, 1801.
— — *Phillips.* Pal. Foss., pl. lx, fig. 102, 1841.
— — *Davidson.* Introd. Brach., vol. i, pl. ix, figs. 224—228, 1853.

Within the last few years the researches of Professors Suess and Lindström have thrown considerable doubt as to this genus and species belonging to the Brachiopoda, among which it had found a home during so many years. If a Brachiopod, it seems the most abnormal of all its genera.

We will therefore merely mention its existence in our British Devonian rocks, where it was found many years ago by Mr. Godwin-Austen, at Ogwell, near Chircombe Bridge, in Devonshire. It is a common fossil in the Devonian Rocks of Couvin, in Belgium; in the Eifel; and at Néhou, in France, &c.

CONCLUSION.

In this Monograph, some 91 so-called species and varieties have been described and illustrated; but of these only about 65, or something less, have been with certainty named; 14 more are, in all probability, good species, but not yet sufficiently made out, on account of the imperfection or insufficiency of the material in our present possession; while the remaining 12 have been indicated merely for the sake of reference, and will, no doubt, when better known, have to be placed as synonyms of some of the 79 above recorded.

The species about correctly identified will be the following:—

The divisions *Lower*, *Middle*, and *Upper* Devonian are used here as terms of convenience, and not as equivalents to the *Lower*, *Middle*, and *Upper* Old Red.	Carb.	Passage Beds.	Upper Devonian.		Middle Devonian.		Lower Devonian.	
	Carboniferous.	Coomhola Series or Shales and Grits above Old Red Sandstone, County of Cork.	Pilton and Marwood Beds of North Devon.	Landlake and South Petherwin Beds.	Torquay, Woolborough, Plymouth, and Dartington, &c., Limestones and Shales.	Ilfracombe Series.	Linton Group.	Looe Slates and Grits.
Terebratula sacculus	×	?	×	...	×	...	...	...
— juvenis	...	...	...	...	×	...	...	...
— Newtoniensis	...	...	...	...	×	...	...	...
Stringocephalus Burtini	...	...	...	...	×	×	...	...
Athyris concentrica	...	?	×	×	×	×	...	...
— phalæna	...	...	...	...	×	...	...	...
Merista plebeia	...	...	...	...	×	×	...	...
Retzia ferita	...	...	...	...	×	...	...	...
Uncites gryphus	...	...	...	...	×	...	...	...
Spirifera Verneuilii vel disjuncta	...	×	×	×	×	×	...	...
— lævicosta vel ostiolata	...	...	...	...	×	...	×	...
— speciosa	...	...	...	...	×	?	...	...
— sub-cuspidata	...	...	...	...	×	...	...	...
— undifera et *var.* undulata	...	...	...	...	×	...	...	...
— nuda	...	...	...	...	×	?	...	...
— curvata	...	...	...	...	×	×	...	...
— Urii	×	...	×	×	×	...	...	...
— simplex	...	...	...	...	×	...	...	...
— cristata, *var.* octoplicata	×	×	×	?	×	×	...	×
Cyrtina heteroclita	...	?	...	...	×	×	...	...
— Demarlii	...	...	...	...	×	...	...	...
— ? amblygona	...	...	...	...	×	...	...	...
Atrypa lens	...	...	...	...	×	...	...	...
— lepida	...	...	...	...	×	...	...	...
— reticularis	...	...	...	×	×	×	...	×
— aspera	...	...	...	...	×	×	...	...
— desquamata	...	...	...	...	×	...	...	...
— flabellata	...	...	...	...	×	...	...	...
Davidsonia Verneuilii	...	...	...	...	×	...	...	...
Rhynchonella triloba	...	...	...	...	×	...	...	...

	Carb.	Passage Beds.	Upper Devonian.		Middle Devonian.		Lower Devonian.	
	Carboniferous.	Coomhola Series or Shales and Grits above Old Red Sandstone, County of Cork.	Pilton and Marwood Beds of North Devon.	Landlake and South Petherwin Beds.	Torquay, Woolborough, Plymouth, and Dartington, &c., Limestone and Shales.	Ilfracombe Series.	Linton Group.	Looe Slates or Grits.
Rhynchonella Pengelliana	...	...	...	...	...	...	...	×
— bifera	...	...	...	...	×	...	...	...
— pugnus et *var.* anisodonta	×	×	?	×	×	×	...	...
— acuminata	×	...	...	...	×	...	...	...
— reniformis	×	...	...	...	×	...	...	...
— pleurodon et var.	×	×	×	×	×	×	...	...
— cuboides	...	...	...	...	×	...	...	...
— laticosta	...	...	×	...	...	...	...	...
— primipilaris et *var.* implexa	...	...	...	...	×	...	...	...
— angularis	...	...	...	...	×	...	...	...
— ? Ogwelliensis	...	...	...	...	×	...	...	...
— ? protracta	...	...	...	...	×	...	...	...
— ? Lummatoniensis	...	...	...	...	×	...	...	...
Camarophoria rhomboidea (vel globulina)	×	...	...	×	×	...	...	...
Pentamerus brevirostris	...	...	...	...	×	...	...	...
— biplicatus	...	...	...	...	×	...	...	...
Streptorhynchus analogus	×	...	×	...	×	×	...	...
— umbraculum	...	...	...	...	×	×	?	...
— crenistria	×	×	×	×	...	...	...	...
— gigas	...	...	...	...	...	...	...	×
Leptæna interstrialis	...	...	...	...	×	...	...	...
— ? nobilis	...	...	...	...	×	...	...	...
— (vel Orthis) laticosta	...	...	...	...	...	...	...	×
Orthis striatula	...	?	×	×	×	×	...	...
— arcuata	...	...	...	...	×	...	...	...
— interlineata	...	?	×	×	...	...	...	...
Chonetes sordida	...	...	...	...	...	...	×	...
— Hardrensis	×	×	×	...	...	...	...	...
— minuta	...	...	...	...	×	...	...	...
Strophalosia productoides = caperata	...	...	×	×	×	...	...	...
Productus prælongus	...	...	×	...	...	...	...	...
— subaculeatus = fragaria	...	...	...	×	×	...	...	...
Discina nitida	×	...	×	...	...	...	...	...
Lingula squamiformis	×	...	×	...	...	...	...	...
Calceola sandalina	...	...	...	...	×	...	...	...

Even a few of the 65 above enumerated may still require further consideration; for instance, under *Spirifera curvata* (of which Schlotheim's typical shape occurs at Hope's Nose, near Torquay) have been included some decorticated specimens, bearing much resemblance to *Sp. glabra*, but which we have provisionally left with *Sp. curvata*, on account of the transverse lines characteristic of that species, which are also observable on some "glabra"-like specimens of *Sp. curvata*. The same observation may be made with reference to certain variations in shape of *Sp. undifera*, which, when deprived of their transverse lines or sculpture (from the effects of fossilisation), it is quite impossible to distinguish from the Carboniferous *Sp. ovalis*. The material at hand in connection with *Rhynchonella Pengelliana*, the largest British Devonian species of the genus with which we are at present acquainted, has not been sufficiently complete to enable us to give a perfect representation or description of the shell. *Rhynchonella laticosta* is also a good and common form in certain Upper Devonian localities; but, as is the case with *R. Pengelliana*, it occurs only in the shape of distorted and compressed casts, so that it is almost impossible from such material to describe the exact form of the shell. It will also have to be determined, by further examination, whether *Rh. angulata* is a distinct species from *Rh. primipilaris*, and its variety *implexa*, as well as whether *Rh.* (?) *Ogwelliensis*, *Rh.* (?) *protracta*, and *Rh.* (?) *Lummatoniensis*, really belong to the genus *Rhynchonella*, or if one or more of them might not be referable to *Camarophoria*. Some uncertainty may also prevail with reference to the question which relates to *Streptorhynchus umbraculum* and *St. crenistria*, which some palæontologists have considered to be distinct species, but which others have combined in one. More material and examination of *Strept. gigas* will also be desirable, the distorted specimens from Cornwall at command not being sufficient to enable us to make out all its characters. The genera, or sub-genera, to which *Leptæna*? *nobilis* and *L.* (vel *Orthis*) *laticosta* should be referred, has still to be accurately determined. Some doubt has also been expressed with reference to *Orthis striatula* and *O. resupinata* being distinct species; and it must be allowed that, if distinct, the difference is but small. It is likewise probable that *Chonetes sordida* and *Ch. Hardrensis* belong to the same species,—this point will, however, require further consideration, as the material from Linton, with reference to *Ch. sordida*, was very imperfect. We will now enumerate those forms of which the greater number, if not quite all, may prove, when better known, to be good species, but of which the material hitherto procured from our British Devonian rocks has not been sufficient to enable us to arrive at a satisfactory identification.

	Carboniferous.	Coomhola Series or Shales and Grits above Old Red Sandstone, in County of Cork.	Pilton and Marwood Series of North Devon.	Landlake and South Petherwin Series.	Torquay, Woolborough, Plymouth, &c., Limestone.	Ilfracombe Group.	Linton Group.	Looe Slates and Grits.
?Terebratula elongata	×	...	×	...	...	...	...	...
?Rensselæria stringiceps	...	?	...	...	...	×	...	...
Athyris Bartoniensis	...	...	...	...	×	...	...	...
— Newtoniensis	...	...	...	...	×	...	...	...
?Spirifera primæva, *Stein.*, described at p. 35 as *Sp. cultrijugata*	...	...	...	...	...	...	...	×
?Spirifera Newtoniensis	...	...	...	...	×	...	...	...
? — hysterica	...	...	...	...	×	...	×	...
? — lineata, vel microgramma	×	...	...	?	×	...	...	...
? — laminosa	×	...	?	...	...	...	...	...
? — insculpta	×	...	...	...	×	...	...	...
?Orthis hipparionyx	...	...	...	...	...	...	...	×
? — granulosa	...	...	...	...	×	...	×	...
Productus scabriculus	×	×	×	...	...	...	...	...
? — longispinus	×	...	×	...	...	...	...	...

Terebratula elongata. Two or three casts found in the neighbourhood of Barnstaple have been with uncertainty referred to this species.

Rensselæria stringiceps. This identification is uncertain; the material at hand being very incomplete.

Athyris Bartoniensis and *A. Newtoniana* have been established on insufficient material; but, as these shells differed much from any of the others found in our Devonian rocks, they have been provisionally named.

Spirifera hysterica. This determination is also uncertain for the reasons given at p. 34.

— *cultrijugata* was so named at p. 35 of this Monograph, but the identification was given under great doubt, the material being very incomplete and unsatisfactory. It is possible that the casts in question might be more correctly referred to *Sp. primæva* of Steininger.

— *Newtoniensis* has been so named after a single specimen in the British Museum. This species (?) will require further investigation.

— *lineata.* All the specimens so named, which I was able to procure, were very imperfect and unsatisfactory; but it is probable that this species, or at any rate a nearly allied form, does in reality occur in our Devonian strata.

? — *laminosa.* Only two or three imperfect casts or impressions supposed to belong to this species have been found in our Upper Devonian Grit. This species has been here recorded on Mr. Salter's authority.

— *insculpta.* Several imperfect specimens bearing much resemblance to the Carboniferous shell have been found in our Middle Devonian Limestones. A search for more complete examples at Lummaton would be desirable.

Orthis hipparionyx. Large internal casts occurring abundantly at Looe have with some uncertainty been referred to *O. hipparionyx.*

Orthis granulosa. I was able to examine only one valve of this so-termed species, and therefore cannot feel certain as to its specific value.

Productus scabriculus, determined from imperfect casts in the Upper Devonian Grits of North Devon.

— *longispinus.* Some casts from the Upper Devonian Grits of Barnstaple have with uncertainty been referred to this species.

The following are very doubtful so-termed species, and are here merely quoted for the sake of reference, as it has not been possible to refer them with certainty to any of the others.

Spirifera canalifera, vel *aperturata.* I have seen no specimen which could with certainty be referred to this well-known Devonian species. An uncertain fragment of a Spirifer from Linton was so identified by Prof. Phillips.

— *mesomala, Sp. obliterata, Sp. megaloba,* and *Sp. rudis,* Phillips, appear to me to have been established from undeterminable fragments or casts.

Rhynchonella triangularis, Sow., from Plymouth, I have never seen, but is no doubt a synonym of some of those already recorded—M'Coy states of *acuminata.*

— *subdentata* has not turned up; it is probably a synonym of some of the others.

— *sphærica.* I believe this to be a Silurian, and not a Devonian shell.

Strophomena persarmentosa has been made out of a distorted undeterminable cast.

— *semicircularis* and *plicata* are also very uncertain. (Any how, it is not the Silurian species originally so named by M'Coy.)

Productus interruptus is probably a Carboniferous, and not a Devonian shell.

From the above review it is evident that not many more than seventy British Devonian species of Brachiopoda have been hitherto discovered. Of these about eighteen are also recorded from the Carboniferous period; or, in other words, fourteen or fifteen appear to be common to the Upper Devonian and Carboniferous, while eleven or twelve may be common to the Middle Devonian and Carboniferous. These statements or numbers must, however, be taken as being as nearly correct as the present state of our information will admit. The following Table shows at a glance what are those species which appear to be common to the *Carboniferous, Upper Devonian* (or Marwood, Pilton, and South Petherwin series), and *Middle Devonian* (such as that of the neighbourhood of Torquay, Newton Abbot, Ogwell, Dartington, Plymouth, &c.), and the *Lower Devonian* (of Looe, Meadfoot, and Linton).

	Carboniferous.	Upper Devonian.	Middle Devonian.	Lower Devonian.
Terebratula sacculus	×	×	×	...
?[1] — elongata	×	×	...	...
Spirifera Urii	×	×	×	...
— lineata	×	×	×	...
? — laminosa (according to Salter)	×	×	...	..
— cristata, *var.* octoplicata	×	×	×	×
? — insculpta	×	...	×	...
Atrypa reticularis	...	×	×	×
Rhynchonella pugnus	×	×	×	...
— acuminata	×	...	×	...
— pleurodon	×	×	×	...
— reniformis	×	...	×	...
Camarophoria rhomboidea, vel globulina	×	×	×	...
Strophomena analoga	×	×	×	...
Streptorhynchus umbraculum, vel crenistria	×	×	×	×
Orthis striatula	?	×	×	...
Chonetes sordida	...	...	...	×
— Hardrensis	×	×	...	...
Strophalosia productoides, vel caperata	...	×	×	...
? Productus scabriculus	×	×	...	...
? — longispinus	×	×	...	...
Discina nitida	×	×	...	...
Lingula squamiformis	×	×	...	...

But, as I have already stated, there must still prevail some uncertainty whether *Sp. glabra*, *Sp. ovalis*, and *Orthis resupinata*, might not also be represented in the Devonian as well as in the Carboniferous period.

Before proceeding further with what we may have to say with reference to the Devonian species of Devonshire, Cornwall, and West Somerset, let us give a glance at those Brachiopoda that occur in slaty and sandy grits, which in some parts of the South of Ireland lie over the upper part of the Old Red Sandstone. In the county of Cork (according to the maps and sections made by the Geological Survey of Ireland) we have underlying the Carboniferous Limestone an enormous development of Carboniferous Slate, which is known to contain Carboniferous fossils only, such as *Spirif. cuspidata*, *Orthis Michelini*, *Strept. crenistria*, *Athyris squamosa*, *Rh. pleurodon*, &c. (Salter). Under these occur another series of dark-coloured clay-slates, and brown, rusty, sandy-looking rocks, which in hand-specimens, according to Mr. Jukes, is readily mistaken for a brown, fine-grained sandstone. These last-named Irish beds constitute,

[1] This point of interrogation indicates that the question relative to either the specific identification or recurrence will require further examination, for reasons already given.

in part at least, the 'Coomhola series' of Jukes, which stratigraphically would belong to the Carboniferous system, but which contain a great majority of Carboniferous species with a very few hitherto known only as Devonian.

The fossils occur abundantly in these lower shales, slates, and sandy rocks in the condition of imperfect distorted internal casts and impressions, and are often so obscure as to render their specific determination impossible, or at least very uncertain. We are, however, sometimes able to reproduce the shell, with its natural shape and character, by pressing a piece of softened gutta-percha into the impressions the shell has left in the rock; and I must here observe, that the aspect of the rock and its accompanying fossils is quite similar to what we find in North Devon, viz., the Marwood and Pilton group. I am moreover indebted to Mr. Jukes for having forwarded for my inspection some hundred specimens collected from those beds by the Geological Survey of Ireland.[1]

In his paper on the "Upper Old Red Sandstone, &c.," published in the 'Journal of the Geological Society' (Nov. 1863), Mr. Salter considers the Carboniferous Slate of Ireland to overlie and to be distinct from the Coomhola series, which last he looks upon as equivalent to the Marwood series of Devonshire, referring it to the Upper Devonian and not to the Carboniferous series. It may therefore be more convenient for the sake of reference and comparison to arrange into three columns those species of Brachiopoda which I have found, by personal examination, to occur in the Carboniferous Shales, 'Coomhola series' of the county of Cork, and the Marwood and Pilton beds of Devonshire and East Somerset. It will not, however, be necessary to mention every species that occur in true and well-known Carboniferous Slates, as these will be found enumerated in the Monograph that treats of that formation, but only to note down those forms which occur likewise in the Coomhola and the Marwood series. We will take no account at present of three or four very obscure and indeterminable fragments which occur both in the Coomhola series and that of Marwood and Pilton, and which may perhaps belong to different species from those we are about to enumerate.

[1] An allusion to these beds and fossils will be found in the footnote p. 42, &c., but a complete account by Mr. Jukes, Mr. Baily, and myself, will be seen in the 'Memoirs of the Geological Survey of Ireland,' or the 'Explanations to accompany Sheets 192 and 199 of the Geological Survey of Ireland, illustrating part of the Counties of Cork and Kerry,' 1864.

We prefix a mark of interrogation to those species of which the identification is not quite certain.	Marwood and Pilton Series of North Devon and West Somerset.	'Coomhola Series,' in the County of Cork.	Carboniferous Shales and Slates.
1. Terebratula sacculus	×	?	×
? 2. — elongata	?	...	?
? 3. Rensselæria, sp., undeterminable	...	×	...
4. Athyris concentrica	×	?	...
5. Athyris, sp., too imperfect to be correctly determinable	×	×	...
6. Spirifera Verneuilii vel disjuncta	×	×	...
7. — striata	...	×	×
8. — Urii	×	...	×
9. — cristata, *var.* octoplicata	×	×	×
?10. Cyrtina heteroclita? (see Pl. XX, fig. 16)	...	?	...
11. Rhynchonella pleurodon	×	×	×
12. — pugnus	?	×	×
13. — laticosta	×	...	...
14. Strophomena analoga	×	...	×
15. Streptorhynchus crenistra	×	×	×
16. Orthis striatula vel resupinata	×	×	×
17. — interlineata	×	?	...
18. Chonetes Hardrensis	×	×	×
19. Strophalosia productoides vel caperata	×	...	...
20. Productus prælongus	×	...	...
?21. — longispinus	×	...	×
22. — scabriculus	×	×	×
?23. — ? approaching to *P. semireticulatus* (see Pl. XX, fig. 17)	...	×	?
24. Discina nitida	×	...	×
25. Lingula squamiformis vel Mola (Salter)	×	...	×

In the determination of some of the Irish species from the 'Coomhola series' a certain degree of uncertainty must still prevail; for instance, it could not be made out whether some crushed specimens should be referred to *Athyris concentrica*, or to *A. Roiyssii*, or whether certain impressions belonged to *O. interlineata*, or to small examples of *O. Michelini*. But what appears quite evident is, that these dark shales and rusty-coloured grits from the county of Cork contain an exceedingly small proportion of true Devonian types, and that by far the greater number are with certainty Carboniferous. It is also quite true that we observe in them casts of a shell exactly resembling those of *Spirifera Verneuilii*, or *V. disjuncta*, found likewise in the Marwood and Pilton beds of North Devon; but the distinction between *Sp. Verneuilii* and *Sp. striata* is so small as to be sometimes with difficulty determined from mere casts or impressions. The fossil which has, however, puzzled me most from those so-termed Coomhola beds was a shell which in external shape closely resembled *Cyrtina heteroclita*, a true Devonian type; but I am also aware that some exceptional examples of *Spiriferina cristata*, var. *octoplicata*, bear resemblance

to certain shapes of *C. heteroclita.* The absence, as far as my experience goes, in these Irish beds, of any examples of *Rhynchonella laticosta, Strophalosia productoides* (or *caperata*, and *Prod. prælongus*—species so exceedingly abundant and characteristic of the North Devon and West Somerset 'Marwood and Pilton beds,' and which we have never yet observed from any Carboniferous rock with which we are acquainted—is very remarkable. On the other hand, out of about twenty-one species which have been hitherto obtained from the 'Marwood and Pilton series,' nine or ten only occur also with certainty in the Cork shales and grits above described; while of the Marwood and Pilton series, some twelve or fourteen out of the twenty-one occur also in the Carboniferous slates and shales of different parts of Great Britain.

It appears to me possible that, if the 'Coomhola series' is not exactly contemporaneous with that of Marwood and Pilton, it would at any rate be the regular continuation of these last-named beds, and thus form a regular passage or connection between the Marwood and the Carboniferous slates and shales which possess only Carboniferous species. It is, however, no positive proof that, because these 'Coomhola,' or Cork beds, have not hitherto shown a trace of *Rhynchonella laticosta, Strophalosia productoides,* and *Productus prælongus,* the two rocks might not be of the same age; for we must not expect to find in every locality every species that is characteristic of the age of the deposit, but the absence of these three forms in the Irish beds is certainly worthy of notice.

With reference to the South Pembrokeshire series to which Mr. Salter attaches so much importance I can add but little; for the only Brachiopod I have seen from its beds is a *Discina,* found there by Mr. Salter, and now in the Museum of the Geological Survey. It is the same as the Carboniferous *Discina nitida,* and occurs also in the greenish shales or silty beds of the Marwood series.

We will now add a few short observations on the geological, geographical, and palæontological distribution of the species we have been able to examine from the counties of Devonshire and Cornwall; but for more ample geological information I must refer the reader to the Memoirs by the Rev. A. Sedgwick and Sir R. Murchison, 'On the Physical Structure of Devonshire,' Sir H. De la Beche's and Mr. Godwin-Austen's memoirs on the same subject. Prof. Phillips's 'Palæozoic Fossils,' and Mr. Pengelly's paper "On the Distribution of Devonian Fossils of Devon and Cornwall," published in the 'Annual Reports of the Royal Society of Cornwall for 1860,' as well as to Mr. Salter's valuable paper on the "Upper Old Red Sandstone and Upper Devonian Rocks," published in the Quarterly Journal of the Geol. Soc. for Nov., 1863.

North Devon and its coast-line from beyond the Foreland to the River Taw, or to Brushford in Somersetshire, is one of considerable geological interest, and has been very carefully examined by the Rev. F. Mules, of Marwood, Mr. Valpy, of Ilfracombe, Mr. J. Hall, of Barnstaple, Mr. Salter, and others. The Rev. F. Mules kindly forwarded for my inspection and guidance a detailed geological map of the district, in

which he had carefully marked every locality from which fossils had been by him discovered. He divides North Devon, as have done some other geologists, into the following five zones:

Zone I would seem to comprehend the whole of the Linton group proper, extending from the Foreland to the west end of Woodabay, together with the grey and claret-coloured shales and sandstones of Martinhoe and Heddons Mouth, and the rough quartzose grits of Trentishoe, Holdstone, and the Hangman; it terminates under the Little Hangman, about the north-east point of Coombe Martin Bay. At the Foreland, two miles east of Lynmouth, is the anticlinal, and here are the lowest beds of the North Devon series, apparently unfossiliferous. Near Watersmeet and Lynmouth fossiliferous bands appear, and from this line all along the Valley of Rocks to Leemouth and Woodabay are abundant fossil remains, the whole unfortunately being imperfectly preserved. Above Trentishoe Town, and across the rough Moorland of Holdstone and the great Hangman, occur blocks of sparry rock, in which are found abundant casts of *Natica*, *Myalina*, and other undetermined forms, Corals, &c.[1]

The Linton and Fowey beds in North Devon and Cornwall are considered by Mr. Salter to be equivalent to the Ardennes-Schiefer, Coblentz-Schichten (or Spirifer-sandstone), Wissenbach-Schiefer. I was therefore anxious to examine with attention the species of Brachiopoda which could be procured from these so-termed Linton beds. The species, but not specimens, appear to be few in number, and the shells are all in the condition of more or less imperfect casts and impressions; and as far as I can judge from those I have obtained from different sources, and especially from Mr. Valpy, who had expressly visited the locality, I could determine only the following few:

1. *Spirifera laticosta*, Lam. = *S. ostiolatus*, Schloth. This appears abundant in the condition of casts and imperfect impressions.
2. — *hysterica*, Schloth. If this shell be properly determined, it is abundant in the state of casts and impressions.
3. *Streptorhynchus umbraculum*, Von Buch, vel *crenistria*. Some impressions would appear to be referable to this shell, and are in part those which Prof. Phillips seems to have named *Orthis compressa*, Sow., in his work on 'Pal. Fossils of Devon,' &c.
4. *Orthis* sp. This may be *O. granulosa*, Phillips, but the specimens I have had were not specifically determinable.
5. *Chonetes* (*Leptæna*) *sordida*, Sow., is abundant.

Besides these, of which I have seen examples, Prof. Phillips (at page 183 of his work already named) states that he has found *Spirifera aperturata* at Linton; but this last identification was, however, made from a very imperfect and uncertain fragment, and therefore cannot be definitely admitted without further evidence. The Spirifers from the Linton

[1] Mr. Valpy informs me that he found this 'sparry' rock, *in situ*, at West Challacombe, just under the Little Hangman.

beds were apparently, in general, species in which the fold and sinus were smooth; but the fragment attributed to *Sp. aperturata* shows that at least one of the forms of the genus was provided with ribs on the sinus and fold.

Orthis granulosa is still an uncertain or not sufficiently made out species; it is said by Phillips to occur at Woodabay, and some very imperfect casts found by Mr. Valpy at Heddons Mouth may possibly be referable to that species. Phillips mentions also *Orthis interlineata* as a Linton species, but of this I have seen no examples from that locality. The distinguished Oxford professor divides the Linton group into a lower, middle, and upper part, and states his so-termed *Orthis longisulcata* was found in the lower part, near Watersmeet and Lynmouth, and in the upper part near West-Lee; but the specimens so named were so imperfect and distorted that I could form no decided opinion as to their true shape and character. Some fragments also seemed to be not unlike *Orthis striatula*. Hence further search among these Linton beds would be very desirable, for out of eight or nine so-termed species of Brachiopoda supposed to occur, but five or six distinct forms appear to me to have been hitherto sufficiently established.

Zone II would extend from about Little Hangman to a short distance beyond Ilfracombe. It commences upon the east side of Coombe Martin Bay; and probably, with beds containing large and weathered examples of *Stringocephalus Burtini*, which are said to occur under Little Hangman. These beds are very hard to open, being silicates of lime and iron, or clay-iron-stone, and from which it is most difficult if not impossible to obtain a good fossil.[1] Here, therefore, we would have true Middle Devonian beds, and perhaps at Coombe Martin Bay some representative of the Stringocephalen-Kalk of the Germans, or beds which Mr. Salter would refer to the Lenne-Schiefer and Eifel-Kalk of that country. This region has been recently studied by Mr. Valpy, who has kindly furnished me with many valuable unpublished notes upon the subject, but from which I can extract but the following passages:—"The prevailing rock of the Ilfracombe group is an argillaceous slate of varied texture, generally rather soft and friable, but occasionally firm enough to be used for roofing-purposes, for which it is quarried at Woolscot, &c. It is intersected by numerous beds of sandstone and every kind of grit, from a fine-grained laminated quartzite, to a rough siliceous rock almost approaching to conglomerate, and in colour from a pale-cream, to grey, blue, and decided red, as at Widmouth. There are numerous intermittent beds of limestone through its whole course, and perhaps the

[1] Mr. Valpy informs me that he has seen large blocks with weathered impressions of small *String. Burtini*, on the west side of Coombe Martin Bay, about a mile west of Hangman, in hard impracticable sandstone, and that the east coast of Coombe Martin Bay wants much examination. There are many thick beds of sandstone, with slates occasionally fossil-bearing; and round the point, we come to the tough siliceous sandstone with large *St. Burtini*, close to which are the Red Quartzose Grits, containing the *Natica* and *Myalina* of the Hangman and Holdstone. I have not myself had the advantage of, as yet, seeing a determinable specimen of *Stringocephalus* from Coombe Martin, but its occurrence has been mentioned by various authors.

characteristic of this group, as compared with that both above and below it, might be the frequent presence of good limestone, which is almost totally absent in both the Linton and Morte series. The clay-slate at a short distance south of the town gives way to a yellowish shale, much quarried for building-purposes, and it is a question with me if this shale does not mark the line of commencement of the Morte beds, running as it does apparently in the general line of stratification of the country about east-south-east from a point near Lee, where, according to the coast-section given by De la Beche, that group begins.

"The general inclination of the strata being east-south-east, as the coast-line from Ilfracombe to Watermouth runs pretty nearly east-north-east, very good sections are seen along it. There is a rather extensive fossil fauna, but the organisms are, as a rule, very imperfect, being mostly in the condition of casts, which, owing to the peculiar nature of the rock, are principally shown on the weathered surface of the beds. I have found between forty and fifty different species of one sort and another, and, though many of them are hitherto undeterminable by reason of imperfection, still enough can be identified to place the group in its proper relation to the formation of which it is a part.

"It may here be observed, that the North Devon stratification presents a regular sequence from its lowest beds at the Foreland, beyond Lynmouth, to the Carboniferous beds south of Barnstaple, so that the organisms of its different groups, though not so perfect as those of the south of the county, yet when identified, will be of greater comparative value in settling the position of their parent beds than those of the more disturbed relative beds from Torquay to Plymouth. Nearly all the species found in this group have also been found at West Hagginton and Pillsbro. There are several localities which can be studied with advantage; such as Helesborough, which, with its prominent reefs, forms the eastern boundary of the harbour of Ilfracombe, and at low water in the spring-tide can be safely examined. Its sea-face consists of a variety of beds, limestones, sandstone, shales, and slates. The limestone rocks are full of remains of Corals, Encrinites, Brachiopoda, Gasteropoda, and Cephalopoda, the same may be said of the shales, and occasionally of the sandstones . . . . Hagginton Hill and beach, where nearly every form of the district may be found. I had the good fortune to come to Ilfracombe just when a large quarry was open on the top of the hill; it was worked for lime, and the waste or 'deads,' as they are here called, were in great heaps by the side, these 'deads' consisting of impure limestone; quartzose sandstones, with much mundic, umber, and ochre, I found to be full of organisms, chiefly Brachiopoda, and I was able to extricate many specimens perfect enough for identification; among these *Fenestella* everywhere . . . . . On the top of the down is a large limestone quarry now in work, abounding in Corals, Crinoids, &c., *Favosites polymorpha* being predominant. On the weathered joints, where apparently water has for ages percolated, are numerous though imperfect remains of Brachiopoda; it is in the same line with the beds in which I found *S. Burtini*, and some of the weathered shells may be of that species; here, too, is *Sp. Verneuilii* vel *disjuncta*, a *Rhynchonella* and *Cyrtina heteroclita* . . . . . Hagginton beach is remarkable from its

numerous alternating beds, sandstone, clay, slate, limestone, and shale, more or less fossiliferous." Mr. Valpy having kindly forwarded for my examination at various intervals a considerable number of the Brachiopoda he had been able to collect from the Ilfracombe group: I now append a list of those that I have been able to identify.

1. *Stringocephalus Burtini.*
?2. *Rensselæria stringiceps,* var.? A shell allied to that species was found by Mr. Valpy in a calcareo-siliceous bed on the Hagginton Beach.
3. *Athyris concentrica.*
4. *Merista plebeia.* The specimens were very imperfect.
5. *Spirifera Verneuilii,* Murch. = *disjuncta,* Sow.
6. — sp.? Too imperfect for accurate determination.
7. — *speciosa.* Imperfect specimens.
8. — *nuda.*
9. — *curvata,* approaching to *Sp. glabra.*
10. *Cyrtina heteroclita.*
11. *Atrypa reticularis,* et var. *aspera.*
12. *Rhynchonella pleurodon.*
13. — *pugnus.*
14. *Strophomena analoga.*
15. *Streptorhynchus umbraculum* vel *crenistria.*
16. *Orthis striatula.*

Besides these, of which I have examined specimens, Mr. Valpy has found fragments which he thinks might perhaps be referable to *Atrypa desquamata, Orthis interlineata,* and *Calceola sandalina?*

We have therefore in this Ilfracombe group a well-characterised Middle Devonian formation, which may be almost considered on a parallel with those of the Torquay, Newton, and Plymouth districts, but with this difference, that in the last named, and in other similar localities, the species are more numerous, and the shell itself preserved.

Zone III. It appears to be difficult to exactly determine the line dividing Zone II from Zone III; but on examining the section of the North Devon coast given by De la Beche, it would appear that his Morthoe group commences apparently about a quarter of a mile east of Lee, and it is immediately here that several greenstone dykes appear, the only ones known on the coast. If this point be the separation between the two groups, a line drawn from it about east-south-east would exactly cut through the olive and cream-coloured shaley beds worked for building-purposes on both sides of the town, and would leave the clay-slate with its associated sand and limestone beds within the Ilfracombe group, so that a line running through all the quarries of this shale, at Slade, Wharnscombe, and Woolscot, would indicate the commencement of the Morte zone, which would extend along the coast as far as Woolacombe, or about to the middle of Morte Bay. This zone is chiefly composed of slates and shales supposed to be destitute

of fossil remains; but at about a mile south of Ilfracombe, and perhaps within the limits of Zone III, Mr. Valpy has found some Crinoidal remains, a fragment of a pipe-like Annelid, and a very imperfect cast of Orthoceras, so that it would be hardly safe to designate this zone as "azoic."

Zones IV and V comprise what has been termed the Marwood and Pilton series and would extend from a little below Woolacombe to the River Taw, or to Brushford in Somersetshire; but it has not yet been quite clearly made out to my mind, that, palæontologically speaking, the Marwood and Pilton beds should constitute separate groups. I must refer the reader to pp. 180-182 of Mr. Salter's paper on the 'Upper Old Red Sandstone,' published in vol. xix of the 'Quarterly Journal of the Geol. Soc.,' for his views upon the subject. Mr. Salter considers the Marwood beds to be the oldest, and to be separated from the Pilton series by a bed of greenish slate or silty beds abounding in what I take to be *Discina nitida* and *Lingula squamiformis*, or *L. Mola* of Salter; and the upper portion of the Pilton beds would, according to the last-named author, pass into true Carboniferous series. The Rev. F. Mules informs me, that what appears to him reasonable of these Marwood beds would be, that they extend from Baggy to High Bay, that at Braunton they are more than a mile wide, and throughout the whole extent are either white or red or mixed sandstone at an high angle, but always with oxidized red sand between them, and, when fossils appear, generally with humus; but immediately one comes to the Pilton beds, then red matter ceases, and the blue of carbon stains the slates mixed with beds of lime. The Lingula-beds are in the midst of the Marwood beds, but never in the Pilton beds. Sloly quarries, containing the *Lingula* and *Discina*, belong to the Marwood beds.

Fossils in the condition of casts and impressions occur in immense abundance in a number of localities throughout these zones; and thanks to the kindness of the Rev. F. Mules, of Marwood, Mr. J. Hall, of Barnstaple, Mr. Symons, of Braunton, and of several other persons, I have been able to examine a very considerable number of fossils from the Marwood and Pilton beds. I have also had many specimens from Baggy, Croyde, and Sloly; and after a careful investigation I was able to determine the following species:

1. *Terebratula sacculus* (rare).
?2. — *elongata.*
3. *Athyris concentrica.*
4. — sp., not determinable.
5. *Spirifera Verneuilii* = *disjuncta.*
6. — *Urii.*
7. — sp. (not determinable).
8. — *cristata*, var. *octoplicata.*
9. *Rhynchonella pleurodon.*
10. — *laticosta.*
11. *Strophomena analoga.*
12. *Streptorhynchus crenistria.*
13. *Orthis interlineata.*
14. — *striatula* vel *resupinata?*
15. *Chonetes Hardrensis.*
16. *Strophalosia productoides* vel *caperata.*
17. *Productus prælongus.*
18. — *scabriculus.*
?19. — *longispinus.*
20. *Discina nitida.*
21. *Lingula squamiformis* vel *Mola.*

Besides these twenty-one species, Mr. Salter mentions *Sp. laminosa ;* and some obscure fragments have been supposed referable to *Rh. pugnus.* The rock near Marwood and Barnstaple is very rotten, and consequently the casts are generally imperfect; but near Braunton it is more compact, and consequently the casts and impressions are at times better preserved.

Prof. Phillips describes Brushford, near Dulverton, in West Somerset, as the east end of the Pilton beds, where he states the following species to have been found:—*Sp. microgemma, Sp. decussata, Sp. unguicula* (*Urii*), *Sp. obliterata, Sp. mesomala, Sp. megaloba, Orthis plicata, O. parallela,* and *Prod. scabriculus.* Thanks to the kindness of the Rev. F. Mules, I have also been able to examine a good many specimens of fossiliferous rock and fossils from the neighbourhood of Brushford, and which I found to agree exactly with those already described from the Marwood and Pilton beds of North Devon.

The following is the list of the species I have been able to identify from these Brushford beds:

1. *Terebratula sacculus.*
2. *Spirifera Verneuilii* vel *disjuncta.*
3. — *Urii.*
4. — *cristata,* var. *octoplicata.*
5. *Rhynchonella pleurodon.*
6. *Streptorhynchus crenistria.*
7. *Orthis interlineata.*
8. *Chonetes Hardrensis.*
9. *Strophalosia productoides,* vel *caperata.*
10. *Productus prælongus.*
11. — *scabriculus.*

And now, to conclude the little we have thought necessary to say in connection with North Devon, we will quote from Mr. Salter's paper the following passage (p. 482):—"It is extremely difficult to say precisely where the Pilton group ends and this group of shales (the Carboniferous) begins; but the absence of sandstone-bands and the presence of only Carboniferous species show sufficiently the reality of the change. *Strophalosia ecaprata,* var. *membranacea* is occasionally present, but not the ordinary variety. It is associated with *Spirifer laminosus, Sp. cuspidatus, Streptorhynchus crenistria, Chonetes Hardrensis, Athyris Royssii, Bellerophon decussatus, Productus costatus, P. Martini, Orthis Michelini, Venus parallela,* Phillips, *Spirifer ovalis* (small), *Sp. bisulcatus, Phillipsia seminifera,* and many others. But these are enough to show that we have passed from the sandy Pilton group to the true Carboniferous slate."

We will now add a few words on those beds which as to age would be intermediate between the upper beds of the Middle Devonian and the Marwood series. These beds occur at Landlake, parish of South Petherwin in Cornwall,[1] and are considered by some geologists and palæontologists (among whom we may quote Messrs. Murchison,

[1] Landlake is in Cornwall, and will be found in Sheet xxv of the 'Ordnance Survey Map,' a short mile due east of South Petherwin, and barely two miles south of Launceston. It is, I believe, in the parish of South Petherwin, and is the chief fossil locality in the district. In the writings of geologists Landlake and South Petherwin are synonyms. There are no fossils in the latter place.

Pengelly, Salter, and others), to be a little older than the Marwood and Barnstaple series; and in his paper already quoted, Mr. Salter mentions that he feels disposed to view the red band of the Morte series, Zone III of the North Devon section, as an equivalent of the beds about Launceston and Petherwin. The following is a list of the Brachiopoda I have been able to recognise from the Landlake or Petherwin beds, and which will agree with the one already published by Mr. Salter:

1. *Athyris concentrica.* In Mr. Pengelly's Collection.
2. *Spirifera Verneuilii = disjuncta = Barumensis = gigantea*, &c.
3. — *Urii = unguiculus.*
?4. — *lineata.* I have not seen this fossil; it is given here from Mr. Salter's list.
?5. — *bisulcata.* From Mr. Salter's list.
6. *Atrypa reticularis*, vel *A. desquamata?*
7. *Rhynchonella pleurodon.*
8. — *pugnus.*
?9. — *subdentata.* From Mr. Salter's list. I have doubts as to the specific value of this so-called species.
?10. *Camarophoria (globulina?) rhomboidea*, Phillips. From Mr. Salter's list.
11. *Orthis striatula*, vel *resupinata.*
12. — *interlineata.* Very good impressions are met with at Petherwin.
13. *Streptorhynchus crenistria.*
14. *Strophalosia productoides = caperata* (rare), and var. *membranacea.*
15. *Productus subaculeatus = fragaria.* Said to be abundant.

From the above it will be seen that out of these fifteen species, nine occur in the Marwood and Barnstaple beds; and as the existence of two or three others of the list have not been identified with certainty, the palæontological difference, as to the Brachiopoda, between the Petherwin and the Barnstaple beds would be small. We may, however, notice the rare occurrence of *Strophalosia productoides* together with abundance of *Prod. subaculeatus* in these Cornwall beds, which is just what we find to be the case in the Upper Devonian beds of Ferques in the Boulonnais, where *Stroph. productoides* is very rare, while *Prod. subaculeatus* is very abundant. Here we also find *Atrypa reticularis*, a shell not yet discovered in the Marwood and Pilton beds. Mr. Salter would therefore look upon these Landlake or Petherwin beds as the equivalents of the "Clymenien-Kalk" of the Prussian geologists, as well as of the red shales of Morte Bay. Mr. Pengelly is of opinion that there exist no beds of the Upper Devonian age in South Devon; but in Cornwall we may mention Tintagel, where *Sp. Verneuilii* abounds, but in a flattened state, and much distorted from the effects of cleavage.

Middle Devonian.

Geologists do not appear to me to have yet been able to establish the exact sequence of the various beds of limestone, shales, and sandstones, which appear to compose the Middle Devonian group of Great Britain; and a glance at the Twenty-second Sheet of the 'Map of the Geological Survey' will show how very disconnected the limestones of the district are,—so much so indeed that it appears even difficult to satisfy oneself of the direction of the stratification or bedding at Ramsleigh, Woolborough, Barton, Lummaton, and in some other places; for in most localities the beds are so contorted, faulted, and even inverted, that it is hardly possible to venture upon even an ideal stratigraphical section. Palæontology can alone guide us in this difficulty; and I am glad to state that, through the kindness of several friends, I have been able to assemble and examine several thousand specimens of the Middle Devonian Brachiopoda from the counties of Devonshire and Cornwall. Unfortunately, however, by far the larger number of specimens are found in a very imperfect state of preservation, and are often much distorted, but it is quite possible to procure tolerably perfect examples of the larger number of the species. The Middle Devonian beds and fossils of North Devon having been already described, we need not allude to them again. We have at Mr. Pengelly's suggestion in the accompanying table, united Bradley, Chircombe Bridge, and Ogwell, into one column, under the name of "Chircombe Bridge," because in fact there is no such fossil-locality as Chircombe Bridge at all. It is simply, says Mr. Pengelly, a small bridge across the little River Lemon, a tributary of the Teign, which it joins at Newton. The Ogwell quarries (there are two, Westhill and Ivy Green) are on the right or south bank of the stream, and Bradley quarry is on the left bank. These quarries are about within a stone's throw of one another, and of Chircombe Bridge. When a geologist uses the words "Chircombe Bridge," he means Bradley, or Ogwell, or both.[1] At Bradley and Ogwell the limestone beds *dip* at about 20° towards S. 39° E.; and therefore *strike* about S. 51° W. and N. 51° E. At the village of East Ogwell there are numerous interstratified, and therefore contemporary, beds of ash and slate, apparently conformably overlying the limestones

[1] There are limestones above the Ogwell Shales, viz., the Great Limestones of Bradley and Ogwell; the passage-beds being well exhibited between Ogwell House and the park; and a small patch of limestone, at West Ogwell village, appears to be included in them; along the line of junction about a mile N.E. of Chircombe Bridge.

I am informed by Mr. Pengelly, that Ramsleigh (not Ramsleugh) is situated between Ogwell and Woolborough. If we were sure of an unbroken sequence (which we very certainly are not), the Ramsleigh beds would be far above those of Ogwell and Bradley, and below those of Woolborough. Lithologically they resemble the Woolborough beds rather than those of Ogwell; but they have very few fossil Zoophytes in common; whilst the Ogwell, Bradley, and Woolborough beds have a large number of Corals and Sponges in common.

just mentioned. These ash and slate beds are succeeded conformably by the Ramsleigh limestones; but in the quarry it is next to impossible to make out stratification at all. Woolborough quarry is an *outlier* of limestone full of fossils, and the ground between it and Ramsleigh is occupied with grits of Carboniferous age, which entirely conceal the Devonian beds. Moreover, it is quite impossible to make out stratification at Woolborough. To use Murchison's expression in October last, "it is a charming piece of bedevilled limestone."

Before proceeding further, we may at once jot down in a tabular view all the Upper and Lower Devonian species we have been able to examine, with their distribution in

This List contains the names of all the British Middle and Lower Devonian Brachiopoda that I have been able to determine.—A few more may, perhaps, turn up with further search; and a few of those here registered will require further examination, so as to determine whether they may not be varieties of some of the others.	Middle Devonian.							Lower.		
	Woolborough Quarry, near Newton Abbot.	Barton and Lummaton, near Torquay.	Dartington, near Totness.	Plymouth Group.	Hope's Nose, near Torquay.	Chircombe Bridge, Bradley, and Ogwell.	Ilfracombe.	Meadfoot.	Linton Group.	Looe (Cornwall).
Terebratula sacculus, *Martin*, et *var.* hastata, *Sow.*	×	×	...	×	×	...	...	...	...	...
— juvenis, *Sow.*	...	×	...	×	...	...	...	...	...	...
— ? Newtoniensis, *Dav.*	×	...	...	...	...	...	...	...	...	...
Rensselæria ? stringiceps, var. ? *Rœmer*	...	...	...	...	...	...	×	...	...	...
Stringocephalus Burtini, *Defrance*	×	...	×	×	...	×	×	...	...	...
Athyris concentrica, *von Buch*	×	...	×	...	×	...	×	...	...	...
— phalæna, *Phil.*	...	...	...	...	×	...	...	...	...	...
— ? Bartoniensis, *Dav.*	...	×	...	...	...	...	...	...	...	...
— Newtoniensis, *Dav.*	×	...	...	...	...	...	...	...	...	...
Merista plebeia, *Sow.*	×	×	×	×	×	×	×	...	...	...
Retzia ferita, *Buch*	×	×	...	...	...	×	...	...	...	...
Uncites gryphus, *Schloth.*	×	...	×	...	...	×	...	...	...	...
Spirifera Verneuilii, *Murch.* = disjuncta, *Sow.*	×	×	...	...	×	...	×	...	...	...
— lævicosta, *Lam.* = ostiolata, *Schloth.*	×	...	...	...	...	...	...	...	×	...
— speciosa, *Schloth.*	...	...	...	...	×	×	?	...	...	...
— subcuspidata, *Schnur*	?	...	...	...	×	...	...	...	...	...
— hysterica, *Schloth.* ?	...	...	...	...	?	...	...	...	×	...
— primæva, *Stein.* ?(= cultrijugata, p. 35)	...	...	...	...	...	...	...	...	...	×
— undifera, *Rœmer*, et *var.* undulata, *Rœmer*	×	×	...	...	×	...	...	×	...	...
— nuda, *Sow.*	×	×	×	×	×	...	×	...	...	...
— curvata, *Schloth.*	×	×	×	×	×	×	×	...	...	...
— Newtoniensis, *Dav.*	×	...	...	...	...	...	...	...	...	...
— simplex, *Phil.*	×	×	×	×	...	...	...	...	...	...
— Urii, *Fleming* = unguiculus, *Sow.*	...	×	...	...	...	...	...	...	...	...
— lineata, *Martin* ? = microgamma, *Phil.*	...	?	...	...	×	...	...	...	...	...
Spiriferina cristata, *Schloth.*, *var.* octoplicata, *Sow.*	...	...	×	...	...	...	...	...	...	×
— insculpta, var. *Phil.* ?	...	×	...	...	...	...	...	...	...	...
Cyrtina heteroclita, *Dav.*	×	×	×	×	×	...	×	...	...	...
— Demarlii, *Bouch.*	×	×	...	...	...	...	...	...	...	...
— ? ambligona, *Phil.*	...	×	...	...	...	...	...	...	...	...
Atrypa lens, *Phil.*	...	...	...	...	×	...	...	...	...	...
— lepida, *Goldf.*	...	×	...	...	...	...	...	...	...	...
— reticularis, *Linn.*	×	×	×	×	×	×	×	...	...	×

	Middle Devonian.							Lower.		
	Woolborough Quarry, near Newton Abbot.	Barton and Lummaton, near Torquay.	Dartington, near Totness.	Plymouth Group.	Hope's Nose, near Torquay.	Chircombe Bridge, Bradley, and Ogwell.	Ilfracombe.	Meadfoot.	Linton Group.	Looe (Cornwall).
Atrypa aspera, *Schloth.*	×	×	×	×	×	...	×	...	...	...
— desquamata, *Sow.*	×	×	?	×	?	...	...	...	...	...
— flabellata, *Goldf.*	×	...	...	...	...	...	...	...	...	...
Davidsonia Verneuilii, *Bouch.*	×	...	×	...	...	...	...	...	...	...
Rhynchonella triloba, *Sow.*	×	×	...	×	...	×	...	...	...	...
— Pengelliana, *Dav.*	...	...	...	...	...	...	...	...	...	×
— bifera, *Phil.*	...	...	...	...	×	...	...	...	...	...
— pugnus, *Martin*, et *var.* anisodonta, *Phil.*	×	×	×	×	...	...	...	...	...	...
— acuminata, *Martin*	×	×	...	×	...	...	...	...	...	...
— reniformis, *Sow.*	...	×	...	...	...	...	...	...	...	...
— pleurodon, var., *Sow.*	×	...	...	...	...	...	×	...	...	...
— cuboides, *Sow.*	×	×	×	×	×	×	...	×	...	...
— primipilaris, *Buch.*	×	×	×	×	×	...	...	...	...	...
— implexa, *Sow.*	×	×	×	×	×	...	...	...	...	...
— angularis, *Phil.*	...	×	×	...	...	...	...	...	...	...
— ? Ogwelliensis, *Dav.*	...	...	...	...	...	×	...	...	...	...
— ? protracta, *Sow.*	...	...	...	×	×	...	...	...	...	...
— ? Lummatoniensis, *Dav.*	...	×	...	...	...	...	...	...	...	...
Camarophoria rhomboidea, *Phil.* (= globulina ?)	×	×	...	...	...	×	...	...	...	...
Pentamerus biplicatus, *Schnur.*	...	×	×	...	...	...	...	...	...	...
— brevirostris, *Phil.*	×	×	×	×	×	×	...	...	...	...
Strophomena rhomboidalis, *var.* analoga, *Phil.*	×	×	×	...	×	...	×	...	...	...
Streptorhynchus umbraculum, *Schl.*	×	×	×	...	×	...	×	...	?	...
— gigas, *M'Coy*	...	...	...	...	...	...	...	...	...	×
Leptæna interstrialis, *Phil.*	×	×	×	×	...	×	...	...	...	...
— ? nobilis, *M'Coy*	×	×	...	...	...	...	...	...	...	...
— (vel Orthis) laticosta, *Conrad*	..	...	...	...	...	...	...	×	...	×
Orthis striatula, *Schloth.*	×	×	×	?	×	×	×	...	?	...
— hipparionyx, *Vanuxen* ?	...	...	...	...	...	...	...	...	...	×
— arcuata, *Phil.*	...	...	...	×	×	...	...	...	...	...
— granulosa, *Phil.*	×	...	...	...	...	...	...	...	×	...
Chonetes sordida, *Sow.*	...	...	...	...	...	...	...	...	×	...
— minuta, *Goldf.* ?	...	...	×	...	×	...	...	...	...	...
Strophalosia productoides, *Murch.* = caperata, *Sow.*	...	×	...	...	...	?	...	...	...	...
Productus subaculcatus, *Murch.* = fragaria, *Sow.*	×	×	...	...	×	...	...	...	...	...
Calceola sandalina, *Lam.*	...	...	...	...	...	×	...	...	...	...

several of the more important localities. Several localities in the neighbourhood of Plymouth have afforded Brachiopoda; but Mount Wise appears to be one of the more important spots. I am informed by Mr. Champernowne that shales with bands of nodular limestone, with *Orthis arcuata* and *Atrypa reticularis*, resting conformably on the Upper and Dolomitic beds of the Limestone, occur at Mutton Cove, near Mount Wise. A little way down in

the limestone is a group of Brachiopoda, agreeing closely with that of Lummaton, Woolborough, and the Upper Dartington beds, of a very limited thickness, among which *Rhynchonella triloba*, *Rh. cuboides*, and *Merista plebeia*, &c., are conspicuous.

Dartington, near Totness, is a very important locality for Brachiopoda; but Mr. Champernowne is of opinion that in the immediate neighbourhood of the Dartington limestone there are no beds to be seen on the level of the Ogwell shales. Hope's Nose is a very interesting locality, and the beds there do not (as far as fossils are concerned) seem to be on a very different level from the Woolborough level: we cannot, I think, be very far wrong if we assign their position to the passage-beds between the limestone and shales and slates above.

Land's End, near Torquay, appears to be a spot worthy of further examination. Mr. Champernowne writes me: "In a cove on the east side of the point known as the Land's End, I have recently discovered beds of shales or impure limestone, in which I have found *Orthis arcuata*, *Atrypa reticularis*, *A. lens*, *Rhynchonella bifera*, *Rh. protracta*, and some other species. Mr. Champernowne, who has devoted much attention to the Middle Devonian formation of Devonshire, sends me the following scheme of their probable correlation:

Newton.	Dartington.	Torquay.	Plymouth.
.....	.....	Hope's Nose.	Shales with *O. arcuata* (Mutton Cove).
Woolborough.	Courtfield Orchard Pit Quarry (all Dolomites.	Lummaton and Barton.*	Mount Wise, lower part of Plymouth Limestone.
Bradley.	Skinner's B. Quarry	.....	.....
Chircombe Bridge Quarry.	.....	Meadfoot (base of Limestone).	.....
.....	.....	.....	.....
West Ogwell and Chircombe Bridge Shales.	.....	Meadfoot Shales and Sandstone.	Purple and Grey Slates (without fossils).

* The intermediate parts are seen in many places dipping away from the Torquay anticlinal, but Mr. Champernowne has thought necessary only to indicate the well-marked Lummaton horizon and the base.

Lower Devonian.

Some geologists, among whom I may name Mr. Pengelly, use the terms *Lower, Middle,* and *Upper Devonian,* as terms of convenience only, not as equivalents to *Lower, Middle,* and *Upper Old Red* (see pages 44-5 of this Monograph); and here we must place *all* the slates of south-east Cornwall, as well as of Mudstone Bay near Brixham, Galmpton Creek on the Dent, and Meadfoot near Torquay: in fact, all the *Pleurodictyum* and *Steganodictyum* beds. The Looe grits (more correctly slates) would be near the top of the Lower Devonian. The term 'Meadfoot Sands' has been erroneously made use of by myself and some geologists. Meadfoot is a sea-beach, hence the word "Sands," the beds in this locality being slates, but they do not appear to contain many species of Brachiopoda.

Mr. Pengelly observes, that Linton is undoubtedly the base of the Devonian series of North Devon; and unless the beds there are Lower Devonian, there can be none of that age in the country. Murchison ('Siluria,' Table, page 433, 1859), Lyell ('Elements,' 6th ed., page 532, 1865), and Salter ('Quarterly Journal, Geol. Soc., vol. xix, page 489, 1864), unanimously place them on this horizon.

Looe, in Cornwall, is a very interesting locality, which abounds in several species of Brachiopoda, but unfortunately only in the state of internal casts and impressions. Those I have been able to examine are the following:

Athyris? sp. ? Pl. IV, fig. 4. Several casts similar to the one figured were found by Mr. Pengelly, at Looe; but none of the specimens are complete enough to be determinable.

Spirifera primæva, Steininger?? Pl. VIII, figs. 1, 2, 3. Described and figured under the denomination of *Sp. cultrijugata,* Rœmer? (p. 35). This fine large species occurs unfortunately in the condition of imperfect casts, no perfect example having as yet been procured. Since the publication of my description, it has appeared to me that these Looe specimens approach more to *Sp. primæva* than to *Sp. cultrijugata.* The correct determination of this shell must, however, depend on the discovery of better examples.

— sp. ? Pl. IV, fig. 33. This internal cast is much out of shape from fossilization, but indicates the presence of a smooth species of *Spirifera* not unlike *Sp. glabra.*

Spiriferina cristata, var. *octoplicata?* Pl. VI, figs. 11, 12, 13, is very common, but rarely well preserved, so that identification cannot be considered as perfectly certain.

Atrypa reticularis, Lin.

Rhynchonella Pengelliana, Dav. Pl. XII, figs. 8, 9.

— sp. ? A small form, undeterminable from the material at hand.

Streptorhynchus gigas, M'Coy. Pl. XVI, figs. 2, 3.
— *umbraculum*, vel *crenistria*. Some fragments apparently attributable to this shell.
— vel *Leptæna* sp. ? Pl. XVIII, figs. 13, 14.
Orthis (vel *Leptæna*) *laticosta*, Conrad.
— *hipparionyx*, Vanuxem? Large internal casts. Pl. XVII, figs. 8—12.

The following geological details have been kindly furnished me by Mr. Pengelly:

"East and West Looe, in Cornwall, are two small towns on the opposites sides, and at the mouth, of the narrow tidal estuary of the River Looe, and are situated about fourteen miles, nearly due west, from Plymouth. The rocks of the district are essentially bluish grey slates; the stratification is beautifully distinct, and the dip, both in amount and direction, is characterised by very considerable uniformity, through great vertical and horizontal spaces.

"According to Prof. Sedgwick it is about thirty degrees east of true south, at an angle of forty degrees ('Quarterly Journ., Geol. Soc.,' vol. viii, p. 16). In some places there is a considerable amount of interstratified schistose grit, and a few thin calcareous bands here and there present themselves. What appears to be contemporary hornblendic ash is occasionally met with, and in some localities quartz-veins are numerous. Some of the less gritty beds are not unfrequently ferruginous, in which case the newly exposed surfaces are of a yellowish-brown or reddish-brown colour; these are the principal, but by no means the only, repositories of organic remains. All the Looe Brachiopoda (described in this Monograph) were from beds of this character.

"Well-defined joints, most of them at (sensibly) right angles to the plane of the horizon, and also to that of stratification, are common, and such as have been some time exposed to the weather, frequently disclose small orifices, which are trustworthy indications of fossils.

"The remarkable Coral *Pleurodictyum problematicum*, which, according to Murchison, is a characteristic fossil of the Lower Devonian rocks (Table, p. 433, 'Siluria,' 2nd ed., 1859), is very abundant in the same beds. Some of the specimens are of considerable dimensions, measuring fully seven inches in diameter. This Coral occurs also in the slates of Meadfoot, Torquay. Mr. Godwin-Austen speaks of it as ranging through the whole middle slate-district of South Devon ('Trans. Geol. Soc.,' 2nd series, vol. vi, part 2, page 468).

"The finer varieties of the Looe slates contain the fossils formerly known as the 'Polperro Fish-remains,' but which have been pronounced to be Sponges by Messrs. M'Coy and Carter, who founded the genus *Steganodictyum* for their reception. These Sponges extend from Looe, westward as far as Fowey, and eastward to the Rame Head, at the entrance of Plymouth Sound. I have met with them also at Bedruthen Steps, on the north coast of Cornwall, a few miles south of Padstow Harbour; and at Mudstone Bay, near Brixham in South Devon, in the slates which underlie the great limestones of Berry Head and Sharkham Point. Like *Pleurodictyum*, they are confined to slate-rocks."

I have considered it desirable to add these particulars in order to indicate the range of some of the organisms that were undoubtedly contemporaneous of the Looe Brachiopoda; and I trust that some local geologist or collector may be able by further search to discover specimens sufficiently complete to enable palæontologists to specifically determine some of the uncertain Brachiopoda described and illustrated in this Monograph.

INDEX TO THE MONOGRAPH OF DEVONIAN BRACHIOPODA.

(Names in Italic are synonyms; a prefixed Note of Interrogation indicates probable synonyms, or species not yet satisfactorily determined.)

LONDON: PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

PLATE X.

DEVONIAN SPECIES.

FIG.

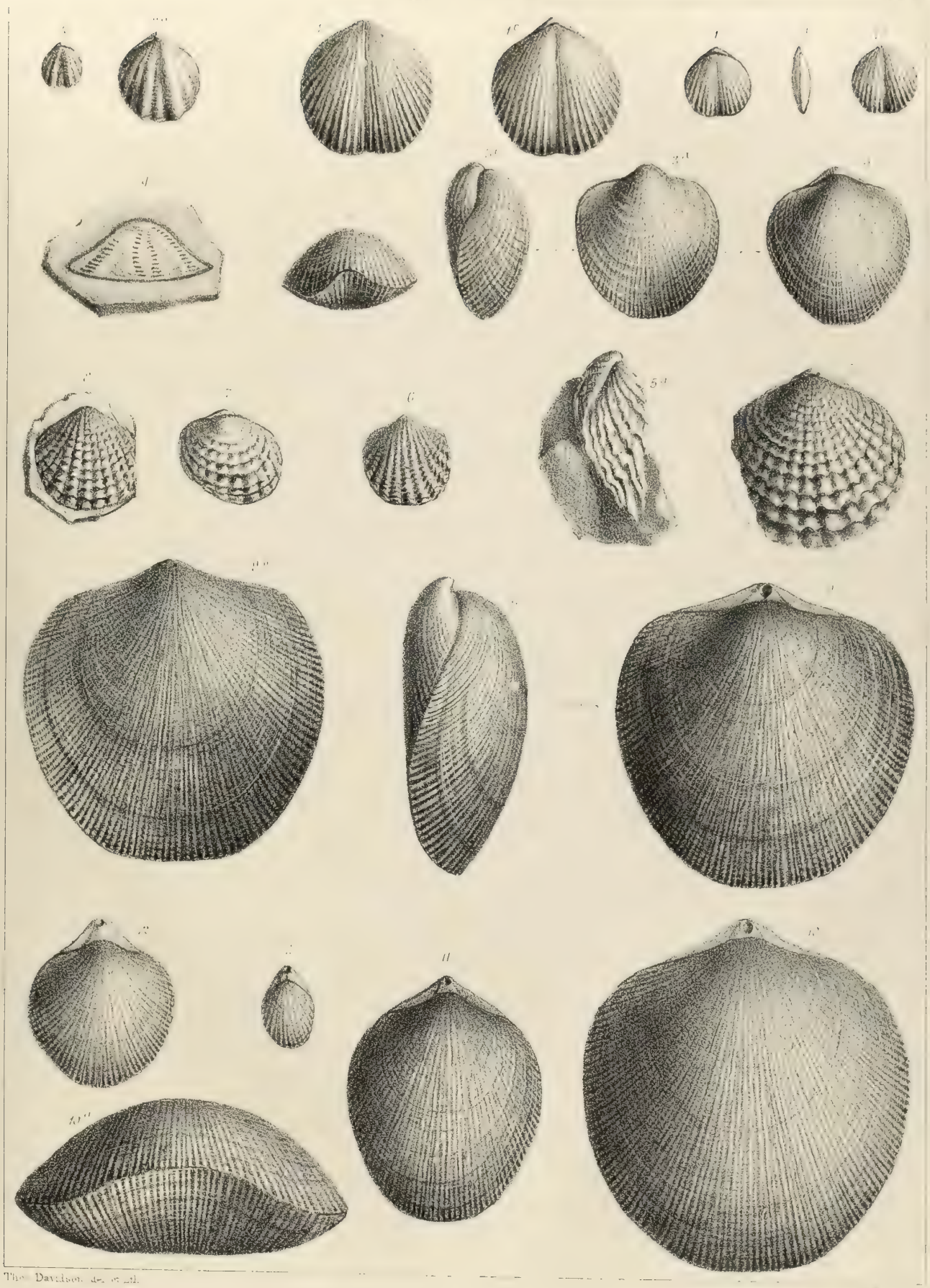
1. *Atrypa lens*, Phillips, sp. Middle Devonian, Hope's Nose, near Torquay. Phillips' original specimens. Mus. Geol. Survey. Fig. 1 *c*, *d*, enlarged.

2. „ *lepida*, Goldf. sp. Middle Devonian, Barton, near Torquay. Collection of Mr. Lee. Fig. 2 *a*, enlarged.

3, 4. „ *reticularis*, Lin. Middle Devonian, Lummaton, near Torquay. Fig. 4, transverse section, showing the spires.

5—8. „ *aspera*, Schloth. Fig. 5, Middle Devonian, near Newton Abbot. Collection Geological Survey. Fig. 6, from Dartington. Collection of Mr. Champernowne. Figs. 7, 8, *A. squamosa*, Sow., from the original specimens.

9—13. „ *desquamata*, Sow. Figs. 9 and 10, very large examples from Woolborough Quarry, near Newton Abbot, and Collections of Messrs. Vicary (fig. 9) and Pengelly (fig. 10). Fig. 11, Woolborough. Collection of Mr. Champernowne. Fig. 12, id. Fig. 13, from Barton. Collection of Mr. Lee.



The Davidson del. et lith.

PLATE XI.

DEVONIAN SPECIES.

FIG.

1—6. *Atrypa desquamata,* Sow. Lanes or Woolborough Quarry. Collection of Mr. Vicary. Fig. 2, specimen from Plymouth, Geol. Soc. Mus., showing portions of the laminal projections. Figs. 3—6, different modifications in shape, from Woolborough Quarry. Fig. 3, Collection of Mr. Stewart.

7. „ „ Interior of the dorsal valve, showing the spiral appendages.

8. „ „ Specimen from which the larger portion of the dorsal valve has been removed, in order to show the back of the spiral coils.

9. „ „ Interior of the ventral valve: F, foramen; D, deltidium; T, teeth; A, adductor or occlusor; R, ventral adjustor muscular impressions; V, vascular impressions.

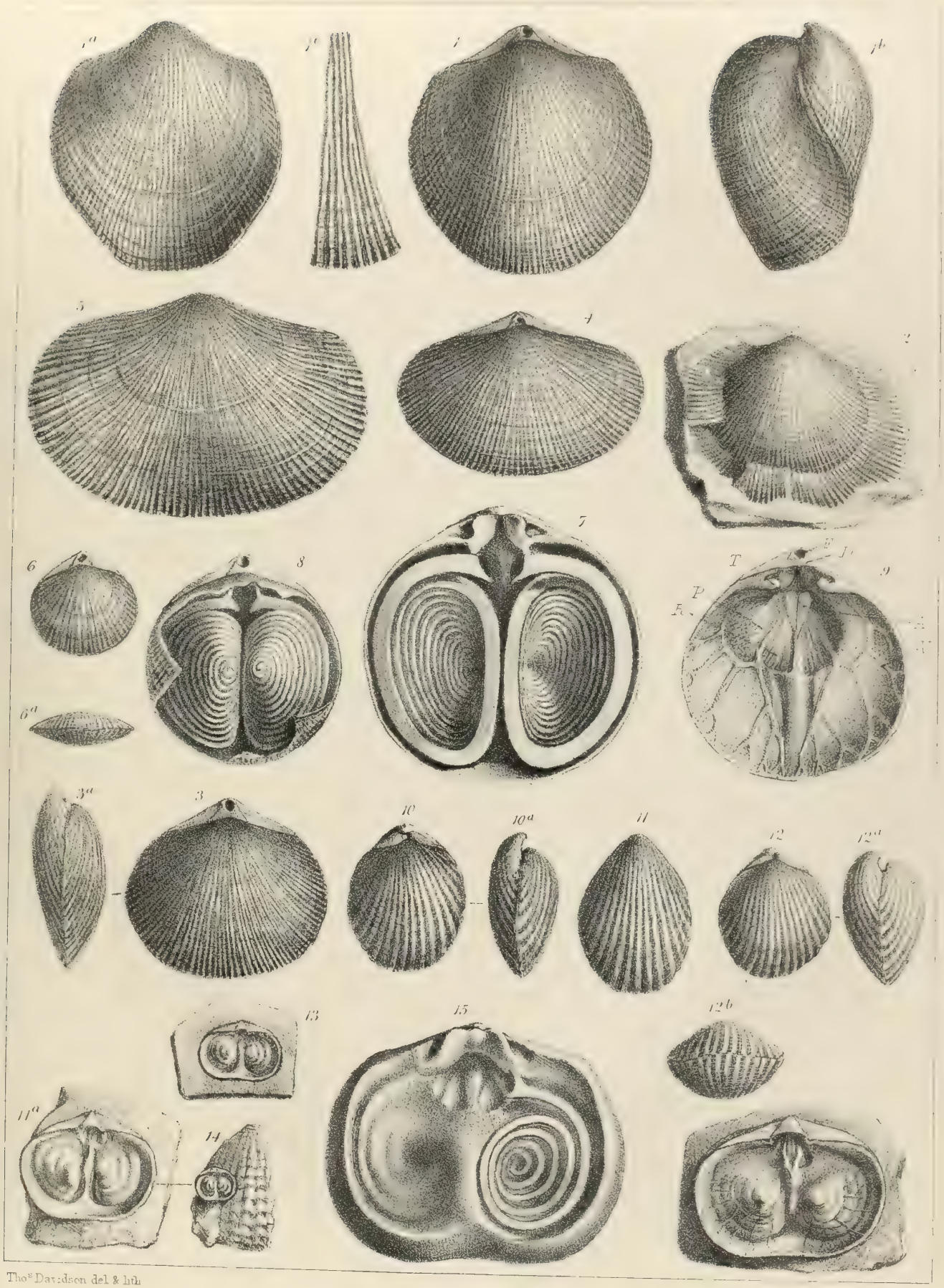
10—12. „ *flabellata,* Goldf. From Woolborough Quarry. Figs. 10 and 12, from the Mus. of the Geol. Survey. Fig. 11, Collection of Mr. Pengelly.

13. *Davidsonia Verneuilii,* Bouchard. Interior of the ventral valve; a large specimen, attached to a valve of *String. Burtini,* from Woolborough Quarry. In the Collection of Mr. Vicary.

14. „ „ Interior of ventral valve attached to *Atrypa aspera,* from Woolborough Quarry. Mus. Geol. Survey.

15. „ „ Interior of the dorsal valve (enlarged), showing the cardinal process, sockets, impressions of the adductor or posterior and anterior occlusor muscle. It also, on one side, shows a restored representation of the spiral lamellæ.

16. „ „ Interior of ventral valve (enlarged), showing the teeth, pseudo-deltidium, adductor and divaricator muscular impressions, as well as the massive cones and vascular impressions.



Thos Davidson del & lith

PLATE XII.

DEVONIAN SPECIES.

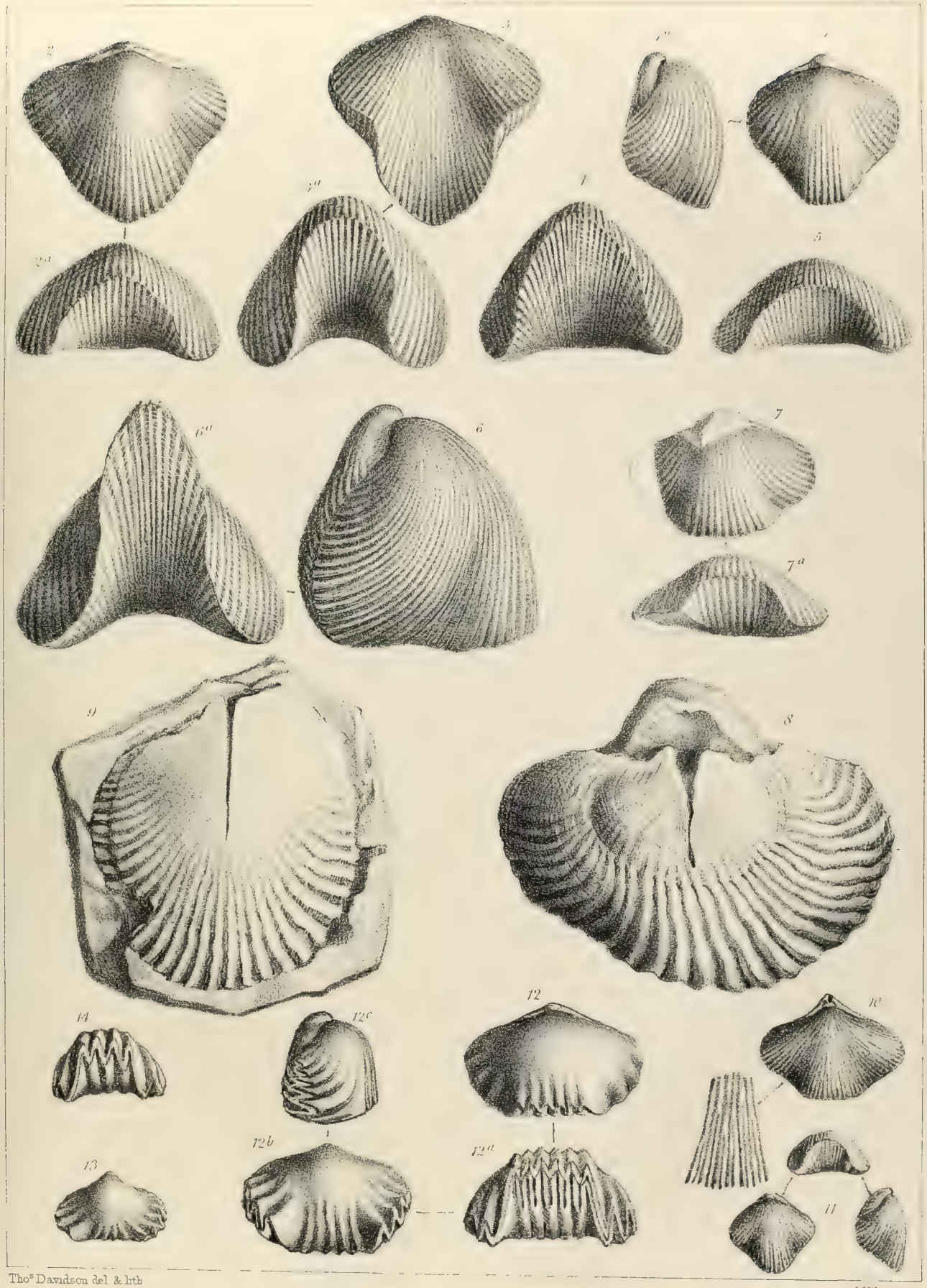
FIG.

1—7. *Rhynchonella triloba*, Sow. Fig. 1, original specimen from the Middle Devonian Limestone of Plymouth. Collection of Geol. Soc. Figs. 2 and 5, Woolborough Quarry. Collection of Mr. Pengelly. Fig. 3, id. Collection of Mr. Vicary. Figs. 4, 6, id., Geol. Survey. Fig. 7, *Atrypa latissima*, Sow., Plymouth. Collection of Geol. Soc.

8, 9. ,, *Pengelliana*, Dav. From Looe, Cornwall. Fig. 8, Collection of Mr. Pengelly; fig. 9, of Mus. Geol. Soc.

10, 11. ,, *bifera*, Phillips. Middle Devonian, Hope's Nose, near Torquay. Fig. 10, Phillips' type. Fig. 11, a smaller specimen, from same locality. Both from the Mus. of the Geol. Survey.

12—14. ,, *pugnus*, var. *anisodonta*, Phillips. Figs. 12 and 14, Phillips' types of *T. anisodonta*. Middle Devonian, Barton, near Torquay. Collection of Mr. Lee. Fig. 13, Lummaton. Collection of Mr. Champernowne.



Thos Davidson del & lith

W West imp

PLATE XIII.

DEVONIAN SPECIES.

FIG.

1. *Rhynchonella acuminata*, Martin. Middle Devonian, Woolborough Quarry. Mus. Geol. Survey.

2. „ „ Torquay. Collection of the Geol. Soc. Found by Sir H. De la Beche.

3. „ „ Woolborough Quarry. Collection of Mr. Vicary.

4. „ „ From Woolborough. British Museum.

5. „ *triangularis*, Sow. (*Atrypa*, Sow.), from the figure 'Geol. Trans.,' vol. v, 2nd ser., pl. liv, fig. 9. Professor M'Coy considers this shell to be a varietal form of *R. acuminata*.

6, 7. „ *reniformis*, Sow. Lummaton, near Torquay. Collection of Mr. Champernowne. Fig. 7, *R. subdentata*, Phillips (not Sow.), Upper Devonian, Petherwin, Cornwall. Mus. Geol. Survey.

8—10. „ *pugnus*, Martin. Fig. 8, Woolborough Quarry. Collection of Mr. Pengelly. Fig. 9, id. Collection of Mr. Lee. Fig. 10, Upper Devonian, Petherwin. Collection of Mr. Pengelly.

11—13. „ *pleurodon*, Phillips. Fig. 12, Upper Devonian, near Barnstaple. Collection of Mr. J. M. Hall. Fig. 13, South Petherwin. Collection of Mr. Pengelly.

14. „ *sphærica*, Sow. The original specimen figured in the 'Trans. Geol. Soc.,' 2nd series, pl. lvii, fig. 3; but I believe it is a Silurian (not Devonian) fossil, which got accidentally in the Collection of the Rev. W. V. Hennah. The specimen is in the Collection of the Geol. Soc.

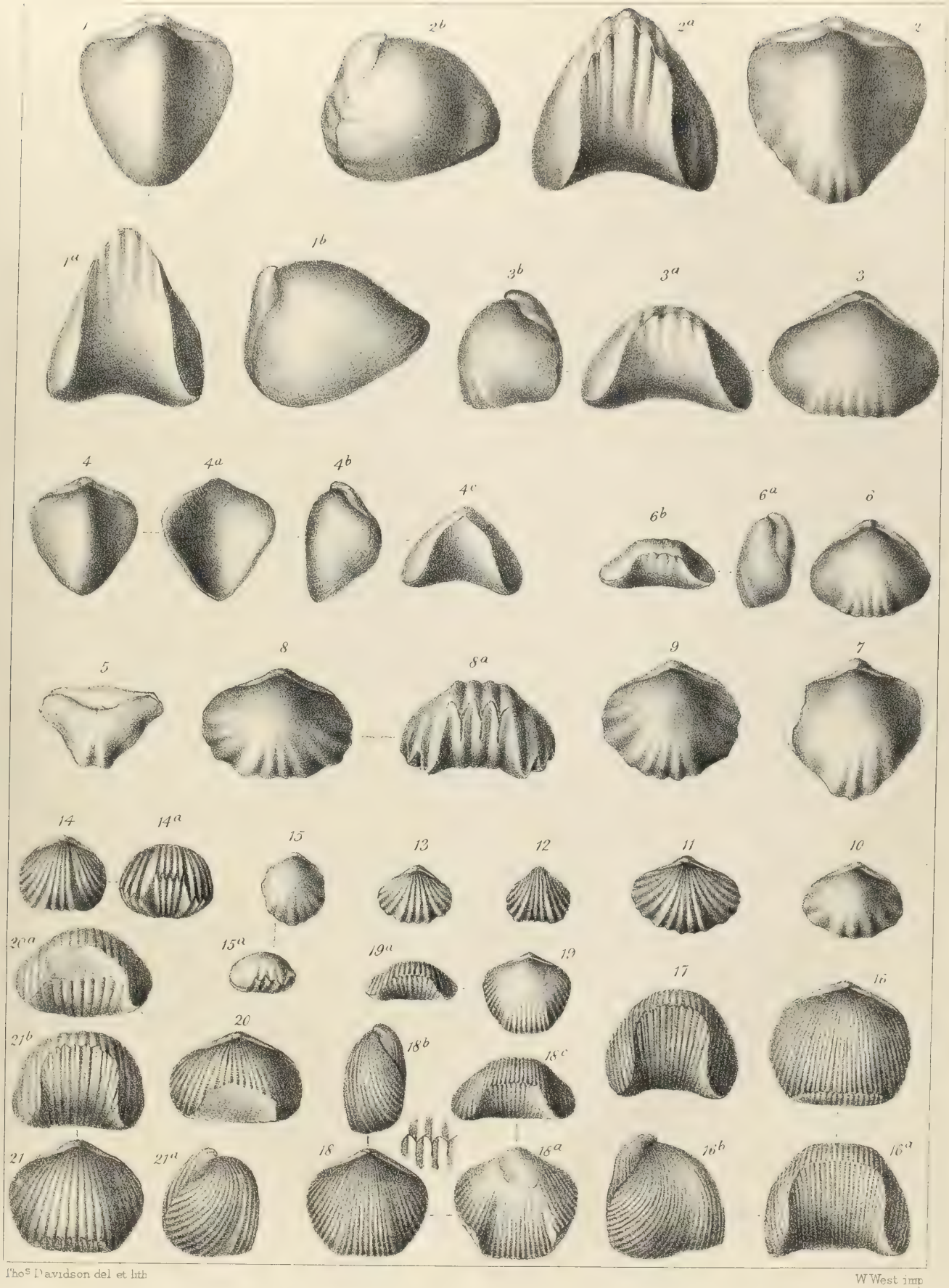
15. „ *subdentata*, Sow. Sowerby's figure in the 'Trans. Geol. Soc.,' vol. v, 2nd ser., pl. liv, fig. 7. This is a very doubtful species.

16, 17. „ *cuboides*, Sow. From Lanes or Woolborough Quarry. Collection of Mr. Vicary.

18, 19. „ „ (*Atrypa crenulata*, Sow.) Fig. 18, Barton, near Torquay. Collection of Mr. Lee. Fig. 19, Plymouth. Collection of Geol. Soc.

20. „ „ (*Atrypa impleta*, Sow.) From the original example. Plymouth. Collection of Geol. Soc.

21. „ „ Lummaton. Collection of Mr. Pengelly.



Thos Davidson del et lith

W West imp

PLATE XIV.

DEVONIAN SPECIES.

FIG.

1—3. *Rhynchonella laticosta*, Phillips. Upper Devonian. Fig. 1, Phillips' original specimen (cast), Baggy Point, North Devon. Fig. 2, from near Barnstaple. Both in Collection of Geol. Survey. Fig. 3, a restored representation.

4—6. „ *primipilaris*, Upper Devonian, Lummaton, near Torquay. Collection of Mr. Pengelly.

7—10. „ *implexa*, Sow. This is probably a var. of *primipilaris*. Fig. 7, Sowerby's original specimen, Plymouth. Mus. Geol. Soc. Fig. 8, a large-ribbed specimen, from Dartington. Collection of Mr. Champernowne. Fig. 9, Lummaton. Fig. 10, *T. comta*, Phillips' type, Barton. Mr. Lee's Collection.

11—13. „ *angularis*, Phillips. Figs. 11, 13, Barton. Collection of Mr. Lee. Fig. 12, Woolborough. Collection of Geol. Survey.

14—18. „ ? or *Cam. Lummatoniensis*, Dav. Figs. 14—17, Lummaton, near Torquay. Fig. 18, Dartington, near Totness. Collection of Mr. Champernowne.

19—22. *Camarophoria* (*globulina*, var. ?) *rhomboidea*, Phillips, Middle Devonian. Figs. 19 and 22, from Woolborough Quarry. Figs. 20 and 21, from Barton.

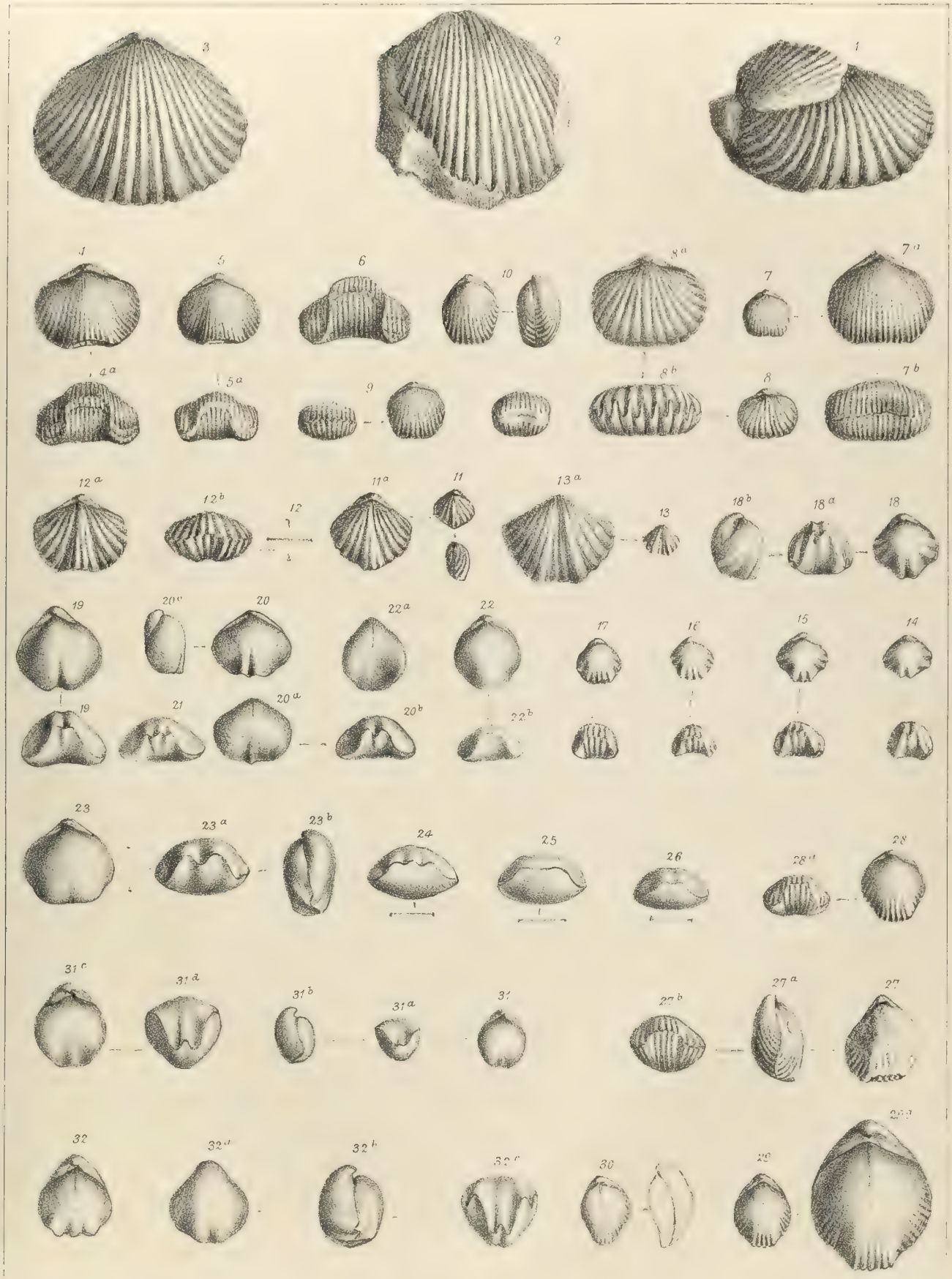
23—26. *Rhynchonella* ? *Ogwelliensis*, Dav. Middle Devonian, Ramsleigh Quarry, Ogwell.

27. „ ? *protracta*, Sow. From the original specimen in the Collection of Geol. Soc. Middle Devonian Limestone, Plymouth.

28. „ „ From north side of Stone House Hill, near Plymouth. Collection of Plymouth Institute.

29, 30. „ „ *P. proboscidialis*, Phillips. From Middle Devonian, Hope's Nose, near Torquay. Fig. 30 is Phillips' figure. Fig. 29 is drawn by myself, from the original specimen in the Mus. of the Geol. Survey.

31, 32. *Pentamerus biplicatus*, Schnur. Middle Devonian, Barton and Lummaton, near Torquay. Fig. 22, in the Collection of Mr. Lee.



Thos Davidson del. et Lith

PLATE XV.

DEVONIAN SPECIES.

FIG.

1. *Pentamerus brevirostris,* Phillips. Middle Devonian, Woolborough Quarry, near Torquay. Mus. Geol. Survey. This specimen had been supposed to belong to *Pent. optatus,* Osar.

2. „ „ From Barton, near Torquay. Collection of Mr. Lee.

3. „ „ Woolborough Quarry. Collection of Mr. Vicary.

4. „ „ From West Ogwell, near Chircombe Bridge. Collection of Mr. Champernowne.

5. „ „ From Lanes or Woolborough Quarry. Collection of Mr. Vicary.

6. „ „ From Barton. Collection of Mr. Lee.

7—12. „ „ From Woolborough Quarry. *Pent. globus,* Bronn, and *A. Cassidea,* Phil. Fig. 7, Woolborough. Brit. Mus. Figs. 8, 9, and 12, Woolborough. Mus. Geol. Survey. Fig. 10, Phillips' figures, 'Pal. Foss.' pl. xxxiv, fig. 148.

12. „ „ Interior of *ventral* valve, Woolborough. Collection of Mr. Vicary.

13. „ „ Interior of *dorsal* valve, Woolborough Quarry. Brit. Mus.

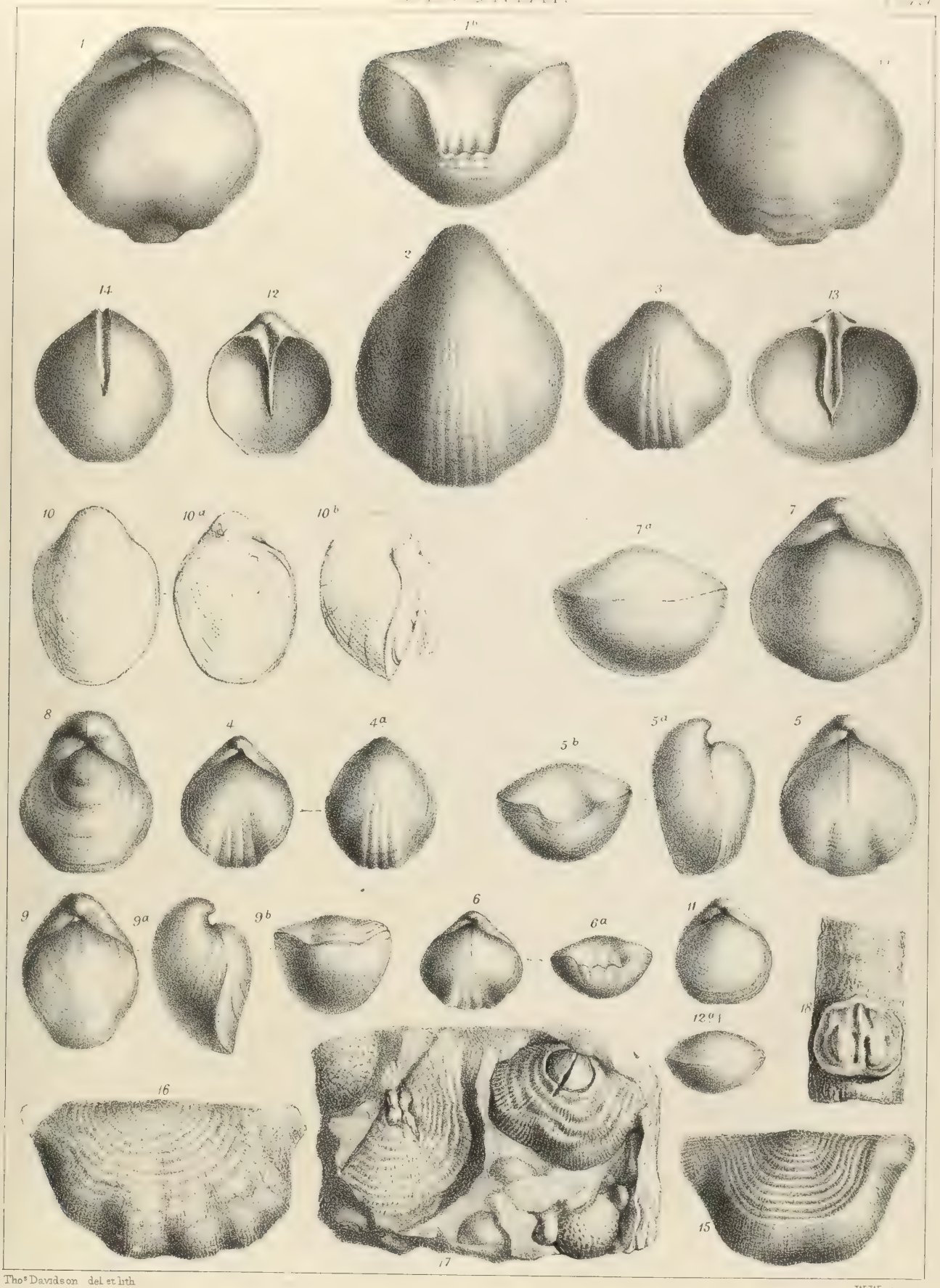
14. „ „ Cast of the ventral valve, Woolborough Quarry.

15. *Strophomena rhomboidalis,* var. *analoga,* Phillips. From the Middle Devonian Limestone of Barton, near Torquay. Collection of Mr. Lee.

16. „ „ From the original example of *L. nodulosa,* Phil.

17. „ „ Internal casts in the Upper Devonian Grits of Braunton, North Devon.

18. *Davidsonia Verneuilii,* Bouchard. Ventral valve, Middle Devonian, Dartington, near Totness. Collection of Mr. Champernowne.



Thos Davidson del et lith

W West, imp

PLATE XVI.

DEVONIAN SPECIES.

FIG.

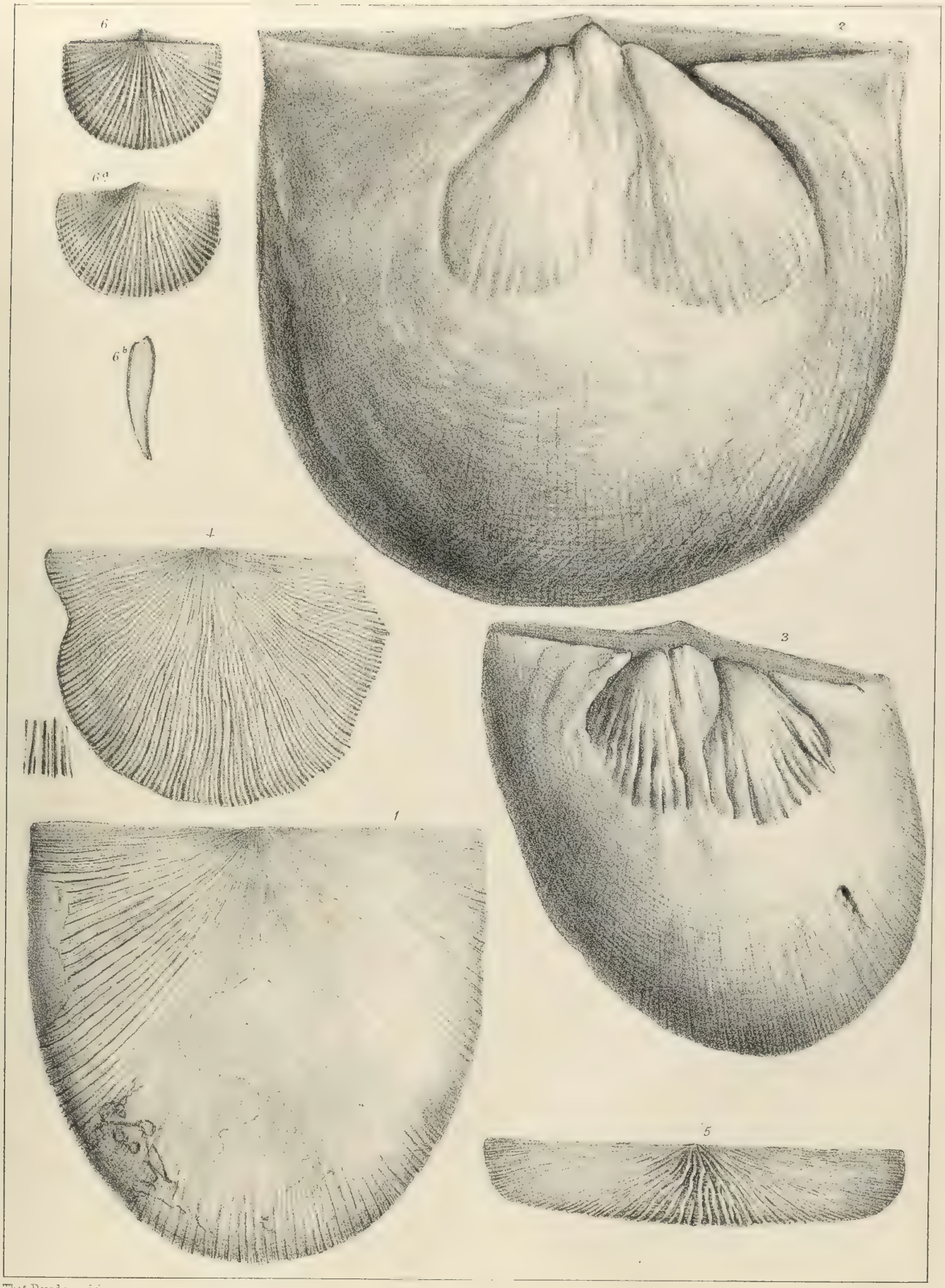
1. *Streptorhynchus gigas*, M'Coy. The original figure in 'British Pal. Foss.,' pl. 2^A, fig. 7. Shales of Looe, Cornwall.

2, 3. ,, ,, Internal casts, Looe. Collection of Mr. Pengelly.

4. ,, ? ,, Looe, Cornwall. Collection of Mr. Pengelly. I am not certain about the identification of this fragment, and figure it only because it comes from Looe.

5. ,, *persarmentosus*, M'Coy. From the figure in the 'British Pal. Foss.,' pl. 2^A, fig. 9. Shales of Polruan, Cornwall. This deformed specimen cannot be correctly specifically identified; its specific value is therefore uncertain.

6. ,, *umbraculum*, Schloth. Middle Devonian, Woolborough Quarry. Collection of Mr. Lee.



Thos Davids .. lith. .r.

W. West, imp.

PLATE XVII.

DEVONIAN SPECIES.

FIG.

1—3. *Leptæna* or *Orthis* ? *laticosta*, Conrad. Fig. 1, from Meadfoot, near Torquay (gutta-percha impressions). Collection of Geol. Survey. Fig. 2, interior of ventral valve; fig. 3, internal cast of ventral valve.

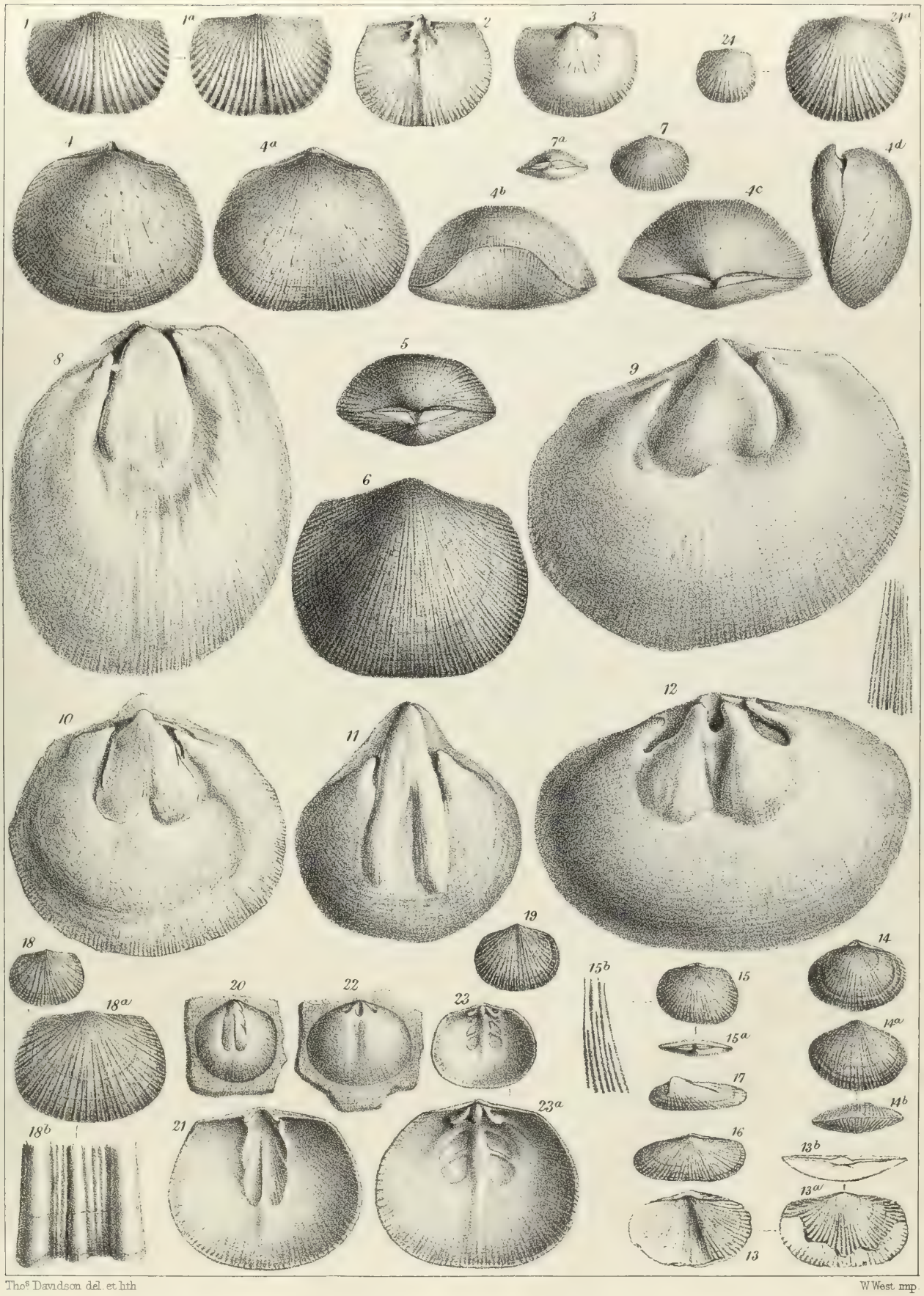
4—7. *Orthis striatula*, Schloth. Figs. 4, 5, Middle Devonian, Woolborough Quarry. Collection of Mr. Lee. Fig. 6, Collection of Mr. Champernowne. Fig. 7, young shell, Lummaton, near Torquay.

8—12. „ *hipparionyx* ?, Vanuxem and J. Hall. Internal casts of the dorsal and ventral valves, from Looe, Cornwall. Figs. 8—11, Collection of Mr. Pengelly. Fig. 10, Mus Geol. Survey.

13—17. „ *arcuata*, Phil. Fig. 13, from the original figure in Phillips' 'Pal. Foss.,' tab. xxvi, fig. 107. Middle Devonian, Hope's Nose, near Torquay. Figs. 14, 15, from Hope's Nose. Collection of Mr. Pengelly. Fig. 16, a specimen much out of shape. Fig. 17, one of Phillips' figures of *O. longisulcata*, 'Pal. Fos. of Devon,' &c., tab. xxvi, fig. 105. This is a distorted specimen, which looks very like some similar ones found at Hope's Nose; the identification is, however, uncertain. Locality, Linton.

18—23. „ *interlineata*, Sow. Fig. 18, Upper Devonian, Landlake, Cornwall. Mus. Geol. Survey. Fig. 19, Petherwin, Cornwall. Mus. Geol. Soc. Fig. 20, internal cast of ventral valve; fig. 21, enlarged interior of same valve; Petherwin. Survey Collection. Fig. 22, internal casts of dorsal valve, Petherwin. Mus. Geol. Survey. Fig. 23, interior of ventral valve; fig. 23*, enlarged; Petherwin. They are drawn from gutta-percha impressions, made from the internal casts.

24. „ *granulata*, Phil. From Middle Devonian, Woolborough Quarry. Collection of Mr. Pengelly. This is a doubtful so-termed species.



Thos Davidson del. et lith

W West imp.

PLATE XVIII.

DEVONIAN SPECIES.

Fig.

1. *Streptorhynchus umbraculum,* Schloth. = *O. crenistria,* Sow. From the figure in the 'Trans. Geol. Soc.,' vol. v, pl. xxxvii. Fig. 7, Middle Devonian, Plymouth.

2. ,, ,, Phillips' figure, 'Pal. Foss. of Devon,' &c., pl. xxvii, fig. 113.

3. ,, ,, Internal cast of the ventral valve.

4. ,, *crenistria,* Phillips' *P. arachnoidea.* Impression from the Upper Devonian, Brown Grits of Braunton.

5. ,, *umbraculum.* Middle Devonian, Woolborough. More lines should have been drawn between the ribs in the enlarged shell fragment, fig. 5^{B}.

6. ,, ? ,, From Woolborough. I am uncertain about the species to which this valve belongs.

7—9. ,, *crenistria.* These figures are taken from Phillips ('Pal. Foss. Devon,' &c., pl. xxvi, fig. 112), and referred erroneously to *Orthis compressa,* Sow., 'Sil. Syst.' Fig. 8 belongs to *Chonetes Hardrensis.* Fig. 7 to *Strept. crenistria.* Upper Devonian, Croyde.

10. ,, ? *semicircularis,* Phillips. This is a very doubtful so-termed species. The figure is copied from that given by Phillips in his 'Pal. Foss.,' pl. lviii, fig. 112^{A}. Upper Devonian, Pilton.

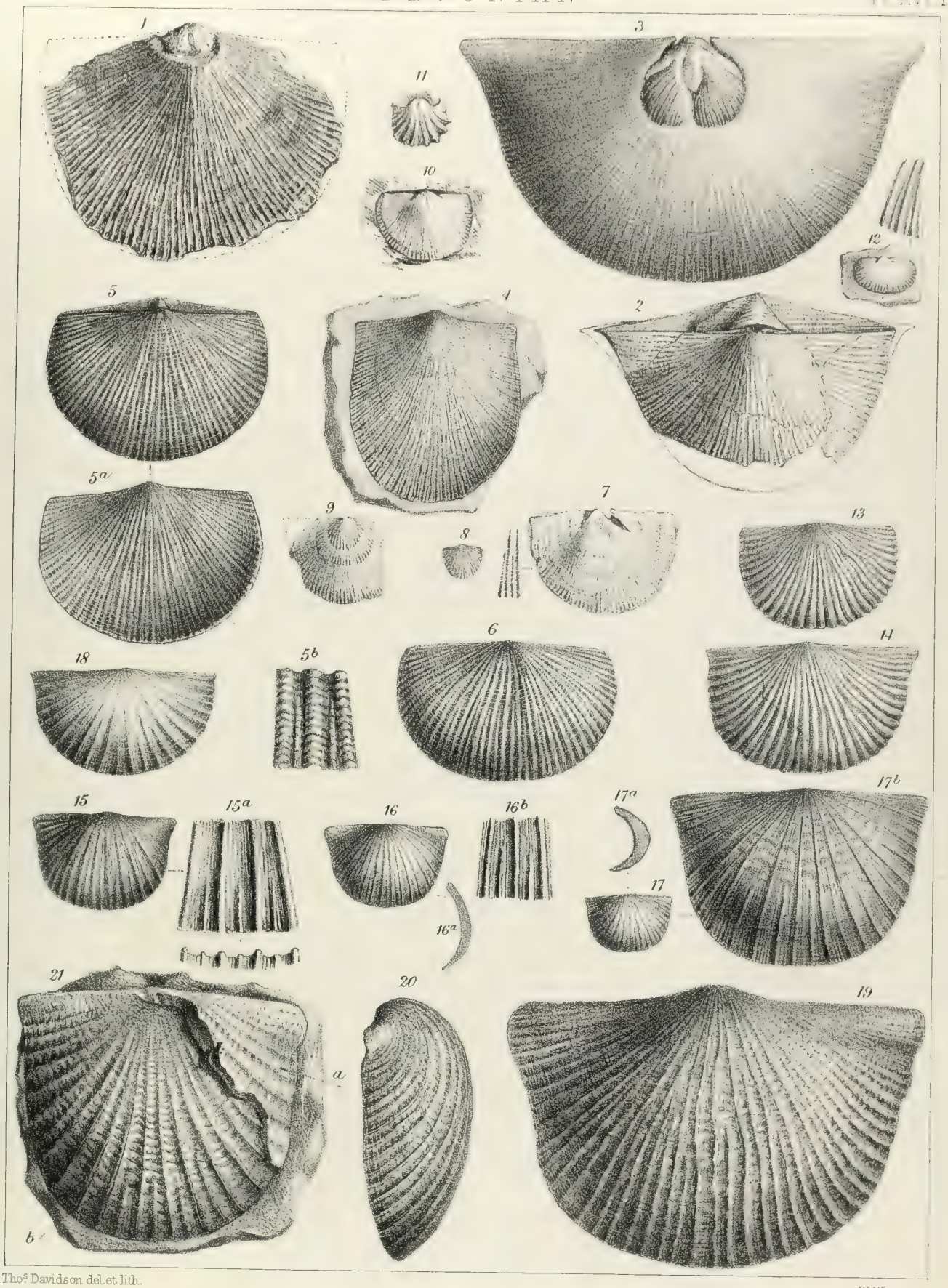
11. ,, *crenistria,* (*Orthis calcar*). From Phillips' figure, 'Pal. Foss.,' pl. lviii, fig. 112. Upper Devonian, Pilton.

12. ,, ,, (?*Orthis plicata,* Sow.) From the original internal cast, 'Geol. Trans.,' vol. v, pl. liii, fig. 10. Upper Devonian.

13, 14. *Leptæna* ? *Looiensis,* Dav. Casts from the Grits of Looe, in Cornwall. Collection of Mr. Pengelly.

15—18. ,, *interstrialis* (*Orthis*), Phillips. Figs. 15, 16, 17, Middle Devonian, Barton. Collection of Mr. Lee. Fig. 18, Collection of Mr. Stewart.

19—21. ,, ? *nobilis,* M'Coy. Figs. 19, 20, ventral valve, Woolborough Quarry. Collection of Mr. Pengelly. Fig. 21, id., in British Museum: *a,* ventral valve; *b,* internal surface of dorsal valve.



Thos. Davidson del. et lith.

W. West imp.

PLATE XIX.

DEVONIAN SPECIES.

Fig.

1. *Streptorhynchus umbraculum.* Portion of the shell enlarged, to show the numerous concentric lines which traverse the interspaces situated between the ribs.

2. ,, *crenistria.* Portion of the shell enlarged, to show that the lines which cross the ribs are likewise prolonged in the interspaces.

3 ,, *umbraculum* ? = *O. tenuistriata*, Sow. From Moreback, and original specimen in Mus. Geol. Soc.

4, 5. *Chonetes sordida*, Sow. The original figures from the 'Geol. Trans. Soc.,' 2nd series, vol. v, pl. liii, figs. 5 and 16. Lower Devonian, Linton.

6. ,, *Hardrensis.* Phillips' figures, 'Pal. Foss. of Devon, Cornwall,' &c., pl. lviii, fig. 104.*

7. ,, ,, From one of Phillips' original specimens, Upper Devonian, North Devon. This specimen is marked with about 100 ribs.

8. ,, ,, Small specimens from the Upper Devonian Grits of Braunton.

9. ,, ,, ? = *Leptæna convoluta*, Phil. Original figure from 'Pal. Foss. of Devon,' &c., pl. xxiv, fig. 96.

10—12. ,, *minuta*, Goldf. ? Fig. 10, Middle Devonian, Hope's Nose, near Torquay. Figs. 11, 12, Dartington, near Totness. Fig. 11, Collection of Mr. Champernowne.

13. *Strophalosia productoides*, Murch. = *Lept. caperata.* Sowerby's figure, 'Trans. Geol. Soc.,' vol. v, 2nd series, pl. liii, fig. 4. Casts in Brown Grits, Upper Devonian, North Devon.

14. ,, ,, Restored specimen from a gutta-percha impression taken from casts in the Upper Devonian Grits from Croyde Bay.

15. ,, ,, Perfect example, drawn from the original specimen of *P. laxispina*, Phil. Upper Devonian, Petherwin, Cornwall. Collection of Geol. Survey.

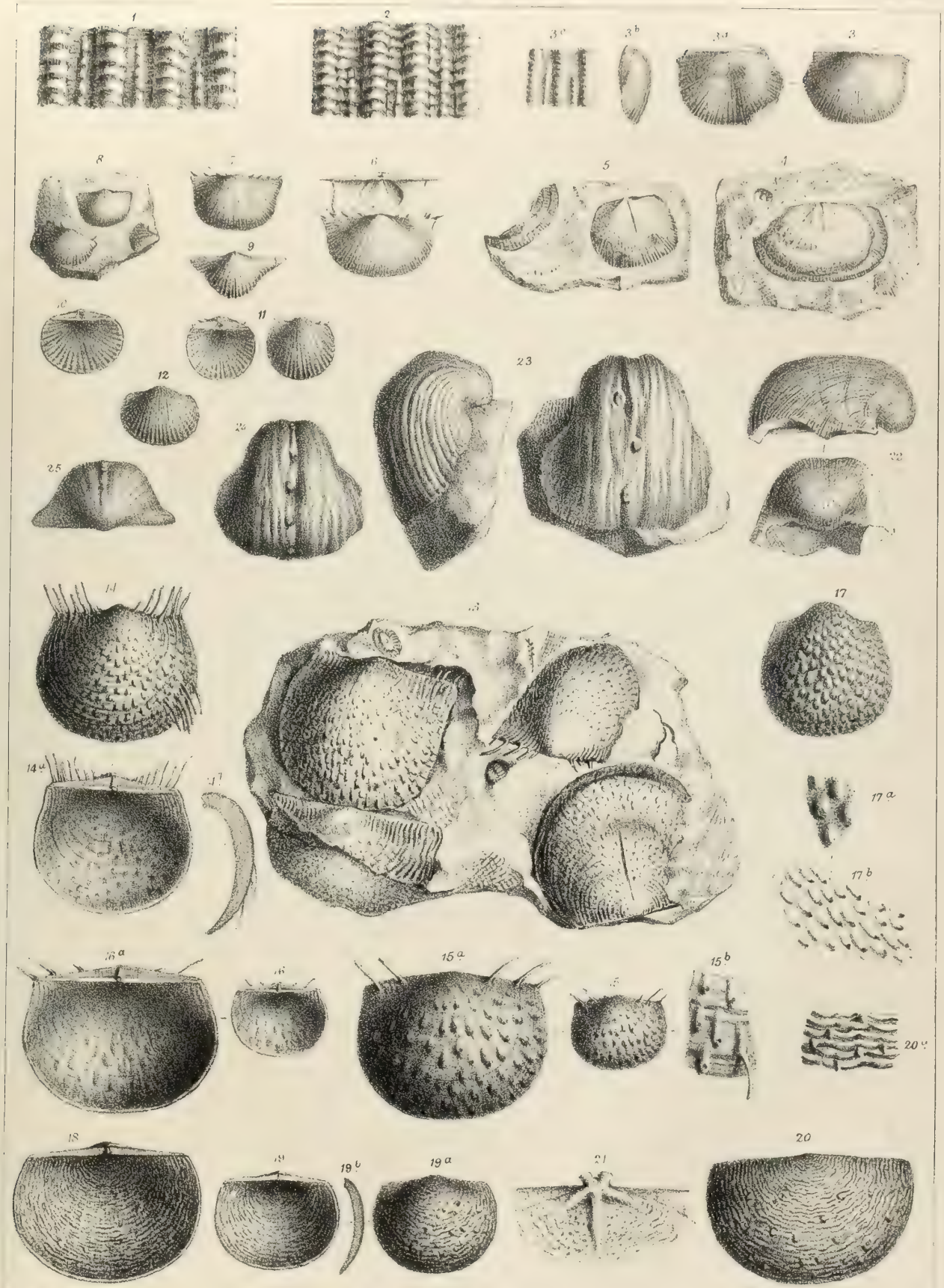
16. ,, ,, Showing the dorsal valve and double area.

17. ,, ? ,, A specimen from Middle Devonian, East Ogwell. Mus. Geol. Survey (labelled *St. pustulosa*).

18—21. ,, *productoides* ? = *P. membranacea*, Phil. From Middle Devonian of South Petherwin. Figs. 18, 19, Collection of Mr. Pengelly. Figs. 20, 21, Mus. Geol. Survey.

22. *Productus prælongus* (*Leptæna*), Sow. Original figures, 'Trans. Geol. Soc.,' 2nd series, vol. v, pl. liii, fig. 29. Upper Devonian, Croyde Bay, North Devon.

23—25. ,, ,, Casts from the Upper Devonian of Croyde Bay, North Devon. Fig. 25, Mus. Geol. Survey.



Thos. Davidson, del et lith. W. West imp

PLATE XX.

DEVONIAN SPECIES.

FIG.

1, 2. *Productus subaculeatus*, Murch. = *fragaria*, Sow. From Middle Devonian, Woolborough Quarry.

3—6. ,, *scabriculus*, Martin. Upper Devonian. Figs. 3, 4, casts of ventral and dorsal valves, from Brown Grits near Barnstaple. Fig. 5, interior of dorsal valve, drawn from a gutta-percha impression taken on a cast in the Brown Grits of Barnstaple. Fig. 6, figure taken from Phillips' 'Pal. Foss. of Devon,' &c., pl. xxv, fig. 97^b.

7. ,, *longispinus*, Sow. ? From casts, Upper Devonian Grits, top of Orchard Quarry, Pilton. Collection of Mr. J. M. Hall.

8. This is drawn from the original specimen of *Lept. interrupta*, Sow., said to have been found in the Devonian Limestone of Plymouth, but which appears to me more like an example of *P. fimbriatus* or *laxispinus*, Sow., from the Carboniferous period, and which may have accidentally been mixed up with the specimens collected at Plymouth by the Rev. W. V. Hennah. Mus. Geol. Soc.

9. *Discina nitida*, Phillips. Upper Devonian ? Foraminated valve, from Frankinurst Quarry, parish of Pilton. Collection of Mr. J. M. Hall.

10. ,, ,, Specimen found by Mr. Salter in the Marwood beds of West Angle, south side. Mus. Geol. Survey.

11, 12. *Lingula squamiformis*, Phillips = *L. Mola*, Salter. Upper Devonian ? from Sloly or Plaistow Mill, parish of Shirwell, North Devon. The *Discina nitida* occurs in same beds.

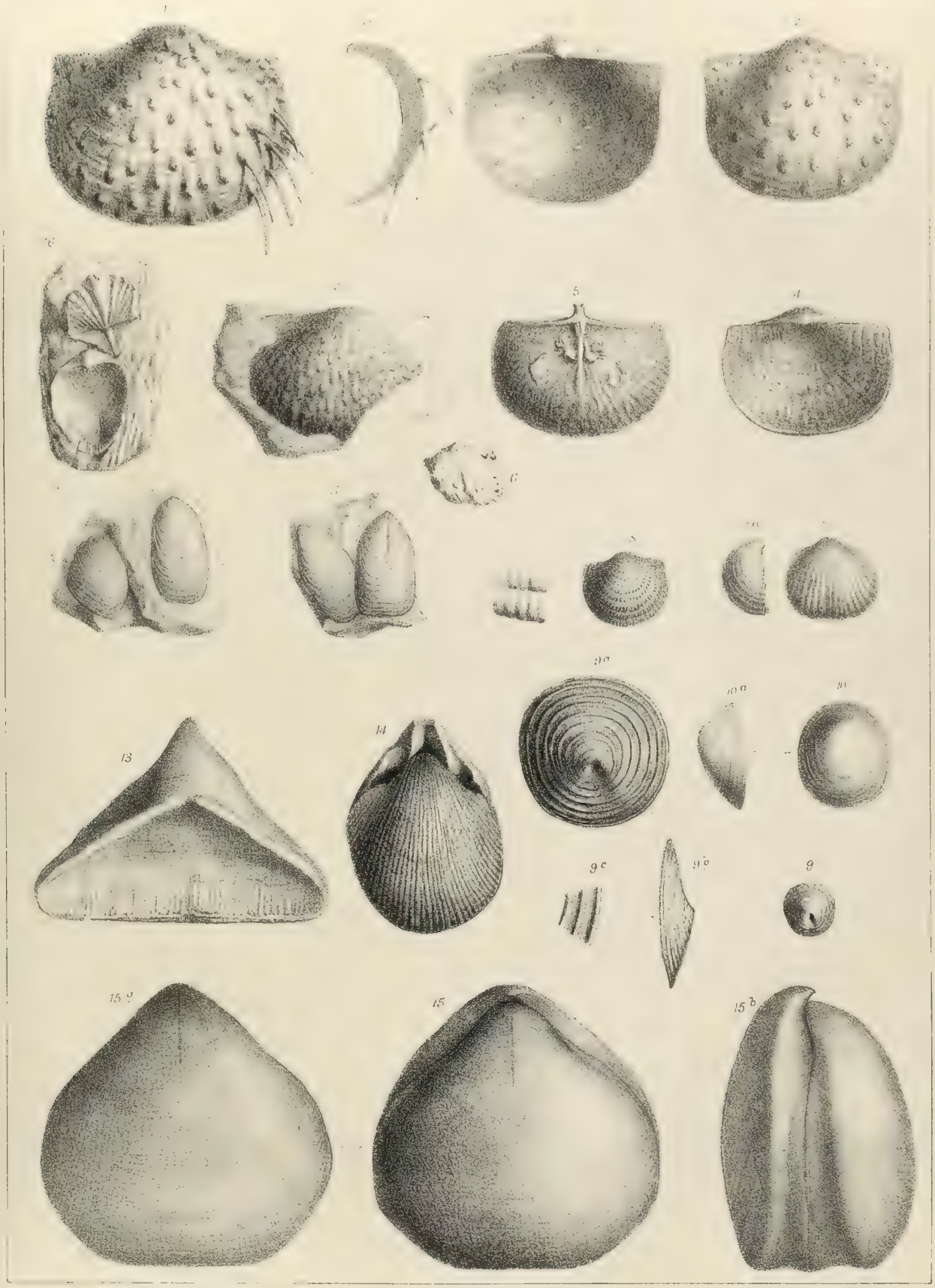
13. *Calceola sandalina*, Linn. Middle Devonian, Chircombe, Ogwell. Mr. Austen's specimens may be seen in Mus. Geol. Survey.

14. *Uncites gryphus*. A better specimen than those figured in Pl. IV, figs. 11, 12. From the Middle Devonian Limestone of Woolborough Quarry. Collection of Mr. Vicary. Some equally large examples have also been found by Mr. Champernowne, at Bradley (edge of the down on the Ogwell side of the valley, above the Mill).

15. Species undetermined. From Lanes or Woolborough Quarry. Collection of Mr. Vicary.

16. *Cyrtina heteroclita* ? ? From the slates or grits, "Coomhola series," of Reenydonagan Point, near Bantry, Ireland. This shell has been alluded to at p. 113, and by Mr. Baily, at p. 21 of the Explanation to accompany Sheets 192 and 199 of the Geol. Survey Map illustrating part of the counties of Cork and Kerry, as being, perhaps, an abnormal condition of *Spiriferina cristata*, var. *octoplicata*.

17. *Productus*. Species undetermined, on the slab containing the *Cyrtyna* ? fig. 16.


1
2
3
4
5
6
7
8
9
9a
9b
9c
10
10a
13
14
15
15a
15b

THE

PALÆONTOGRAPHICAL SOCIETY,

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLXV.

A MONOGRAPH

OF

BRITISH BELEMNITIDÆ.

BY

JOHN PHILLIPS,
M.A. OXON., LL.D. DUBLIN, F.R.S., F.G.S., ETC.,
PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF OXFORD.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1865.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

BRITISH BELEMNITES.

HISTORICAL NOTICES.

Belemnites were first so named in Germany, in the celebrated work of Georgius Agricola, of date 1546, and described by him among the 'Figured Stones' which then began to attract attention in Europe. In 1677 they were noticed in England by Dr. Plot ('Natural History of Oxfordshire'), and in 1678, by an equally famous pioneer of natural history, Dr. Lister.[1] From this time the well-known controversy regarding their nature—whether they were mere stones, crystals, horns, or shells—was stoutly maintained by Grew,[2] 1681, Woodward,[3] 1695, Lhwyd,[4] 1699, and others in England, and by many foreign naturalists, until the general progress of zoology and geology left no room for doubt as to their affinity with the shelly supports of other better-known Cephalopoda.

The description of species of British Belemnites begins with Dr. Plot, 1677, the first Keeper of the Ashmolean Museum in Oxford, to whom I am therefore especially bound to render due justice. It is easy to recognise in his writings and figures the large species of Belemnite, called *Belemnites abbreviatus* by a later writer, which occurs in the Coralline Oolite of Headington, near Oxford;[5] *B. elongatus*, Miller, is probably one of the two species from the Upper Lias of Great Rolwright, Oxon.; and the deeply grooved species (*B. sulcatus*, Mill.), is common near Oxford. ('Natural History of Oxfordshire,' pl. iii,—3, 4, 5, 6.)

[1] 'Historiæ Animalium Angliæ, tres tractatus,' 1678, 4to.

[2] 'Catalogue of Rarities,' &c., 1681, fol.

[3] 'Essay towards a Natural History of the Earth,' 1695, 8vo.

[4] 'Lithophylacii Brittannici, Ichnographia,' 1699, 8vo.

[5] "If vehemently rubbed, the only one amongst all that I have that, like amber, takes up straws and some other light bodies." ('History of Oxfordshire,' p. 94.)

Lister follows, in 1678, with special notice of the small mucronate fossil, which he called *B. minimus*, common in the "Red Chalk" of Yorkshire, the county in which he resided. ('Hist. Anim. Angliæ.') He says it is found in all the cliffs as you ascend the Wolds, for above a hundred miles in compass, at Speeton, Londesborough, and Caistor, but always in a red ferruginous earth. This remarkable observation shows how near were the able inquirers of the seventeenth century to the discovery which was made a century later by W. Smith in another part of England.

Lhwyd, in 1699, gave descriptions of no less than eighty-two specimens of Belemnites, with their localities, and figures of two guards, and one phragmocone. The localities indicated show that this diligent man had collected from most of the strata of England, and it is interesting to read his remark that in his native Wales he nowhere found a single Belemnite. Except in the Lias of the southern coast of Wales, no one will be likely to find any now in the otherwise rich principality. Few of the specimens collected by Plot and Lhwyd are now to be found in the Oxford Museum.

The Coralline Oolite and Calcareous Grit yielded to Lhwyd "Belemnites maximus oxyrhynchus," and the large Belemnites, known as *B. abbreviatus*, Mill., from the quarries at Cowley, Bullington, Stansford, Marsham, Garford, Basisleigh—all within easy reach of Oxford. A subfusiform small Belemnite, possibly the young of the large species already named, is quoted from Cowley and Marsham. One locality is given for a large cylindrical species, which is remarkable:—"In medio saxo invenimus, ad collem Garsingtonensem." He also quotes a small specimen from the stone quarries of Thame, and other very small examples. These are the only statements known to me of any Belemnite being found in the Portland Rocks of England.

From the Oxford Clay by the Cherwell we have the young form of *B. sulcatus*, Mill., also recognised at Apsley, in Bedfordshire. Murcot (now Moorcot) on the edge of Otmoor, produced a fine example of *B. tornatilis*, seven inches long. Huntingdon, and Pyrton, in Wiltshire—"e puteo carbonibus eruendis destinato"—are also quoted for Belemnites of this age.

The Bath Oolites, in their various stages, yielded several examples. "Stunsfield," as it was then written, is cited for three canaliculate forms, which include the two now generally known as *B. Bessinus* and *B. fusiformis*. At Barrington, Kidlington, and Witney, localities visited near Oxford, examples occurred, but the species are untraceable.

We recognise fossils of the Marlstone from Alderley and Wootton-under-Edge, in Gloucestershire, but cannot determine the species.

Lias Belemnites were collected at Boughton and Marston Trussel in Northamptonshire, Whitton-on-Humber, Pyrton Passage on Severn, and Radstoke, in Somerset, but the descriptions are insufficient for identification.

Chalk Belemnites are mentioned in Kent and Norfolk, but special attention was not directed to them.

Morton, the author of the excellent 'Natural History of Northamptonshire,' in 1712,

mentions, but with no critical attention, Belemnites corresponding to the great types already familiar to the English collectors. Fusiform Belemnites ("Belemnites ari pistillum referens") of Lhwyd, with a ventral canal, are mentioned in Upper Lias Clay at Marston Trussel and Oxendon, and in Stone at Crick. It is easy to recognise *B. elongatus* of Lias, and *B. sulcatus* of Oxford Clay, among the contents of Morton's drawers, and it is evident that he looked curiously and carefully at those objects; but he gives no figures, a somewhat remarkable exception to his general practice, which is to present a great number of very tolerable illustrations of invertebral fossils.

Woodward.—Belemnites were much studied by Dr. John Woodward, not merely as to the true nature of these fossils, in which he was signally wrong, but as to the diversity of their forms, and the variety of accidental circumstances by which they are accompanied. In his 'Method of Fossils' (1728) he speaks of "the *Belemnites fusiformis*" of J. Bauhin, another of a different form pointed at each end, and of a "conic" Belemnite. In the 'Natural History of Fossils' (1729) he gives several particulars and a good deal of general information about the conic, fusiform, and bicuspid Belemnites, the two former having one 'chap or seam' running down one side, the latter no such seam. In this his latest notice of Belemnites we find him at last willing to correct his former notions, and to admit that they might be of "animal, and not of mineral nature, as he had ever taken them to be" (p. 104). The species of Belemnites thus defined may be in some degree ascertained by the reference to localities. Thus, the bicuspid sorts, being quoted from the chalk-pits of Northfleet, Greenhithe, and Croydon, are easily recognised as the incomplete fossils called Actinocamax by Miller, now included in the genus Belemnitella. The fusiform Belemnites include the well-known "Stunsfield" species (also quoted from Hannington, in Wiltshire), and one of similar general shape but different in construction from "Spitten," in Yorkshire, where there are "great numbers of them in blue clay in a large cliff." Another locality given is a tile-clay-pit, near Thurnham, three miles from Maidstone, in Kent; this was a species of the Gault, probably that now called *B. minimus*. One other locality is given for a fusiform Belemnite, viz., a quarry half a mile west of Clipston, Northamptonshire; it probably refers to a species in the Marlstone, such as *B. clavatus*, Blainville.

In his group of conic Belemnites Woodward placed the larger portion of the specimens which had come under his notice. Most of them had the "chap or seam running lengthways of the surface," which we find in many Oolitic Belemnites, or else the narrow canal which belongs to the Cretaceous Belemnitellæ.

Belonging to this latter group were specimens from Greenhithe and Northfleet, in Kent, which the author suspected to be of the same kinds as the bicuspid sorts already noticed[1]. The large *Belemnites abbreviatus* of the Coralline Oolite was received by Woodward from Cowley Common, near Oxford, with vermiculi (Serpulæ) and small oysters adherent. An allied species occurred at Stowell, in Gloucestershire, in the Oolitic zone of

[1] At present we should refer those incomplete "bicuspid" to these more perfect "conic" examples.

Dundry. The Bath Oolite series also yielded him specimens corresponding or allied to *B. sulcatus* of Miller, from Sherburn, Birliphill, Farmington, Yanworth, Northleach, Colne Allens, in Gloucestershire; and Barrington, in Oxfordshire. The Marlstone of Clipston, in Northamptonshire, furnished specimens probably of *B. paxillosus.*

From the Lias of Boughton and Ashley, in Northamptonshire, joints probably of the phragmocone of *B. elongatus,* Sow.; and from the Upper Lias (Alum Shale) of Whitby several specimens, probably of *B. vulgaris,* Young and Bird.

One remarkable locality, Silverton, Devonshire, is quoted for several specimens of a conic Belemnite, with "a seam or sulcus running down one side of this body for the whole length of it." This obviously describes a canaliculate species of the Inferior Oolite; but Silverton is situated in the Trias. Perhaps we ought to read Silverston, in Northamptonshire. On the whole, it may be concluded that the following species were handled by Dr. Woodward:

Chalk	Belemnitella mucronata, *Schl.* . .	Kent.
"	— plena, *Blainv.* . . .	Kent.
Gault	Belemnites minimus, *Mill.* . . .	Kent.
Speeton Clay . . .	— jaculum, *Ph.* . . .	Yorkshire.
Oxford Oolite Group .	— abbreviatus, *Mill.* . .	Oxfordshire.
Bath Oolite Group .	— sulcatus, *Mill.* . . .	Gloucestershire.
" .	— fusiformis, *Mill.* . . .	Oxfordshire.
Lias	— clavatus, *Bl.* . . .	Northamptonshire.
"	— vulgaris, *Y.* and *B.* . . .	Yorkshire.
"	— elongatus, *Mill.* . . .	Northamptonshire.
"	— paxillosus, *Schl.* . . .	Northamptonshire.

In 1764 Mr. Joshua Platt, a patient and not unsuccessful explorer of the fossils of Stonesfield, near Oxford, communicated to the Royal Society observations on the structure of Belemnites,[1] which contain the sound opinion that the Belemnite was a shell formed, as the hard parts of mollusca are, by deposition from a secreting surface.

In the elegant work of Mr. Parkinson, 1804, Belemnites appear among the "organic remains of a former world," and the terms employed by Woodward retain their place. The "conic" Belemnite, the "cylindrical" Belemnite, and the "fusiform" Belemnite of Stonesfield, the large, nearly round fossil of the Oxford Clay, and the mucronate form of the Chalk, are represented, but not critically distinguished.

In 1823 the Geological Society of London received from Mr. J. S. Miller, a native of

[1] 'Phil. Trans.,' liv, p. 38. Mr. Platt was the "discoverer" of the Stonesfield mammals, though, perhaps, he may not have known the full value of the lower jaw of *Amphitherium Broderipii* (Owen), which formed part of the collection furnished by him to an ancestor of my late friend, the Rev. C. Sykes, of Rooss, who, at my request, gave the specimen to the Yorkshire Phil. Society. (See Owen, 'Brit. Mammal.,' p. 58.)

Dantzic, residing at Bristol, and charged with the custody of the Museum of the Institution there, 'Observations on Belemnites,' in which twelve species were named, described, and figured. Notwithstanding some errors, which may be partly typographical (as when Plot, who wrote in 1677, is represented as communicating a paper to the 'Phil. Trans.' in 1764, the true author being Joshua Platt), this is a treatise of much value, and it made a first and important step in the right direction. He describes and figures the following species, mostly named by himself.

1. *Belemnites abbreviatus.* Pl. VII, figs. 9, 10. From Weymouth and Dundry. Inferior Oolite. The specimen figured is in the Museum at Bristol, and appears really to have been derived from the Coralline Oolite, in which the species is common. It has not been found in the Inferior Oolite at Dundry or elsewhere. The description is inadequate, and other species have since been ranked under this name.
2. *Belemnites aduncatus.* Pl. VIII, figs. 6, 7, 8. From Weymouth and Lyme, in Lias. The former locality is incorrect. It is difficult to identify this species, though specimens occur in Upper Lias which somewhat resemble this figure of Miller.
3. *Belemnites sulcatus.* Pl. VIII, figs. 3, 4, 5. From Dundry, near Oxford. Inferior Oolite. There is more than typographical confusion here. Figs. 3 and 4 are taken from Dundry specimens, and belong to a species found in the Inferior Oolite. Fig. 5 is from an Oxford specimen of a different type, out of the clay of that name. Mistakes in regard to this name are very common.
4. *Belemnites elongatus.* Pl. VII, figs. 6, 7, 8. From Lyme, in Lias. Imperfectly defined, so that different species have been since called by this name.
5. *Belemnites longissimus.* Pl. VIII, figs. 1, 2. From Lyme, in Lias.
6. *Belemnites acutus.* Pl. VIII, fig. 9. No locality;[1] but reference is made with doubt to Lhwyd, fig. 1683, which represents a fossil from Merston, in Northamptonshire. Much confusion in regard to the application of this name by Blainville and later writers.
7. *Belemnites tripartitus,* Schlottheim. Pl. VIII, figs. 10, 11, 12, 13. No locality given. Not easily identified, among several cognate forms.
8. *Belemnites ellipticus.* Pl. VIII, figs. 14, 15, 16, 17. From Dundry. Inferior Oolite. By many writers identified with *B. giganteus.*
9. *Belemnites electrinus.* Pl. VIII, figs. 18, 19, 20, 21. Salisbury, Brighton, Lewes, Chalk. Some foreign localities are given in error, the Baltic species being different from that of Maestricht.
10. *Belemnites fusiformis.* Pl. VIII, fig. 22; Pl. IX, figs. 5—7. Stonesfield.
11. *Belemnites minimus.* Pl. IX, fig. 6. Folkstone, Ringmer, &c. Gault.

[1] See on a future page the localities now admitted.

Mr. Miller also describes, under the name of *Actinocamax verus*, the incomplete guard of a twelfth Belemnite, from which the part containing the "alveolus" had been removed by decomposition of the nacreous laminæ. Before his death this was made clear to the ingenious author, to whom we are indebted for a still more valuable contribution to palæontology, viz., the essay on 'Crinoïdea.'

For the greatest addition ever made to British fossil conchology we are indebted to James Sowerby, who in 1812 commenced, and James De Carle Sowerby, who continued the labour of engraving the countless mollusca of the strata of the British Isles.

It is only in the sixth volume, and towards the end of that volume, that figures of Belemnites occur. They relate to species which had been previously described, some in English and others in foreign works, and include fossils of the Lias, Oolite, and Chalk.

From the Lias.—*B. pistilliformis*, t. 589, f. 3. *B. penicillatus*, t. 590, f. 5, 6. *B. elongatus*, t. 590, f. 1. *B. acutus*, t. 590, f. 7, 8, 10.

From the Oolites.—*B. abbreviatus*, t. 590, f. 2. *B. compressus*, t. 590, f. 4 (Scarborough). (*B. ellipticus*, mentioned p. 182. *B. gigas*, mentioned p. 182.)

From the Chalk, Greensand, and Gault.—*Belemnites granulatus*, t. 600, f. 3, 5. *B. lanceolatus*, t. 600, f. 8, 9. *B. attenuatus*, t. 589, f. 2. *B. minimus*, t. 589, f. 1. *B. mucronatus*, t. 600, f. 1, 2, 4, 6, 7. (Fig. 1 is referred by Sharpe to *B. lanceolatus*, Schl.)

Beloptera is also noticed, and three species from the Cænozoic series are figured; one, *B. anomala*, from Highgate; the others, *B. belemnitoidea*, and *B. sepioidea*, from France.

W. Smith, in his works entitled 'Stratigraphical System of Organized Fossils' (1817) and 'Strata identified by Organic Remains' (1816 and following years) notices some of the Belemnites in his large collection, now placed in the British Museum.

Among the fossils selected for identifying the Upper Chalk he places *Belemnites mucronatus;* to the Gault, or "Micaceous Brickearth," he assigns *Belemnites minimus;* and to the Oxford or 'Clunch' Clay, the Belemnite which has been since called *Owenii*, and has received other designations. The work was never completed.

In the 'Stratigraphical System' he gives two Belemnites from the Crag, no doubt drifted; one, a siliceous cast of alveolus from the Chalk. Two Belemnites from the Chalk, one from the Upper Greensand, one from the Gault, one from the Kimmeridge Clay, one from the Coralline Oolite, two from the Oxford Clay, one from the Kelloways Rock, one from the Fuller's Earth Rock, two from the Inferior Oolite, one from the sand and sandstone below, four from the Marlstone, with which rock the publication ceased. The species are mostly recognisable, except some of those in the Marlstone; among them may be enumerated the following:

Chalk	Belemnites	mucronatus, *Sow.*
Greensand	—	plenus? *Blainv.*
Gault	—	minimus, *Sow.*
Kimmeridge Clay . . .	—	excentricus, *Blainv.*
Coralline Oolite . . .	—	abbreviatus, *Miller.*

Oxford Clay. Kelloways Rock	Belemnites Owenii, *Pratt.*
Fuller's Earth Rock. Inferior Oolite	— canaliculatus, *Schl.*
Marlstone	— paxillosus, *Schl.*
	— elongatus, *Mill.*

In 1822 the Rev. G. Young and Mr. J. Bird issued the first edition of their 'Geological Survey of the Yorkshire Coast.' Among the objects noticed and figured are a few Belemnites:

B. vulgaris, common in the Alum Shale (Upper Lias).
B. excentralis, said to occur in the Oolite (of Malton), the Upper Shale (Speeton), and the Chalk.
B. fusiformis, from the Speeton Shale.
B. tubularis, from the Alum Shale.

In the second edition (1828) one more species, called *B. compressus*, is noticed, and somewhat strangely figured. The names were given without reference to any works but those of Sowerby and Miller, and the species here marked *fusiformis* and *compressus* are not those so named by earlier writers.

Sir H. T. de la Beche, among other proofs of his attention to the organic contents of the Lias of Dorsetshire, presented to the Geological Society a drawing of a rare Belemnitic fossil, which he termed an Orthoceratite (1829). It has but a small and slender guard, and a very slender phragmocone, but possesses an elongated anterior shell. Prof. Huxley has described it from more perfect examples, under the generic title of Xiphoteuthis. It occurs in the middle Lias of Lyme Regis.[1]

In the first volume of my work entitled 'Illustrations of the Geology of Yorkshire,' 1829, I noticed nine specific groups of Belemnites from the Lias and Oolites of the Yorkshire coast, from my own observations among the cliffs, and still more from the rich collections freely opened to be by Mr. Bean and Mr. Williamson. The public collections at Whitby and York were also examined. Almost immediately after the publication of this volume I visited the Strasburg Museum, and found M. Voltz busy in those excellent observations which place him, in my judgment, in the very first rank of the naturalists who have really studied Belemnites. From him I learned much; and in the second edition of my work already named (in 1835) the following stands as the "Synoptic List of Yorkshire Species," arranged according to the strata in downward series:

Chalk	B. mucronatus, *Sow.*
"	— granulatus, *Sow.*

[1] 'Mem. Geol. Survey' ("Organic Remains"), 1864.

Red Chalk	B. Listeri, *Phil.*.
Speeton Clay	— minimus, *Sow.*
,,	— jaculum, *Phil.*
Speeton Clay and Kimmeridge Clay	— lateralis, *Phil.*
Coralline Oolite	— abbreviatus, *Mill.*
,,	— Blainvillii, *Voltz.*
Oxford Clay	— gracilis, *Phil.*
Kelloways Rock	— anomalus, *Phil.*
,,	— tornatilis, *Phil.*
Bath Oolite	— quinquesulcatus, *Bl.*
,,	— Aalensis, *Voltz.*
Upper Lias	— tubularis, *Y.* and *B.*
,,	— compressus, *Voltz* not *Sow.*
,,	— trifidus, *Voltz.*
,,	— subaduncatus, *Voltz.*
,,	— paxillosus, *Voltz.*

Mr. Samuel Woodward recorded in his 'Synoptical Table of British Organic Remains' (1830) the following species:

Chalk	B. granulatus, *Sow.*
,,	— electrinus, *Mill.*
Chalk Marl.	— lanceolatus, *Sow.*
Gault	— Listeri, *Mant.*
,,	— attenuatus, *Sow.*
,,	— minimus, *Sow.*
Oxford Clay	— gracilis, *Phil.*
Stonesfield Slate	— fusiformis, *Park.*
Great Oolite	— compressus, *Sow.*
Inferior Oolite	— sulcatus, *Mill.*
,,	— ellipticus, *Mill.*
,,	— abbreviatus, *Mill.*
Lias	— tubularis, *Y.* and *B.*
,,	— elongatus, *Mill.*
,,	— aduncatus, *Mill.*
,,	— longissimus, *Mill.*
,,	— pistilliformis, *Sow.*
,,	— acutus, *Mill.*
,,	— penicillatus, *Sow.*

Dr. Buckland's researches in Belemnites began in 1829.[1] In his 'Bridgewater Treatise on Geology and Mineralogy,' 1836, he gave many interesting drawings of Belemnites and other fossil Cephalopoda, and added useful comparative diagrams of recent decapod and octopod cuttles. He gives many examples of "ink-bags of Belemno-sepia, and their

[1] 'Geol. Soc. Proc.,' i, 96; and 'Trans.,' iii, 217.

nacreous sheaths," from the Lias of Lyme Regis, and represents one specimen, stated to be unique, from the cabinet of Miss Philpotts, which shows together the guard, phragmocone, and ink-bag; he names it *B. ovalis*. Of *B. pistilliformis*, Sow., also, a specimen is figured, showing traces of the ink-bag. A third Belemnite from the Lias, very short, with thin guard, is called *B. brevis*? A restoration of "Belemno-sepia," with the included shelly parts, usually called Belemnite, is attempted, and the analogies of the Belemnitic animal are discussed in the spirit of the remarks of Blainville.

In consequence of the cutting through Oxford Clay at Christian Malford, in Wilts, by the Great Western Railway, Mr. W. C. Pearce, Mr. S. P. Pratt, Mr. Buy, Mr. Reginald Mantell, Mr. W. Cunnington, and other collectors, were able to obtain many admirable examples of two groups of Cephalopoda, which gave occasion to several valuable memoirs. In January, 1842, Mr. Pearce noticed a conical shell which resembled the Belemnite by having, like it, a concamerated portion traversed by a marginal siphuncle, and protected by a brown, thick, shelly covering, which gradually became thinner towards the superior part. "Immediately above the chambers is an ink-bag, resting on what resembles the upper part of a sepiostaire, and composed of a yellow substance finely striated transversely, being formed of laminæ of unequal density." Some other notices are added, and the author assigns to his specimens the generic name of Belemnoteuthis.[1] Mr. Cunnington afterwards added the specific name. It has been regarded as congeneric with *Acanthoteuthis* of Münster, and called *A. antiquus*.

The 'Philosophical Transactions' for 1844 contain the important memoir of Prof. Owen on the Belemnites found in the Christian Malford cutting. Many parts of the structure of Belemnites, and the affinity of the animal to other Cephalopoda, are successfully cleared up in this instructive and valuable essay. The author was, however, not supplied at that time with such satisfactory specimens of true Belemnites as of the Acanthoteuthidæ already mentioned. In consequence, these groups were not distinguished, and the beautiful restored figure ('Phil. Trans.,' 1844, pl. viii) is not so satisfactory as later discoveries might have furnished the means of producing. To this memoir, and to a later work of the professor,[2] we shall refer in future pages for information on special points of structure.

In 1848, Dr. Mantell communicated to the Royal Society "Observations on some Belemnites and other Fossil Remains of Cephalopoda, discovered by his son, Mr. Reginald Mantell, C.E., in the Oxford Clay at Christian Malford, near Trowbridge, in Wiltshire." Two species of straight-shelled Cephalopoda are here figured and described, and shown to belong to two genera, viz., one the Belemnoteuthis of Pearce, with ink-bag, uncinated arms, and a chambered shell, with thin investing fibrous sheath; the other a Belemnite common in the Oxford Clay, to which several names have been assigned. Now, for the first time, the two narrow processes which extend beyond the divisions of the phragmocone

[1] 'Proceedings of Geol. Soc.,' vol. iv, 592.

[2] 'Palæontology,' 8vo, ed. 2, 1861.

were clearly distinguished, and the several parts of this somewhat complicated shell placed in comparison with the corresponding parts of Belemnoteuthis. In 1849, further details from other examples were communicated by the same indefatigable naturalist to the Geological Society, showing the two remarkable processes already alluded to. The author expressly declares that he had never found in specimens of the numerous Belemnites which he had examined any trace of the ink-bag or its dark contents.

The volume for 1850 of the 'Memoirs of the Palæontographical Society' contains an account of the Cephalopoda of the Stonesfield Slate by Prof. Morris and Mr. Lycett. Two species are described and figured, viz., *B. fusiformis*, Park., and *B. Bessinus* D'Orb., which is regarded by Oppel as a synonym of *B. sulcatus*, Miller, and *B. canaliculatus*, Schl.

In the volume for 1853 of the same Society the Belemnitidæ of the Upper Cretaceous system are described and figured by Mr. Sharpe, five species, which will be found with the same names in the Catalogue of Prof. Morris.

Prof. Morris presents in his 'Catalogue of British Fossils,' edition 2nd, 1854, the following thirty-one species:

Chalk	Belemnitella lanceolata, *Schl.* = *Belemnites mucronatus*, Sow.
,, ...	— mucronata, *Schl.* = *B. electrinus*, Mill.
,, ...	— plena, *Blain.* = *Actinocamax vera* of Miller, and *Belemnites lanceolatus*, Sow.
,, ...	— quadrata, *Defr.* = *B. granulatus*, Sow.
Gault and Red Chalk . .	Belemnites ultimus, *D'Orb.* (*B. Listeri*, Phil.). Folkstone.
Gault	— attenuatus, *Sow.* Folkstone.
,, ...	— minimus, *Lister.* Ringmer; Bletchingly; Folkstone; Wilts.
Speeton Clay	— lateralis, *Phil.* Brantingham; Speeton.
,, ,, ...	— jaculum, *Phil.* Speeton.
Coralline Oolite . . .	— abbreviatus, *Mill.* Malton; Garsington.
Oxford Clay and Kelloway Rock	— anomalus, *Phil.* Yorkshire.
,, ,, ,, . .	— Beaumontianus, *D'Orb.* Loch Staffin.
,, ,, ,, . .	— gracilis, *Phil.* Yorkshire.
,, ,, ,, . .	— hastatus, *Bl.* Cambridgeshire; Wiltshire; Dorset.
,, ,, ,, . .	— Owenii, *Pratt* (*B. Puzosianus*, D'Orb.). Wilts; Dorset.
,, ,, ,, . .	— tornatilis, *Phil.* Yorkshire.
Lower part of the Great Oolite	— Bessinus, *D'Orb.* Stonesfield.
,, ,, ,, . .	— fusiformis, *Park.* (*B. Fleurisianus*, D'Orb.). Stonesfield.
Inferior Oolite . . .	— canaliculatus, *Schl.* Gloucestershire.
,, ,, ...	— ellipticus, *Mill.* Dundry.
,, ,, ...	— giganteus, *Schl.* (Morris gives for synonyms *B. quinquesulcatus* of Blainville, *B. compressus* of Sow., and *B. Aalensis* of Voltz. In some foreign museums *B. longus* of Voltz is added to this synonymy, which will be considered hereafter.)

Inferior Oolite . . .	B. sulcatus, *Mill.*	Considered to be the equivalent of *B. apiciconus*, of Blainville. Dundry.
Lias	— acuarius, *Schl.*	(It is supposed by Prof. Morris to be identical with *B. tubularis* of Young and Bird and *B. lagenæformis* of Zieten.) Whitby, Yorkshire; Gloucestershire.
,, ...	— acutus, *Mill.*	Shornecliff; Charmouth.
,, ...	— aduncatus, *Mill.*	Lyme; Weston.
,, ...	— breviformis *Voltz.*	Gloucestershire.
,, ...	— brevirostris, *D'Orb.*	Cheltenham.
,, ...	— compressus, *Voltz.*	Yorkshire.
,, ...	— elongatus, *Mill.*	Somerset; Dorset; Ross; Cromarty.
,, ...	— longissimus, *Mill.*	Lyme; Western; Boll.
,, ...	— paxillosus, *Voltz.*	Yorkshire; Gloucestershire.
,, ...	— penicillatus, *Bl.*	Dorset; Gloucestershire.
,, ...	— pistilliformis, *Sow.*	Charmouth.
,, ...	— subaduncatus, *Voltz.*	Yorkshire.
,, ...	— trifidus, *Voltz.*	Yorkshire.

In 1855 Mr. S. P. Woodward, besides giving a compendious and effective classification of the Belemnitidæ as a group of Cephalopoda Tetrabranchiata, presented a drawing of the solid parts of the Belemnitic animal seen dorsally,[1] and another of *Belemnoteuthis antiquus* seen ventrally.[2] In his supplement (1856) he calls attention to a specimen in the possession of Mr. Buckman which exhibits the fossil ink-bag within the phragmocone of a Belemnite. The classification here referred to will be considered hereafter.

The work of Mr. Martin Simpson (1855) on the 'Fossils of the Lias of Yorkshire' includes notices of forty species and varieties of Belemnites, of which specimens may be seen in the Whitby Museum. I have examined that collection carefully, and have found it very instructive. Mr. Simpson's descriptions are careful, but, being unaccompanied by figures, inspection of the original specimens is necessary for understanding the distinctions relied on.

For the latest and most important additions to our knowledge of the structure of Belemnitidæ by British authors we are indebted to Prof. Huxley's descriptions of some remarkable specimens obtained by Mr. E. H. Day from the Lower Lias near Charmouth. In this elaborate memoir[3] the facts embodied in the various statements of previous observers are re-examined, and a nearly complete view is furnished of the structure and relations of the solid parts of the Belemnitic animal. In particular, the anterior solid parts (*pro-ostracum*) are placed in their true significance, both in the Belemnites of ordinary form, as *B. elongatus*, and in the new genus Xiphoteuthis. To this valuable essay we shall again refer.

[1] 'Manual of the Mollusca,' pl. ii, fig. 5.

[2] Ibid., p. 75.

[3] "British Organic Remains" ('Memoirs of the Geological Survey'), Monograph 2, 1864.

Several foreign writers of eminence have incidentally noticed the more frequently occurring British Belemnites, and in this manner, better sometimes than by the descriptions or figures, we are able to establish, in a few instances, a satisfactory synonymy with Schlotheim, Blainville, Voltz, D'Orbigny, Münster, Quenstedt, Oppel, and Von Meyer. To these authors reference will be frequently made as we proceed.

Lists of Belemnites, and scattered notices of individual species, have been often given by British authors while describing particular strata or remarkable localities; but there is, perhaps, no group of fossils which demands so much caution in quoting references of this nature to species not always really determined by examination of a large number of specimens in different periods of growth.

STRUCTURE OF BELEMNITIDÆ.

According to the knowledge now acquired, the solid parts of the Belemnitic animal consisted of an internal shell of somewhat complicated structure, which for clear explanation requires representations of at least three aspects of the surface and three or more sections of the interior. By employing always fixed letters of reference for these aspects and sections, the descriptions become more compact, symmetrical, and characteristic. To begin with the principal sections, which are represented in the first diagram, one being longitudinal, the others transverse—

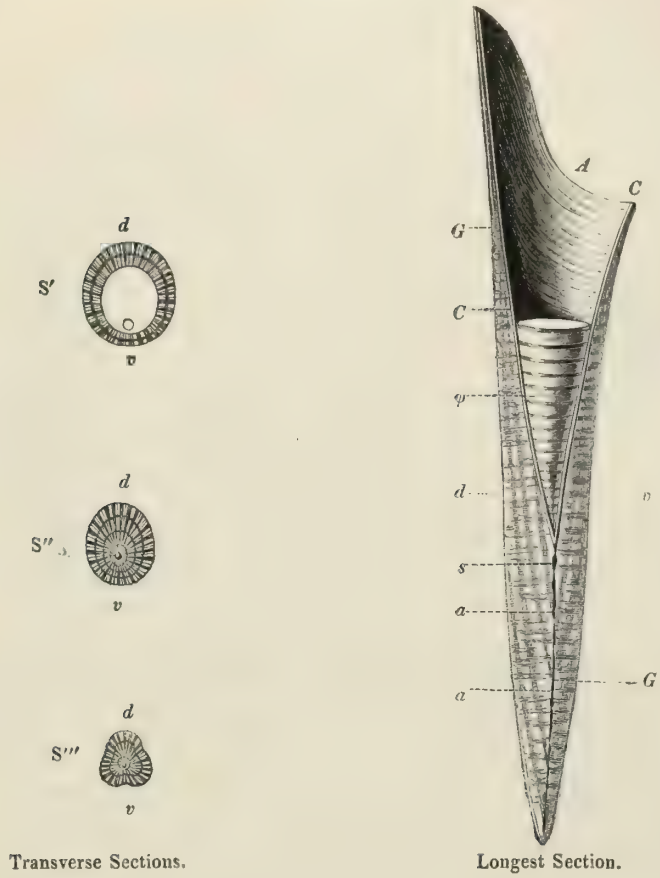
The portion of the Belemnite most commonly preserved in a fossil state is the posterior or caudal part, marked *G* in the first diagram. It is to this sparry, usually pointed, and more or less cylindrical, conical, or tapering mass, that the ancient discussions as to the horny, shelly, or mineral nature of the Belemnite belong. This was, in fact, for Woodward and Lister the Belemnite. It has been called the guard, sheath, rostrum, or osselet.

In the transverse section taken at the apex of the phragmocone the concentric curves represent successive stages of growth, the inner rings being deposited first, as in exogenous trees. Indications of a thin capsule, or formative membrane, appear in some Belemnites of the Oxford Clay and Lias, investing the guard.[1] In the Oxford Clay it is represented by a granular incrustation; in some Lias Belemnites it appears in delicate small plaits, like ridges and furrows. The whole mass of the guard is fibrous, and usually transparent carbonate of lime; not exactly calcareous spar, unless we suppose a minutely fibrous kind of crystallization, like that sometimes seen in stalactite. It is still more like arragonite, and some kinds of recent shells, not such as Pinna or Hinnites, with large prismatic cells, but, as Dr. Carpenter remarks, like Septaria. A distinctly cellular

[1] Mantell, 'Phil. Trans.' Owen, 'Phil. Trans.' Huxley, 'Mem. of Geol. Survey.'

structure is difficult to demonstrate in these fibres, which Owen describes, in specimens from Christian Malford, as of a trihedral prismatic form, and of $\frac{1}{2000}$th of an inch in

DIAGRAM 1.



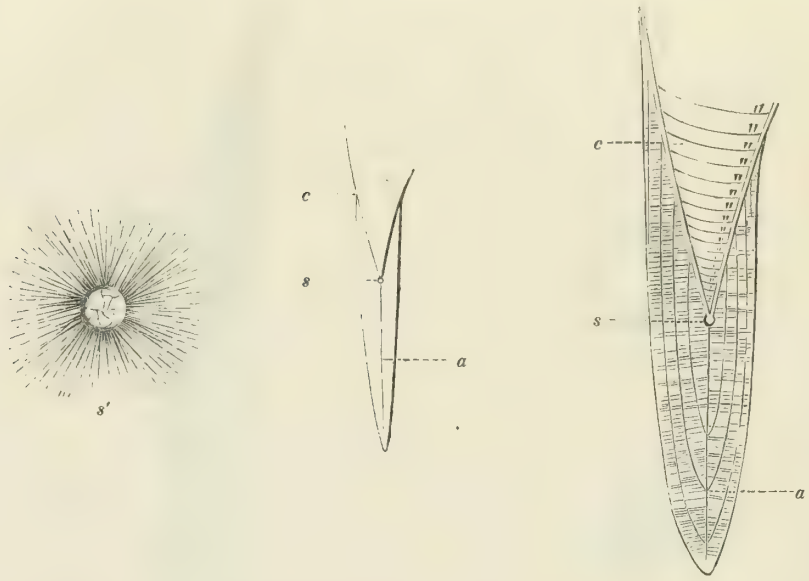
G. Guard. *φ.* Phragmocone. *C.* Conotheca. *A.* Alveolar cavity. *s.* Sphericle of the guard. *a a.* Axis of guard. S′ S″ S‴. Transverse sections. *d.* Dorsal aspect. *v.* Ventral aspect.

diameter. In some species they are very much larger. They appear sometimes connected into pencils; mostly, however, they are ranged perpendicularly to the laminæ of growth, which they cross without interruption, to meet on the axial, or, as it is called by Voltz, the apicial, line. The Belemnite is found in nearly the same mineral condition whatever be the containing rock. It is sometimes wholly removed, leaving a hollow, into which the conical mould of the alveolar cavity projects. This happens in the upper beds of the Lias in Yorkshire and in the Marlstone of Rutland.

The Belemnitic shell begins in a very small spherule, the wall of which has not been very clearly seen; but, by observation of specimens in Oxford Clay and Lias, it appears to

have been a thin cellular tissue (*s′*) like that of the youngest parts of the conotheca and the smallest septa.

DIAGRAM 2.



It is supposed by some writers to have been extended backward into a small canal at the meeting of the fibres along the axis of the guard, and forward into the pipe or siphuncle of the phragmocone, of which more hereafter. On the little spherule a system of pencils of radiating cells grows up, in a lamina which embraces the spherule on all sides except its anterior or part of its anterior face. There the phragmocone is already begun, either by the spherule extending into a short tube representing the siphuncular opening in a septum, or without such entering short tube. Successive laminæ of radiating cells, more and more extended backward, but stopped in a forward direction by the growing phragmocone, cover the spherule, meet on the axial line, and constitute a small, rather fusiform Belemnite (middle figure), in which the septa appear, and the siphuncle takes its place.

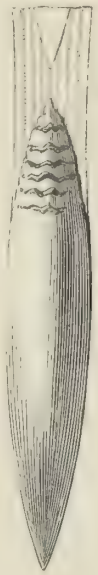
In some instances there appear to be traces of more than one such spherule, with its pencils of diverging fibres, enclosed in the guard, as if the phragmocone had aborted, or its earliest chambers were spherical, and united by a short pipe.

If this description be well considered, it will appear certain that the phragmocone is not a chambered body made to fit into a conical hollow previously formed in the Belemnitic sheath, as some have conjectured, but that both sheath and cone grew together; or, if any difference there were, the phragmocone must have been of earlier growth, and by its enlargement limited the forward extension of the successively deposited laminæ of the guard.

The phragmocone was formed on the exterior of a secretive surface, and the fibrous sheath on the interior of another secretive surface, both extended together from the germinal capsule. The incremental striæ are external on the phragmocone, and internal on the guard.

The guard is sometimes fusiform when young, and grows cylindrical or conical with age; but it is doubtful if any example is satisfactorily in accordance with the figure of Blainville (pl. i, fig. 4), which represents a fusiform mass enclosed in laminæ of growth quite parallel to it. In some cases detached Belemnites assume a fusiform shape by the decay of the laminæ in the peripheral parts about the point of the alveolus. This seems to arise from a difference of composition of the laminæ thereabout. It is seen very often in the elongated Belemnite of the Speeton Clay, and in specimens of *Belemnites quadratus*. On such as these Miller commonly founded his genus Actinocamax.

DIAGRAM 3.



The part marked W is often wasted away in soft, brittle laminæ.

The surface of the guard is sometimes marked by ramified impressions of vessels, and more frequently by certain systematic grooves, which furnish some of the grounds for convenient classification.

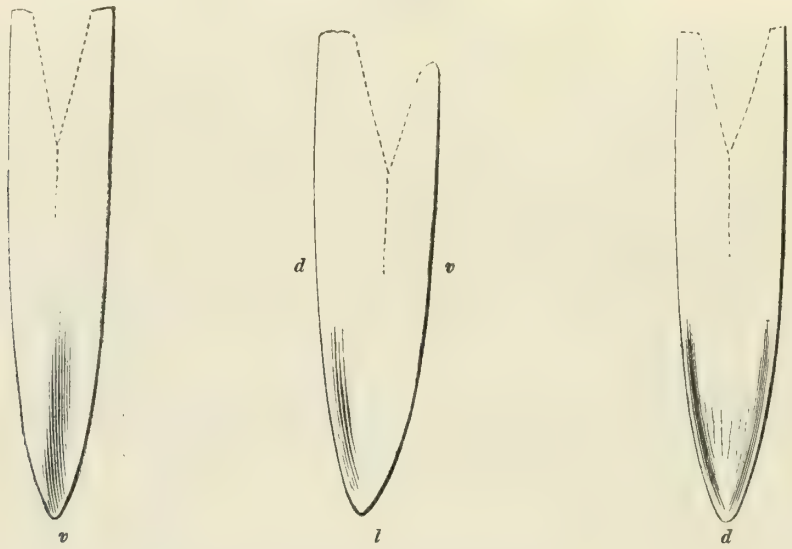
Confining our attention at present to the guard, it may be remarked that the anterior edge is seldom completely traceable; we may, however, be sure that in every case the dorsal edge and its alveolar cavity extended much farther forward than the ventral edge, as represented in Diag. 1. Another point of importance regards the plane of symmetry of the shell, for this always passes directly through the axis or apicial line of the guard, from the middle of the dorsal to the middle of the ventral face. On each side of this plane (except in cases of deformity or accident) the masses and areas are equal and equally disposed, and the markings of the surface are in pairs, while along the middle line thus defined on the dorsal and ventral faces the markings are single. Thus, three aspects of the guard always require attentive inspection and special description, a circumstance rarely observed by Belemnitologists.

The generally smooth surface of Belemnites is only broken by grooves of greater or less depth, striæ, and small plications, and continuous or interrupted small ridges. All these correspond to peculiarities of the formative membranes, and are sufficiently characteristic and constant to serve for more than specific distinction, as will more fully appear hereafter.

The successive laminæ of the guard are not parallel, but in the greater number of cases grow thicker towards the point, and remarkably thinner towards the anterior edges. These laminæ meet the apicial line (*a*) at angles usually acute, and still more acute in their intersection with the conical cavity, which receives the phragmocone, so that they might even appear to be parallel to it. As many as three hundred laminæ of growth have been counted in the cross section of the solid part of a Belemnite from the Oxford Clay, and

as many as eighty in the section of the thinner guard over the alveolar cavity.[1] The thickness of the laminæ is about $\frac{1}{500}$th of an inch on the average, sometimes not more than $\frac{1}{1000}$th of an inch.

DIAGRAM 4.

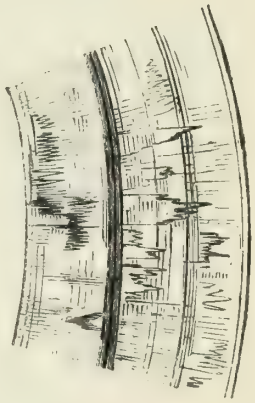


v Is the ventral or lower aspect, *l*, the lateral, and *d* the dorsal, of *Belemn. canaliculatus*, Oxford Clay.

In some Belemnites in the calcareous nodules of the Lias, and in others which occur in the hard Chalk of Antrim, it is difficult to see the laminæ of growth in the clear, horny, yellow, spathose mass of the guard. On the other hand, specimens which occur in clay, shale, or open-grained limestone, show these laminæ very clearly and in great plenty.

DIAGRAM 5.

Longitudinal section of laminæ of guard.



Transverse section of laminæ of guard.

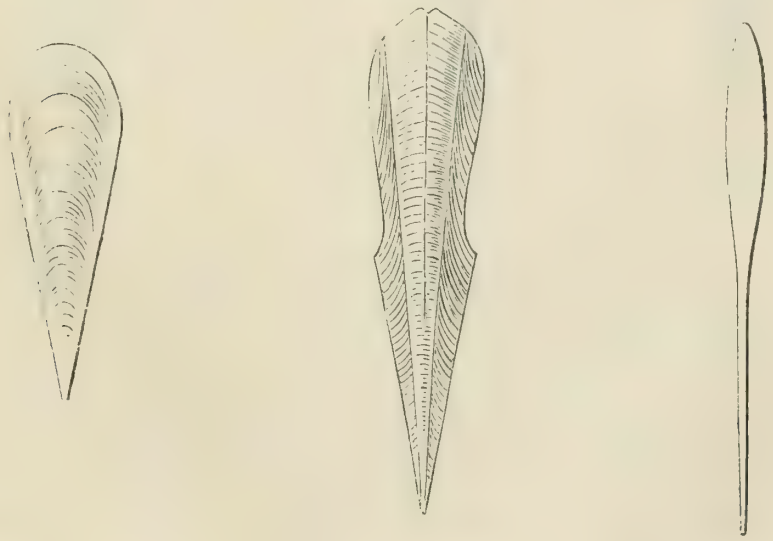
[1] Owen, 'Phil. Trans.,' 1844.

Phragmocone.

The conical cavity of the guard is often empty, but as often filled with a shell of similar form, expanding gradually forward, and divided across by many shelly plates, each concave outwardly, and pierced by a small pipe or siphuncle (σ) near one edge. By these plates or septa the conical shell is divided into chambers, the last being very large in comparison with the others, and destined to cover the breathing organs, heart, and other viscera. The thin conical shell (*c* in the diagram) which covers these chambers is distinct from the substance of the guard, and is called the 'conotheca' by Huxley. The whole chambered mass with this shell is named "*phragmocone*" by Owen. It has been also called "*alveolus*," but that title is better bestowed on the cavity in the guard which receives the phragmocone. The sheath or guard extends forward over this conotheca, but grows by degrees so thin as to become untraceable. Beyond the end where it thus disappears the conotheca is further extended, and in some instances acquires so much length and peculiarity of form as to require a separate designation. The most convenient, perhaps, is that proposed by Huxley, viz., "*pro-ostracum*," or anterior shell. In some cases this extension seems to run out in one simple broad lobe—this appears to happen in Lias Belemnites; in others—Oxford Clay species, for example—it forms two long, narrow, parallel plates. Whatever be the form of this *pro-ostracum*, it is properly a dorsal extension of the conotheca of the Belemnite. In the genus *Xiphoteuthis* it is a very elongated part, larger than the guard, and united to it by a very long (generally depressed), shelly, conothecal extension.

The phragmocone is rarely found complete. The best examples to show its general

DIAGRAM 6.



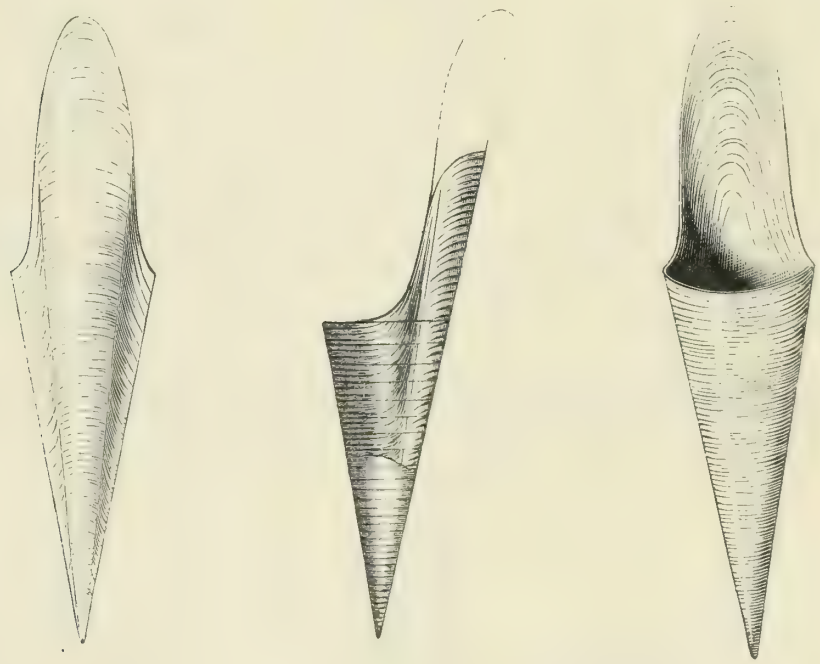
Oolite. 1 — Oxford Clay. 2 — Lias. 3

figure have been obtained from the laminated Oolite of Solenhofen, the laminated Clay of Christian Malford, and the laminated beds of Lias in Dorsetshire and Yorkshire. Three different forms are thus put in evidence; we may add, as a fourth, the elongate shape of Xiphoteuthis.

In the preceding sketches the conotheca is supposed to be opaque, so that the interior septa are not seen. The aspect is dorsal. 1 is from *Belemnites hastatus*, from Solenhofen. 2, *B. Owenii*, from Christian Malford. 3, *Xiphoteuthis elongatus*, from Lyme.

The external aspect of the phragmocone of *B. paxillosus* is given in the next diagram, in three aspects, dorsal, lateral, and ventral. The figures are *restored*, from a variety of specimens which give the requisite information, no one being complete.

DIAGRAM 7.



Dorsal aspect. Lateral aspect. Ventral aspect.

The surface of the conotheca is marked by lines of growth in singular and characteristic curves, first accurately examined by Voltz.[1] According to this observer, the conical surface may be described in four principal regions radiating from the apex; one dorsal, with loop lines of growth advancing forward; two lateral, separated from the dorsal by a continuous straight or nearly straight line, and covered with very obliquely arched lines in a hyperbolic form, in part nearly parallel to the dorso-lateral boundary-line, and in part reflexed, so as to form lines in retiring curves across the ventral portion, nearly

[1] 'Observations sur les Belemnites,' 1830.

parallel to the edges of the septa. Measured round the cone, the dorsal region occupies about $\frac{1}{4}$th, each lateral (or hyperbolic region, as Voltz calls it) about $\frac{1}{8}$th, and the ventral region about $\frac{1}{2}$ the circumference. The straight or nearly straight boundaries of the dorsal space are called asymptotes. There is occasionally a straight line along the middle of the dorsal region crossing the "ogivial" dorsal axis; this line is in some cases elevated, in others depressed. Fine longitudinal striæ appear on the outermost layer of the phragmocone especially in the ventral region.

The proportions of the phragmocone, its transverse septa, chambers, and siphuncle, vary in different species of Belemnites. The axis of the general figure is for the most part a little curved, always in such a manner that the apex is slightly bowed towards the lower or ventral side. If a longitudinal section be made right through the siphuncle, from the dorsal to the ventral line, and the angle of inclination to each other of the sides of the phragmocone be measured, it will be found that this angle grows more and more open as we approach the apex. If another longitudinal section be taken across the cone from side to side the boundaries will be nearly straight, and the angle of inclination of the sides nearly constant. It is this angle which should be given as a part of the specific character. Taking an example from a phragmocone of any Belemnite, the septa are found to be nearer and nearer to one another as the cone grows smaller and we approach the apex. In some Belemnites the septa are circular; in others elliptical, the longer axis being between the dorsal and the ventral face, and passing through the siphuncle. In *B. paxillosus* the diameters are as 100 to 108. The curvature of the septal plate is nearly spherical or spheroidal; the arc included is about 50°, but toward the apex greater, even exceeding 90°. The radius grows shorter and shorter in a greater proportion than the diameter lessens. The intervals between the septa are about $\frac{1}{6}$th of the diameter. In a series of septa exposed by section of the phragmocone of *B. canaliculatus*, the intervals were thus found nearly—

17, 16, 15, 14, 13, 12, 11, 10, 10, 9, 8;

and in another less regular—

15, 14, 13, 10, 8, 10, 9, 9, 8.

In neither case could the septa be counted to the end, but the whole number was estimated to be about thirty in a length of $\frac{3}{4}$ths of an inch. In a specimen from Lyme Regis ten septa occur in the space of $\frac{1}{10}$th of an inch near the apex.

M. Voltz figures a fragment of *Belemnites Aalensis* containing ten septa in a space of 1·83 inch. The angle of this cone being 21°, and its base 1·14 inch, it is practicable to calculate the probable number of septa, till near the apex they would become untraceable. The cone would be $3\frac{3}{4}$ inches long, and would contain fifty septa before the smallest was reduced to $\frac{1}{10}$th of an inch, and sixty before the diameter was reduced to $\frac{1}{18}$th.

In a pyritous specimen of *B. vulgaris*, Y. and B., from the Upper Lias of Whitby I count sixty septa, of which the anterior twenty are singularly pressed inwards close up to

the undisturbed part, which is only $\frac{3}{4}$ths of an inch long. In the Oxford Museum is a portion of the phragmocone of *B. giganteus,* which has a length of $3\frac{1}{3}$ inches, greater diameter $2\frac{1}{2}$, lesser $1\frac{5}{8}$, and ten septa. If continued to the apex, its length would have been above 8 inches, the number of septa eighty or more, before becoming untraceable. The anterior vaulted part of the phragmocone may be estimated as equal to the chambered part; and adding to this the probable extent of the guard, the total length of the shell would be not less than 24 inches.

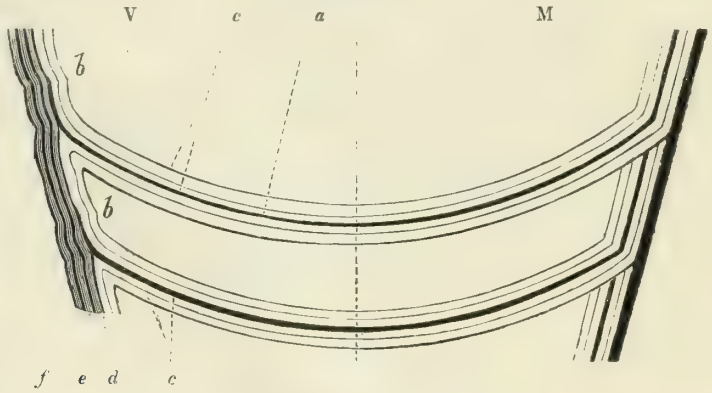
This, however, is probably not the utmost length of Belemnites, such as those called *giganteus, Aalensis,* and *ellipticus,* in which sometimes the sparry guard behind the phragmocone attains the length of a foot or more, and the total extent may have been 3 to 4 feet.

Fifty septa occur in a specimen of *B. paxillosus,* in the Bristol collection, in a length of 2·8 inches.

The angle of inclination of the sides of the phragmocone is probably constant for the same species of Belemnites, but it varies much in different specimens. Quenstedt gives a section from Lyme Regis of a phragmocone with sides inclined at 8° 40′.[1] I have never met with so slightly converging a cone in the Lias; but among Mr. Moore's specimens from Ilminster, usually referred to *B. elongatus,* is a cone with slopes meeting at 12°. It is more common to find the angle above 20° and under 28° for all species in the Lias and Oolites. I have a specimen measuring 32°; unfortunately we cannot often refer these phragmocones to their proper guards.

The structure of the conotheca and of the transverse septa has not appeared the same to every observer, partly because there may be some real differences in the shells of different species, but more frequently from incomplete knowledge of the disguises induced by laminæ of bisulphide of iron and carbonate of lime attached to the real shell-structure. To M. Voltz must again be awarded the praise of just observation in this matter. In his 'Treatise on Belemnites,' an instructive figure is given, to show the difference between the description of Miller and his own. This is copied in diag. 8, where M shows the section according to Miller, V that according to Voltz.

DIAGRAM 8.



[1] 'Cephalopoden,' t. 31, f. 1.

Miller supposed the transverse plate of the phragmocone to be composed of five parallel laminæ, all bent forward to line the conotheca, which consisted of one thin plate only (M, in diag. 8). Voltz explains that the conotheca is formed of three laminæ; that it is bordered internally by only a short flange extended from the transverse plate; that it is inflected at the junction with this flange, the inflection being limited by two small incisions. The transverse plate (*a*, in diag. 8) is composed of several thin laminæ, but is not so thick as the conotheca. Miller has not distinguished from the real substance of the shell the thin laminæ of carbonate of lime (diag. 8, *c*) which often line internally the conotheca and septa. My own observations agree in general with those of M. Voltz, but it seems useful to describe the appearances presented in two or three easily procurable species, which present some small differences.

Diag. 9 represents the section along the dorsal face of three transverse septa abutting on the conotheca. This enclosing shell is formed of three layers towards the opening, but of two only towards the apex. Still nearer to the apex it is composed of one layer only, and that finally ends in a porous or cellular plate, very like what can be traced on the limiting texture of the spherule at or beyond the apex of the phragmocone. This Belemnite is in the Oxford Museum, from the Lias of Lyme Regis. The septa are flanged, and, as it were, bracketed where they meet the conotheca, and a small triangular interstice appears between the bracket and the conotheca.

In *Belemnites vulgaris* of Young and Bird, from the Upper Lias of Whitby, the septa are apparently single plates—at least this appears to be the case in the hinder part of the cone.

DIAGRAM 9.

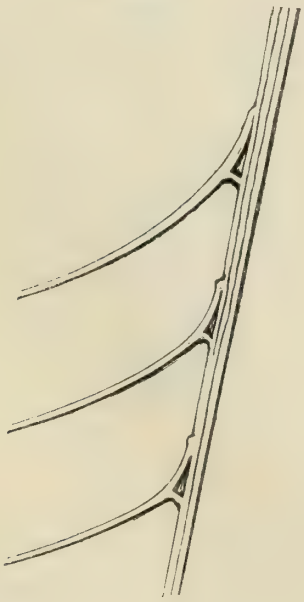
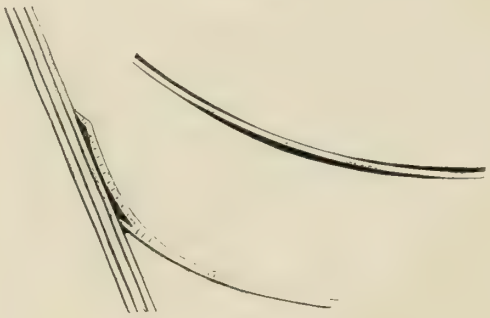


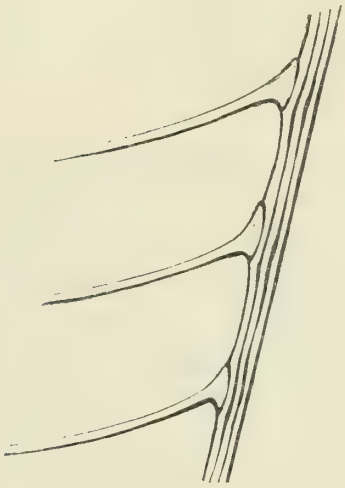
DIAGRAM 10.



In diag. 10, taken from another specimen in the Oxford Museum, from Lyme

Regis, the long advancing flange is clearly traced against the triple conotheca. The septum itself is of unusual construction, as represented in the second figure. It contains three plates—the middle one clear and sparry, and of uniform thickness; the upper one is quite dark, and thicker in the middle, like a periscopic convex lens; the lower one is thinner in the middle, like a corresponding concave lens.

DIAGRAM 11.



In a specimen of *B. tornatilis* from the Oxford Clay the conotheca is triple, the two inner laminæ being somewhat curved in conformity to the short abutment of the septa (diag. 11). The appearances which have been described are not always easy to eliminate from the various shaded and crystallized laminæ which overlie the septum, and present delusive appearances of structure. Bisulphides of iron, zinc, and lead, and carbonate of lime in a variety of aspects, form layers on the walls or fill up entirely the chambers.

According to my observations, there is reason to expect that the phragmocone will afford specific characters more definite, if not so often available as those of the guard.

When the conotheca is removed, and the cast of the chambers appears, the impressions of the septal flanges remain in several species very plainly on the cast, and cause undulations in the exterior outline of the conotheca.

Through each transverse plate is a perforation, near the ventral margin, formed by the retroflection there of the laminæ of the plate. These reflected parts of the plate are some-

DIAGRAM 12.

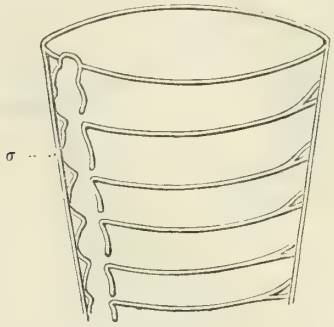
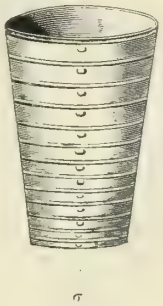


DIAGRAM 13.



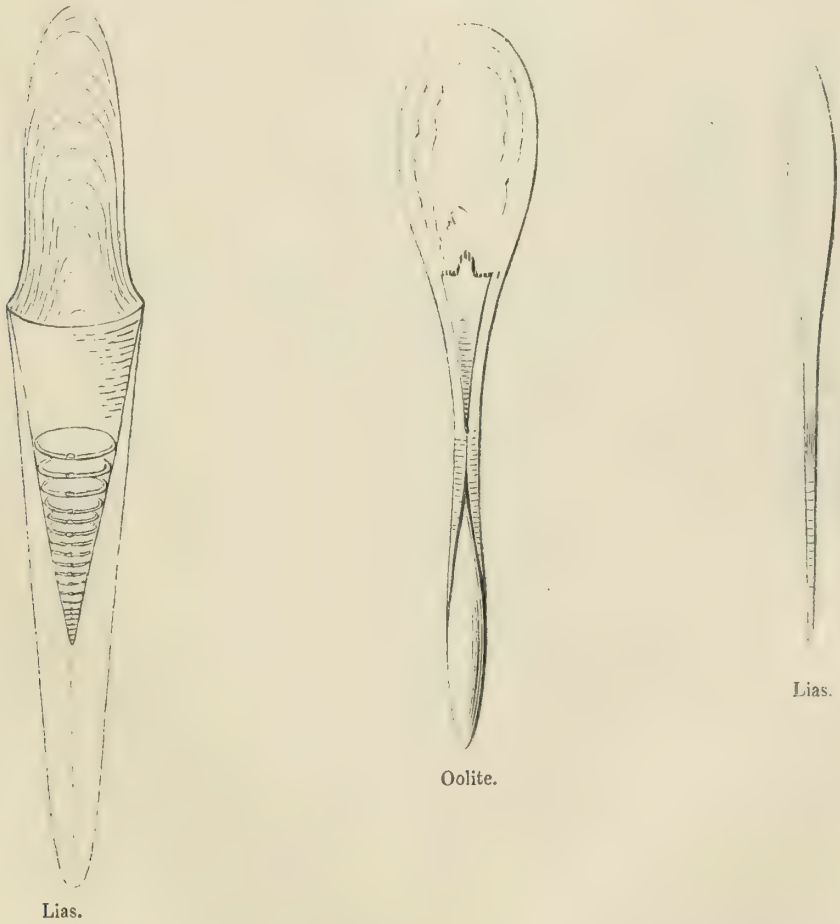
times found to be expanded in the interseptal spaces, as happens to many Orthocerata and Nautili. This is represented by Voltz in a specimen of *B. Aalensis*.[1] The series of

[1] 'Observ. sur les Belemnites,' pl. i, fig. 3.

perforations with the short tubes to each constitutes what is called the siphuncle (σ), which is sometimes so close to the ventral side that its expansions touch the conotheca.[1] In diag. 12 is seen the longitudinal section through the siphuncle, showing the retroflexions of the septa which form the siphuncle, and how this approaches and touches the conotheca. The phragmocone is that of *Belemnites vulgaris*, from the Upper Lias of Yorkshire. Diag. 13 shows the marks left by the siphuncle on the "chambered cone," which remains when the conotheca is wholly or partially removed.

As already observed, the specimens are few in which the phragmocone and guard are found together complete, or in such a state as to allow of a correct judgment of the whole figure, if complete. Such specimens have been found in the Oolite of Solenhofen and in the Oxford Clay near Chippenham. In the Lias of Lyme Regis and Yorkshire the structure of the phragmocone in relation to the guard is sufficiently ascertained to justify a restoration of the whole shell. In diag. 14 are presented three such figures, one from the

DIAGRAM 14.



Oolite of Solenhofen (*B. hastatus*), two from the Lias, viz. *B. paxillosus* and *Xiphoteuthis elongata*.

[1] Voltz., loc. cit., pl. i, fig. 1.

Though no complete specimen has occurred of any Belemnitic animal, late discoveries, especially those of Mr. Day in the Lias at Lyme Regis, have established many facts regarding the muscular system of the body, the hooks on the arms, the funnel, ink-bags, eyes, and other parts of importance. Restorations have been attempted at various times by several naturalists since first Miller presented a general sketch showing the affinity of the Belemnite to the Sepiaceæ. Buckland's figure ('Bridgewater Treatise,' pl. lxi, fig. 1) represents the ventral aspect of the animal, with funnel, ink-bag, and posterior latero-caudal fins. Only eight arms are distinct in the figure. On the two longer ones are circular suckers. Quenstedt ('Cephalopoden,' t. xxiii, fig. 16) presents a drawing of the dorsal aspect, showing lateral fins expanded from the alveolar region, with a thin membranous expansion over the fibrous guard, and an equally thin fleshy covering to the anterior part of the phragmocone. The two longer arms are bare, the eight shorter ones have hooks. D'Orbigny sketches a side view, with pointed fins near the extremity of the tail, the Belemnite lying exposed on the back, the two longer arms bare, the others with two rows of suckers each. Ten arms are assigned to the animal by Quenstedt and D'Orbigny, as in the restorations by Owen,[1] which, however, is partly modelled on Belemnoteuthis. This uncertainty in regard to the prehensile organs of the animal has been in some degree removed by the researches of Mr. Day in the Belemnitic beds of Lyme Regis and Charmouth. Several specimens collected by this gentleman have shown in their true relative position the guard, the phragmocone, the anterior extension of the conotheca, and the coronet of hooks which margined the arms. Two of these specimens have been figured by Huxley.[2] In one the part of the guard below the phragmocone measures about $\frac{1}{10}$th part of the whole animal, in the other about $\frac{1}{7}$th. Von Buch had estimated the length of the animal to exceed that of the shell by eight or ten times; but if by the term shell we mean to express the whole of the solid calcareous or horny substance, its length is nearly equal to that of the animal, for it reaches, as in the Sepiaceæ, to the edge of the funnel. The outline of the body of the animal is not yet recovered; in specimens of the Lias the ink-bag, funnel, and portions of the sclerotic arcs of the eye, are designated by Huxley; but the muscular substance of the arms, mantle, and fins is untraceable. Such traces do occur in the Oxford Clay in connection with Belemnoteuthis, but the entirely different proportions of the guard in these animals render it improbable that the swimming apparatus could be quite on the same model as in the Belemnite.

DIAGRAM 15.

[1] Owen, 'Phil. Trans.,' 1844.

[2] 'Mem. of Geol. Survey,' 1864.

Especially in the anterior part and in the circle of hooked arms Mr. Day's specimens have been found very suggestive. The arms are, on the whole, unexpectedly short (as compared with those of Belemnoteuthis); the head also, with the eyes, appears smaller in proportion than among other Cephalopoda, and the whole body seems longer in proportion than is usual among them, in this respect more resembling the Calamaries (Loligo) than the Cuttles (Sepia).

CLASSIFICATION OF THE BELEMNITIDÆ.

To the earlier writers the family of the Belemnitidæ was known only by the two prominent examples now called Belemnites and Belemnitella, and of these they knew not the whole. The chambered cone was not always clearly understood as an essential and very characteristic part of the whole shell until Klein (1731) gave forth his 'Descriptiones Tubulorum Marinorum,' which include Orthoceratites. In this essay Belemnites constitute the eleventh genus of Tubuli Marini, and are thus clearly defined:

"Belemnites est tubulus marinus; fossilis; materiæ ad Seleniticam accedentis; teres; transversim fractus concentricis striis, in longitudinem fissus canaliculo pervio, semper in medio posito, donatus; in basi nonnunquam ferens conum, olim testaceum, concameratum, instructum siphunculo."

This cone was, and still often is, called the alveolus, though that name properly belongs to the conical cavity. The siphuncle of this chambered shell is regarded by Klein as connected with the central canal of the guard, and with a globule at its apex. He founds this opinion chiefly on specimens from the Chalk, and compares this structure to that of the chambered *Nautilus crassus*, distinguishing this from the open-shelled Argonaut. In agreement with previous writers, he distributes Belemnites into three groups—cylindric, conical, fusiform.

Fifty years afterwards, Miller, satisfied himself of the affinity of Belemnites to the shelly parts of Cephalopoda, perceived the analogy of the animal to which the fossil belonged with the recent possessor of the "Cuttle-fish bone," and presented a conjectural drawing to illustrate the generic character, which is in these words:

Genus. Belemnites.—A cephalopodous? molluscous animal, provided with a fibrous, spathose, conical shell, divided by transverse concave septa into separate cells or chambers connected by a siphuncle, and inserted into a laminar, solid, fibrous, spathose, subconical or fusiform body extending beyond it, and forming a protecting sheath or guard. ('Geol. Trans.,' 2nd series, vol. ii, p. 48.)

It is unnecessary now to notice his genus "Actinocamax," which is only the retral portion of the guard of a Chalk or Gault Belemnite, separated at or near the apex of the phragmocone—often by natural decay of the shelly laminæ.

De Blainville's great work follows that of Miller, and his classification is in all respects more advanced and comprehensive. It contains eight sections, of which the first is founded on a mistake of Miller, and the last is merely a small appendix of forms which are now distributed in the other sections.

A. No alveolar cavity. (*Actinocamax* of Miller.)

B. Alveolar cavity very small, fissured on the margin, and without septa. (Example —*Belemnites quadratus*. Chalk.)

C. Alveolar cavity large, fissured on the margin, and without septa. (Example—*Belemnites mucronatus*. Chalk.)

D. Alveolar cavity large, chambered, siphunculated, with a ventral canal more or less evident from the base to the summit of the guard. (Example—*B. sulcatus*, Miller. Oolite.)

E. Alveolar cavity large, chambered, siphunculated ; without fissure or canal at the base, but with two lateral furrows at the summit of the guard. (Example—*B. apicicurvatus*, Blainv. Lias.)

F. Alveolar cavity large, chambered, siphunculated; no fissure or canal at the base or furrows at the summit of the guard. (Example—*B. abbreviatus*, Miller. Oolite.)

G. Alveolar cavity very large in proportion, chambered, siphunculated; no fissure, canal, or grooves. (Example—*B. obtusus*, copied from Knorr, so as to give quite a wrong notion, but it was previously and better figured by Klein (ix, 2). This section is founded in a mistake.)

H. Species incompletely known—a mere appendix.

We have therefore effectively, in Blainville's classification, only five sections of Belemnitidæ, two of which (B and C) may be referred to Belemnitella, leaving three (D, E, F) for the restricted genus of Belemnites.

Blainville adds to his memoir descriptions of Beloptera, Pseudobelus, Rhyncholites, and Conchorhynchus.

In Bronn's 'Lethæa Geognostica,' 1837, we find the Belemnites ranked in three divisions:

A. Integræ.—Sheath without fissure at the basis, with 7—0 furrows at the point. Confined to Lias and Inferior Oolite. Subdivisions according to the number of the furrows near the point.

B. Canaliculatæ.—A distinct canal, beginning from the anterior end, or near it, to or towards the point on the ventral aspect. (Sometimes another canal opposite this.) On the right and left sides often a fine single or double line from the

basis to or towards the point. (No ink-bag?) Species mostly confined to the Middle Oolite, but rarely in Coral-Rag, and only peculiar kinds in the Inferior Oolite; two or three in Gault.

C. Fissæ.—Basis with a deep short fissure, not extending backwards beyond the alveolar region; no furrows at the point. Confined to Cretaceous strata.

D'Orbigny separates the third division of Bronn from other Belemnites under the title of Belemnitella; for the others he forms five groups, characterised by peculiarities of the rostrum or guard:[1]

1. Acuarii.—Rostrum more or less conical, often furrowed or wrinkled at the lower extremity, without ventral or lateral furrows in the anterior part. (Lias and Oolites.)
2. Canaliculati.—Rostrum elongate, lanceolate, or conical, provided below with a ventral canal occupying nearly the whole length; no lateral furrows. (Inferior Oolite and Great Oolite.)
3. Hastati.—Rostrum elongate, commonly lanceolate, with lateral furrows on a part of the length, and an anterior ventral furrow, very distinct. (Lias, Oxfordian, Corallian, Neocomian, and Gault.)
4. Clavati.—Rostrum elongate, often clavate, with lateral furrows, but no anterior ventral furrow. (Lias.)
5. Dilatati.—Rostrum compressed, often enlarged, with lateral furrows and a deep *dorsal* anterior groove. (Neocomian.)

This author, from a study of recent Cephalopoda, was led to the supposition, and finally, after researches among fossil groups, to the conviction, that in many Belemnites, independently of age, the rostrum was longer or shorter in proportion to the alveolar axis, according to sex, the males having a longer and the females a shorter guard. But with advancing age, in some cases, the growth of the female guard restores, or nearly restores, the equality. He regards the embryonic Belemnites as always composed of a sphericle and a rostrum with a circular section.

Mr. S. P. Woodward, in 1851,[2] presented a more practical view of the family of the Belemnitidæ than any previous British writer. The definitions of the family and its subdivisions are as under:

Belemnitidæ. *Shell* consisting of a *pen*, terminating posteriorly in a chambered cone (phragmocone); sometimes invested with a fibrous *guard*. The air-cells of the *phragmocone* are connected by a *siphuncle*, close to the ventral side.

[1] 'Terr. Jurassiques,' p. 73.

[2] 'Manual of the Mollusca,' p. 73.

Belemnites.

Phragmocone horny, slightly nacreous, with a minute globular nucleus at the apex; divided internally by numerous concave *septa*. *Pen* represented by two nacreous bands on the dorsal side of the phragmocone, and produced beyond its rim in the form of sword-shaped processes. *Guard* fibrous, often elongated and cylindrical, becoming very thin in front where it covers the phragmocone.

Section I.—Acœli, *Bronn.*

Without dorsal or ventral grooves.

Subsection 1.—*Acuarii.*

Without lateral furrows, but often channelled at the extreme point. (Example—*B. acuarius.* Lias.

Subsection 2.—*Clavati.*

With lateral furrows. (Example—*B. clavatus.* Lias.)

Section II.—Gastrocœli, *D'Orb.*

Ventral groove distinct.

Subsection 1.—*Canaliculati:* no lateral furrows. (Example—*B. canaliculatus.* Inf. Oolite.)

Subsection 2.—*Hastati:* lateral furrows distinct. (Example—*B. hastatus.* Oolite.)[1]

Section III.—Notocœli, *D'Orb.*

With a dorsal groove, and furrowed on each side. (Example—*B. dilatatus.* Neocomian.)

Belemnitella, *D'Orb.*

The guard has a straight fissure on the ventral side of its alveolar border; its surface exhibits distinct vascular impressions. The phragmocone is never preserved, but casts of the alveolus show that it was chambered, that it had a single dorsal ridge, a ventral process passing into the fissure of the guard, and an apical nucleus. (Example—*B. mucronatus.* Chalk.)

[1] Blainville, by whom the species was named, quotes it as from Lias, and also from the Clay of the Vaches Noires (Oxfordian). It seems, however, not to be found at all in the Lias.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLXV.

MONOGRAPH

OF

THE FOSSIL REPTILIA

OF THE

LIASSIC FORMATIONS.

BY

PROFESSOR OWEN, F.R.S., F.L.S., F.G.S., &c.

PART FIRST.

SAUROPTERYGIA.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1865.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

MONOGRAPH

OF

THE FOSSIL REPTILIA

OF THE

LIASSIC FORMATIONS.

ORDER—SAUROPTERYGIA, *Owen.*

Genus—PLESIOSAURUS, *Conybeare.*

Species—Plesiosaurus dolichodeirus, Conybeare.

(TABS. I—IV.)

OF the *Plesiosaurus dolichodeirus,* Conyb., the first described and the typical species of the genus, three more or less entire specimens have come under my observation, which have been obtained from the Lower Lias of Lyme Regis and Charmouth, Dorsetshire. One of these, formerly in the possession of the late Duke of Buckingham and now in the British Museum, was the subject of Conybeare's original description.* A second, in the British Museum, is figured by Buckland in his 'Bridgewater Treatise,' vol. ii, pl. xix, fig. 2; the third, also in the British Museum, is the one which I have selected for illustration in the present MONOGRAPH (Tabs. I and II). In this the vertebral series is entire; there is no break in the long cervical region, as in the other two specimens; its perfection, in this respect, satisfactorily shows that the head is at, or nearly at, the correct distance from the trunk, with the neck outstretched, in the two former specimens, the greater completeness of which, in regard to the limbs, supplies what is wanting in this respect in the present skeleton (see Tab. I, figs. 2 and 3).

The condition of the vertebral column in the originally described or type-specimen of the *Plesiosaurus dolichodeirus* is such as to suggest that the carcass, after it sank to

* 'Transactions of the Geological Society,' 2nd series, vol. i, p. 381, pl. xlviii.

the bottom, had been preyed upon by some contemporary carnivorous marine animals. It seems as if a bite of the neck had pulled out of place the eighth to the twelfth vertebræ. Those at the base of the neck have been scattered and displaced, as if through more "rugging and riving." Some creature which has had a grip of the spine, near the middle of the back, has pulled to one side all the succeeding vertebræ of the pelvis; their adhesion to that part and, more or less, to each other, being retained. This wrench would expose the abdominal viscera, *à tergo,* where we now see the upper or inner surface of the abdominal ribs or sterno-costal arches. The intermediate and succeeding portions of the vertebral column retain their natural relative positions, as in the prone position of the carcass; and the skull, scapular arch and appendages, pelvic arch and appendages, and the tail, show respectively their relative positions as in the entire animal. Many of the otherwise undisturbed vertebræ, however, have turned, so as to present their most extensive surface to the direction of the slow, cosmical, compressing force operating on their imbedding stratum.

This is the case with the first twenty cervical vertebræ in the specimen Tab. I, which appears to have settled in the Liassic mud back downwards, their spines being turned toward the right side; beyond the twenty-first cervical the vertebræ have rotated in the opposite direction, presenting more or less of a side view, with the neural arch and spine turned to the left; but most of the spinous processes have been removed with the matrix in the original exposure of the specimen. The trunk preserves the supine position, exposing the broad coracoids (52), and pubes (64), with scattered, intervening, abdominal ribs. Part of the left pectoral fin (53—56) is *in situ;* a smaller part of the corresponding pelvic fin (65—67) lies across the pelvis.

No partial force has operated after interment to dislocate any of the vertebræ, save the few terminal ones of the tail, which have disappeared, probably dragged away with whatever tegumentary expansion may have there represented a caudal fin.

In the specimen figured by Dr. Buckland * the skeleton, as it is exposed to view, lies prone; the vertebræ, whilst their matrix was in the state allowing them to turn, have presented their largest surface to the direction of superincumbent pressure, the spines of those at the basal half of the neck being turned down or toward the right side, while those of the dorsal vertebræ have yielded in the opposite direction, both kinds presenting more or less of a side view. The thoracic ribs have slipped some way from their articulations, yet preserve, in the main, their relative positions, in serial succession. The anterior dorsals overlie the coracoids, and the posterior dorsal and sacral vertebræ overlie the dislocated parts of the pelvis. One of the thickened, short, and straight sacral ribs abuts against the right ilium. Upwards of thirty caudal vertebræ extend, in nearly a straight line, from the sacrum. The vertebræ at the fore part of the neck have been displaced, and in great part lost. Of the head little is visible, save the mandibular rami. The bones of both fore and hind paddles on the

* Op. cit., vol. ii, plate x, fig. 2.

right side are in an instructive state of preservation, especially those of the hind fin, which exemplifies the slight superiority of length as compared with the fore fin, characteristic of the present species.

The following are admeasurements of corresponding parts of the three skeletons above mentioned, that of "entire length" being now capable of being given by reason of the integrity of the cervical region of the spine between the head and the pectoral or scapulo-coracoid arch.

	Conybeare's specimen. Ft. in. lines.	Buckland's specimen. Ft. in. lines.	Specimen Tab. I. Ft. in. lines.
Entire length (two or three inches of the tail wanting?)	9 5 0	9 8 0	8 9 0
Length of head	0 8 6*	0 8 2	0 8 6†
,, neck	4 0 0	4 10 0‡	4 10 0
,, trunk, from fore part of sternum to end of ischium	3 0 0	3 6 0	2 8 0
,, tail	2 0 0	2 4 0	(imperfect.)
,, pectoral limb	1 10 0	1 9 0	(imperfect.)
,, pelvic limb	2 0 0	2 2 0	(imperfect.)
,, humerus	0 7 0	0 7 6	0 7 6
,, femur	0 7 0	0 7 4	(wanting.)
,, radius	0 3 0	0 3 0	0 3 6
,, tibia	0 3 0	0 3 3	
,, manus	1 0 0	1 0 0§	
,, pes	1 2 0	1 3 0	
Breadth of pubis (transverse diameter)	0 5 0	(obscured)	0 6 0
Length of ischium (longitudinal diameter)	0 4 6	(obscured)	0 5 0

From the amount of concordance in the dimensions of the above three skeletons, it may be inferred that the average length of the mature animal of the present species of *Plesiosaurus* was between nine and ten feet. Two specimens of certain portions of the skeleton, now in the British Museum, one of which is the subject of Tab. III, support this conclusion.

Vertebral characters (Tabs. III and IV).

Cervical series.—The cervical vertebræ of the *Plesiosaurus dolichodeirus*, at the fore part of the neck (Tab. III, fig. 1, *a*, *c* 4—7), have the centrum (*c*) of a length equalling the breadth of the articular end; but the dimension of breadth increases in a greater

* Estimated at that of the lower jaw.

† Nine inches, if the angle of the jaw be restored, as dotted in Tab. II.

‡ It may be that the head has been drawn a little forward in the displacement of the anterior cervical vertebræ.

§ Some of the terminal phalanges are here estimated for.

ratio as the vertebræ enlarge and recede in position; so that the length of the centrum may be one sixth less than the breadth at the middle (Tab. III, figs. 4, 5, 6) and hind part of the neck. There are, however, varieties in this respect, and the equality of length to breadth of centrum is maintained through a greater extent of the neck in some specimens than in others. The vertical diameter of the middle of the terminal articular surface (ib., fig. 6 *c*) is less by nearly one fourth than the breadth of the same. The sides of the centrum are longitudinally concave (ib., fig. 5), as is also the under part (ib., fig. 4), but in a minor degree in the middle and posterior than in the small anterior cervicals (ib., fig. 1, *c*).

The costal surface is at the lower part of the side of the centrum; it is narrow vertically, in proportion to its length in the anterior cervicals, but gains in vertical extent without being elongated in the same degree, and consequently occupies a larger corresponding extent in the middle cervicals (ib., fig. 4, *pl*),* in which the costal surface exceeds one half the length of the centrum; it is divided by a longitudinal cleft, and is situated a little nearer the posterior than the anterior surface of the centrum. In the third to the seventh cervicals (ib., fig. 1, c 7) the costal surface is separated by a tract exceeding its own vertical diameter from the neurapophysial surface (ib., fig. 1, *n*); in the succeeding cervicals the intervening tract equals the costal surface (ib., fig. 4, *c*); and the interval is never less, and is sometimes more, in the cervical vertebræ to near the base of the neck. The terminal articular surface (ib., fig. 6) is moderately convex at its periphery and very gently concave in the rest of its extent, with a small central, often transversely linear, impression in the centre.†

The free surface of the centrum is finely rugose in the smaller anterior cervicals, and is not smooth in any of the others; towards the articular ends the roughness is more marked, by irregular narrow risings and groovings, which become more longitudinal in direction in the succeeding cervicals (ib., figs. 4, 5). The under surface (fig. 5) is concave transversely from the costal pit (*pl*) to the two venous openings, and is convex between those openings, which divide the surface pretty equally into three parts, Lengthwise, as already stated, the under surface is gently concave. The neurapophysial surface is less angular than in some other species, the lower angle being rounded off, making the lower border approach to a curve. Anchylosis of the neural arch with the centrum seems to have been complete in the anterior cervicals of the specimen figured in Tab. III, fig. 1; and I have not yet seen a cervical centrum of the present species from which the neural arch had become detached, save by fracture. The zygapophyses are proportionally large; the anterior ones (ib., *z*, *z*) extend forward, in the anterior vertebræ almost immediately above the centrum, overhanging the

* Here obscured by the confluent base of the rib.

† "The concavity again slightly swelling in a contrasted curve near the middle of the circular area," (Conybeare's first Memoir, p. 582, April, 1821) is the character of the terminal articular surface in the *Plesiosaurus arcuatus*, from the Lias in the neighbourhood of Bristol.

posterior two fifths of the centrum in advance; the articular surface, the length of which equals two thirds that of the length of the centrum, looks obliquely upward and inward; that of the posterior zygapophysis has the reverse aspect. As the cervicals approach the back the zygapophyses diminish in relative size, and their articular surfaces become less horizontal. The posterior zygapophysis (Tab. III, fig. 4, *z'*) overhangs a small part of the end of the succeeding centrum, and the neurapophysis (ib., fig. 4, *n*) rises with a deeper concavity at the back than at the fore part. That this anchylosis had not occurred in the similarly sized and in the larger specimens of the cervical vertebræ of the *Plesiosaurus* described and figured by Conybeare in his first famous Memoir* is due to their having been derived from a younger specimen of a larger species from the Bristol Lias, probably *Plesiosaurus arcuatus.*

The neural spine (Tab. I, *ns*; Tab. III, fig. 4, *ns*) arises narrow between the bases or back part of the prezygapophyses (*z*), and its base extends, increasing in thickness gradually to near the back part of the postzygapophyses (*z'*). The height of the spine averages half the vertical extent of the entire vertebra from its summit to the lower level of the centrum, being rather shorter in the anterior cervicals and exceeding that length at the base of the neck. In the anterior cervicals the contour of the neural spine extends from the fore part of the base, in a curve increasing in convexity at the upper part, and terminating by a rounded apex overhanging, in the foremost vertebræ (as at c 4, Tab. III), the concave contour of the hinder border. The upper part of the spine becomes more squared as the spine itself gains in height, in the larger posterior cervicals, by the increasing fore-and-aft extent of their upper part, as in fig. 4, *ns*.

The pleurapophysis of the axis (Tab. III, fig. 1, *x pl*) has its posterior angle extended backward; that of the third cervical has its anterior angle also produced forward, but in a minor degree. Both angles continue to be more produced in the succeeding vertebræ, but the front one most so, until, in the fifth cervical, they are equal in length; the hinder one then elongates, but they do not touch or overlap the contiguous pleurapophyses until about the tenth cervical vertebra. The extent of this terminally dilated or extended border of the riblet exceeds that of the diameter of the same from its upper articulation outward or downward. The line of articulation is discernible in most of the anterior vertebræ, but in fig. 1 coalescence has commenced, if it be not complete, as in figs. 4, 5, 6, *pl*, in which the expanded part of the pleurapophysis has been broken off, showing the approximated head and tubercle adapted respectively to par- and di-apophysial divisions of the costal surface. In

* "Notice of the discovery of a new fossil animal, forming a link between the Ichthyosaurus and Crocodile, together with general remarks on the osteology of the Ichthyosaurus; from the observations of H. T. de la Beech, Esq. F.R.S., M.G.S., and the Rev. W. D. Conybeare, F.R.S., M.G.S. (Read April 6th, 1821.) Drawn up and communicated by the latter." The observations on the vertebral characters of the new reptile are said to have been made "on the organic remains contained in the Lias in the vicinity of Bristol" (p. 559). 'Transactions of the Geological Society of London,' first series, vol. v.

some vertebræ a low and narrow ridge extends from the neur- to the pleur-apophysial surfaces, as at *c*, fig. 4.

The degree of concavity of the sides of the centrum in the anterior cervicals, exposed in the specimen figured in Tab. III, fig. 1, has been exaggerated by the pressure to which it has been subject, the effects of which are more conspicuous upon the skull: the cancellous mid-part of the centrum has opposed less resistance than the compact articular ends.

The atlas (*a*) has been disarticulated from the occipital condyle (ı); the hemispheric articular cup is thus well displayed, with its smooth and shining surface. The coalescence of the centrums of the atlas (*a*) and axis (*x*) is complete. A tubercle from the side of the centrum of the atlas represents the pleurapophysis; its neural arch is broken away; that of the axis developes a spine similar to and but little smaller than that of the third cervical.

The dimensions of the seven vertebræ here preserved in connection with the skull will be seen in Tab. III, fig. 1, where they are figured of the natural size. The average dimensions of a cervical centrum of the present species, from the middle and basal half of the neck, are, as in figs. 4, 5, 6—

	In.	lines.
Length	1	4
Breadth of articular surface	1	6
Height of middle of ditto	1	3
Length of costal pit	0	6
Transverse diameter of outlet of neural canal	0	6

Dorsal series.—The transition from the cervical (Tab. I, C) to the dorsal series (ib., D) is effected by the usual elevation of the costal surface by gradational steps, continued through about five vertebræ, until a single costal surface is presented by a large diapophysis from the neural arch. The number of cervical vertebræ so defined in the specimen figured in Tab. I is forty-one. In the first dorsal, characterised by the diapophysial support of the rib (Tab. IV, figs. 1 and 2, *d*), the non-articular part of the centrum is smoother than in the cervical vertebræ, the ridges or rugæ occupying a smaller extent near the two ends, where they indicate the attachments of the capsular ligaments. The longitudinal concavity between the two ends is uniform and rather more than in the cervicals. The venous foramina are wider apart and not divided by any special transverse convexity on the under surface of the centrum. A vertical ridge leads from the side of the centrum (ib., *c*) to the under part of the diapophysis (ib., *d*), nearer the hind than the fore end of the centrum.

The diapophysis is convex and longest superiorly; the fore part is rather hollowed, the hind part flattened, and both converge to the ridge forming the shorter under surface. The articular surface (*d*) of an irregular oval form, with the small end down-

ward, looks downward, outward, and a little backward, the process being slightly inclined that way. The margin of the articular end of the centrum is better defined than in the neck; about a line's breadth is, as it were, shaved off; the rest of the surface (fig. 2, *c*) is very slightly concave, sometimes undulated, always nearly flat, and with a small central depression, or a tendency there to a tubercle. The length of the dorsal region in the skeleton (Tab. I) 8 feet 9 inches long, is 2 feet 6 inches; the number of dorsal vertebræ is twenty-one.

Sacrum.—Two vertebræ (ib., *s*) succeeding the dorsals are distinguishable, through the greater thickness and straightness of their short pleurapophyses, as sacral; these elements abut against, or afford ligamentous union to, the iliac bones.

Caudal series.—The caudal vertebræ (Tab. I, c *d*, Tab. IV, figs. 3—9) are shorter in proportion to their breadth than the others; the centrum approaches to a cubical figure, the under surface (figs. 4 and 7) becoming broad and flattened; and the contour of the terminal articular surfaces shows a similar tendency to flattening, giving a transversely extended quadrate figure, with the angles rounded off (figs. 5 and 8); the margin is thicker, more rounded off, less defined than in the dorsal vertebræ. The articular surface itself is more concave than in the antecedent regions of the backbone, and becomes deeper in the terminal subcompressed vertebræ (fig. 9); the movements of the tail in swimming having been helped here by a greater amount of yielding intervertebral substance, approaching in the same degree to the condition of the spine in fishes. The costal surface (figs. 3, 6, *pl*) is elliptic, with the long axis subvertical, the margin prominent, the cavity simple and rough for the ligamentous attachment of the riblet; it is situated on the upper half of the centrum close to the neurapophysis, the outer end of the base of which contributes to the upper part of the margin in the anterior caudals (fig. 5, *d*).

The pleurapophyses in this region (Tab. IV, 5, *pl*) do not expand terminally, as in the neck; they are short, thick, and straight, simulating transverse processes; their non-confluence with the centrum exemplifies the minor vigour of vital co-ossifying influences in terminal parts.

The hæmapophysial surfaces (fig. 3 *h'*) impress the inferior angles of the posterior surface of the centrum; occasionally, where a hæmapophysis has become anchylosed and broken off, its adherent base gives the appearance of a process from that part of the centrum (ib., figs. 6, 7, 8, *h'*). The venous foramina are at the lower part of the sides of the centrum. The neural arch (figs. 3, 5, *n*) rapidly diminishes in size and in the length of the neural spine, *ns*. The zygapophysial surfaces become more vertical, the anterior, *z*, looking inward; the posterior zygapophyses, *z'*, are the first to disappear. The hæmapophyses (fig. 5, *h*) are free, and were ligamentously connected with the centrum above and with each other below, circumscribing there the hæmal canal. The proximal surface is expanded, with a subtriangular facet cut obliquely at the anterior part for articulation with its own surface, and with a smaller, less definite

surface posteriorly for the intervertebral substance and a small part of the succeeding centrum, where a slight expansion of the everted border of the articular surface is the sole indication of such hæmapophysial junction. In the terminal vertebræ these surfaces with the hæmapophyses have disappeared, and the centrum, now showing a compressed form, supports only a contracted, anchylosed, seemingly exogenous neural arch, which finally disappears.

The following are transverse diameters of the centrum in different regions of the spine, in the specimen, 8 feet 9 inches long, of *Plesiosaurus dolichodeirus*, figured in Tab. I:

	In.	lines.
Tenth cervical vertebra	1	0
Middle dorsal ditto	2	0
Tenth caudal ditto	1	3

Cranial characters (Tabs. II and III).

The skull in this skeleton presents, what is rare, the side or profile view (Tab. II) like that of the succeeding anterior cervicals. Its upper part is much injured. The following bones are recognisable:—mastoid 8, tympanic 28, squamosal 27, malar 26, maxillary 21, premaxillary 22; the end of the long pterygoid is seen at 24, abutting against the lower end of the tympanic. But little of the composition of the mandible is discernible: the tightly closed jaws show the extent of the interlocking of the long, slender, curved, and sharp-pointed teeth.

Of those of the lower jaw the crowns of upwards of twenty may be traced; the longest occupying the middle three fourths of the series, and the largest of these being the foremost. In some parts of the series two teeth pass into the same dental interspace of the opposite jaw.

The admirably wrought-out specimen figured in Tab. III, fig. 1, exhibits the upper surface of the somewhat crushed skull. Of the basi-occipital a part of the upper surface (1) and of the single median convex condyle is shown. The exoccipitals (ib., 2) preserve their connection with the lateral and upper parts of the basi-occipital, and show the surfaces—seemingly sutural—from which the superoccipital (ib., 3) has been displaced. These surfaces (2, 2) are thick and triangular; they are parallel with the middle of the foramen magnum, the lower half of which is formed by the basi- and ex-occipitals. From the outer and back part of the exoccipital the paroccipital process (4, 4) is continued; of subtriedral form, long, slender, and tapering to a thin rounded apex: the outer side appears to be sutural, and that of the left side is applied to the tympanic (ib., 28): the length of this process is 8 lines. The breadth of the occiput, outside of the exoccipitals, is 1 inch 5 lines; that of the foramen magnum is 6 lines. That the rough triangular upper surfaces of the exoccipitals are natural, not the result of frac-

ture, I infer from their being on the same level, and from the corresponding surfaces being presented by the single arched bone (3) representing the superoccipital. This has been displaced by the pressure operating not quite vertically, but with an inclination from the left to the right, which has turned the spines of the cervical vertebræ to the right, and which has so far displaced the superoccipital in the same direction that it lies with its concavity or arch embracing, as it were, the right superoccipital, this concavity having formed the upper half of the foramen magnum. The apex of the superoccipital lies beneath the right branch of the parietal; the outer surface of the piers of the superoccipital arch is moderately smooth and convex; the breadth of the base of the arch is 1 inch 3 lines, that of the span of the arch is 5 lines.

The parietal (ib.; 7) is thick and transversely extended posteriorly, where it is overlapped by the mastoids (8), anterior to which it contracts to form the crest between the temporal fossæ. The crest is interrupted by the parietal foramen (*f*), anterior to which it is resumed for a short extent—3 lines, before the frontal suture. The total length of the parietal is 1 inch 11 lines; the length of the crest is 1 inch 3 lines. The thick and rather rugged hinder bifurcate part of the parietal is overlapped or embraced by the mastoid (8), and these bones curve outward and backward to articulate with the squamosal (27) and with the tympanic (28), which is continued in the same direction to the joint of the mandible (29). All these bones together form a strong arch, curved backward in the present specimen, but owing its horizontal position to the posthumous pressure, and having the piers of the arch directed downward as well as outward and backward in the natural state.

The suture between the frontals (11) remains, and that between the postfrontals (12) and the expansions of the parietal (7′) upon the sides of the cranium may be traced. There is a smooth superorbital (11′) between the rougher frontal and the orbit, unless the fissure defining them be a fracture and not a suture. The external facial plate of the prefrontals is rough; it overlaps the fore part of the frontal and part of the nasal, and extends to the small external nostril. The nasals (15) overlap the fore part of the frontals, and extend about as far in advance of the nostrils as they do behind them, continuing the median ridge from the frontals forward, in which, however, the median suture is visible. The outer surface of the maxillaries and premaxillaries shows a kind of granular rugosity, which subsides in the maxillary as this bone (21) extends beneath the orbit. The limits of the lacrymal (73) are not definable. The malar (26) forms the hinder half of the suborbital boundary; its surface is smooth, and increases in breadth to beyond the orbit, when it contracts and becomes rugous where it joins the postfrontal (12) and squamosal (27). The bony boundary between the orbital and temporal cavities is crushed and much cracked: but the outer end of a postfrontal or postorbital is wedged into the squamous union of the malar and squamosal. The latter (27), of a tri-radiate form, curves from the malar round the outer and back angle of the temporal fossa, and extends backward upon the tympanic: the ray directed

mesiad, and overlapping the mastoid (8) and tympanic (28), is the longest, and terminates in a point: the surface of the bone is smooth.

The temporal fossæ are broader than they are long. At their forepart the parietal side-wall of the cranium expands as it advances, and is continued into the postfrontal or postorbital partition.

The orbits are rounded anteriorly, and both the upper and under parts of the frame make an angular junction with the straight hinder part.

The nostrils have the usual small size and backward position.

In both orbits some of the thin sclerotic plates of the eyeball (*s*, *s*) are preserved; this is the first specimen in which I have had evidence of this structure.

The interlocking of the teeth of the upper and lower jaws, through the singular care and skill devoted by Mr. Harrison to the removal of the matrix, is peculiarly well displayed in this instructive fossil.

The foremost tooth in each premaxillary make a pair, which curve forward and downward between the two foremost teeth of the lower jaw, the premaxillary teeth slightly diverging as they descend, Tab. III, fig. 3. The succeeding premaxillary teeth, four in number, alternate with mandibular ones. I cannot make out with certainty the maxillo-premaxillary suture, but the fifth tooth, counting backward, seems to be near to or upon it. The second premaxillary tooth is double the size of the first; the third, fourth, and fifth gradually diminish; the sixth (first maxillary ?) is small; the seventh tooth suddenly resumes the size of the second; and the eighth, of nearly equal size, curves down close to the seventh, and the two are interposed between the interspace of opposite mandibular teeth. From four to five smaller teeth are traceable behind the eighth, and there may have been more in the upper jaw.

Of the lower jaw ten teeth are shown on each side; the second, third, fourth, and fifth are the longest and largest, as in Tab. II. In general, the teeth of the upper jaw are separated by intervals allowing the passage of those of the lower; the teeth of the foremost premaxillary pair being closer together; and those of the foremost mandibular pair being wider apart. They all present the usual generic character of crown—long, slender, curved, pointed, circular in transverse section, with the enamel finely but definitely ridged longitudinally. The longest exserted crown measures ten lines, the shortest four lines, the thickness being in proportion.

The true number of the teeth in the lower jaw is yielded by the specimen of the dentary bone, Tab. III, fig. 2, in which twenty-five alveoli are shown on one side, and twenty-four on the other. The size of the alveoli, and the extent of their interspaces, are greatest at the anterior half of dentary. The small successional teeth at the posterior part of the series are so advanced as to look like a double row at that part. A longitudinal groove or depression at the inner side of the base of the alveoli lodged the thicker mass of the vascular gum overlying the matrices of the successional teeth.

The skull of the *Plesiosaurus dolichodeirus* is broad in proportion to its length, with

a broad and short muzzle, of an equilateral triangular figure if the transverse lines across the fore part of the orbits be taken as the base, the two sides converging to the rounded apex in almost straight lines, with a feeble indication of a constriction where the maxillo-premaxillary suture seems to be. The contour is undulated by the expansions for the sockets of the larger teeth, which produce risings, with intervening furrows on the granulate alveolar borders of the jaws. The mandibular rami converge to their terminations at the symphysis, which is not prolonged or expanded.

The specimen (Tab. III, fig. 1) from the Lias of Charmouth was wrought out of its matrix by the estimable discoverer of the Liassic Dinosaur (*Scelidosaurus*) described in a former Monograph. It is an admirable example of patience, pains, and skill; in the bestowal of which, for the furtherance of science, upon the fossils roughly wrought out of the quarries in his neighbourhood, Mr. Harrison found solace during the long and trying illness which confined him to his bed, until his final release by death.

Pectoral and pelvic limbs (Tab. I, figs. 2, 3).

To complete the characters of *Plesiosaurus dolichodeirus* I have reproduced, in outline, the bones of the pectoral, fig. 2, and pelvic, fig. 3, limbs, as they are preserved in the type-specimen. The humerus, 53, shows rather more convexity at the anterior border, and a deeper concavity at the posterior border than in some other species (*Plesiosaurus Hawkinsii*, *Pl. macrocephalus*,* *Pl. rugosus*, e. g.). The radius, 54, and ulna, 55, are of equal length; the ulna not being shorter than the radius, as in *Pl. Hawkinsii* (Tab. XIV, fig. 6); the ulna has not the olecranal process or epiphysis, as in the *Pl. rugosus* (Tab. XIV, fig. 2, 55′); and both antibrachial bones are less broad, in proportion to their length, than in the *Pl. macrocephalus* † (Tab. XIV, fig. 4). The carpus shows seven bones, four in the proximal, three in the distal row; their homologies will be pointed out in the description of *Plesiosaurus rugosus*. The metacarpal of the first digit (Tab. I, fig. 2, 1), answering to "pollex," supports at least three phalanges; that of the fifth digit, seven phalanges; the metacarpal of each of the others, six phalanges, but the terminal ones may be wanting in some. The pelvic fin (fig. 3) is rather longer than the pectoral one; in both fins the fifth digit (v) articulates on a more proximal plane than the others, *i. e.* nearer the trunk, as in most other *Plesiosauri*. In the same skeleton the pectoral limb equals seventeen of the middle cervical vertebræ in length; ‡ in *Pl. macrocephalus* it equals sixteen of these vertebræ, in *Pl. rugosus* it equals fifteen.

* 'Geological Transactions,' 2nd series, vol. v, pl. 43.

† Ib.

‡ The artist has drawn the outline of the limb-bones, figs. 2 and 3, on a larger scale than that of the skeleton, in Tab. I.

Plesiosaurus homalospondylus (Tabs. V—VIII).

In the year 1842 I examined, in the Museum at Whitby, Yorkshire, a collection of Plesiosaurian vertebræ, which had been taken out of a heap of rubbish from the old alum works carried on in the upper Alum Shale—a part of the Liassic series on that coast, characterised by the *Ammonites heterophyllus*, Sow.

The vertebræ were divisible into two groups, indicative of two species of *Plesiosaurus*.

Of one kind there was a series of sixteen consecutive cervical vertebræ, characterised by the unusual concavity of the terminal articular surfaces of the centrum. On making a section of two of these vertebræ cemented by the matrix in their natural state of co-adaptation, the margins of the opposed articular surfaces were two lines apart, showing the thickness of the inter-articular connecting ligamentous substance at that part, while the middle of the articular surfaces left an interval of eleven lines, thus approaching the ichthyosaurian type of vertebral union.

The following were dimensions of the centrum of these cervicals.

	In.	lines.
Length	1	9
Breadth of articular surfaces	1	11
Height of ditto	1	10

The inferior surface of the centrum showed a median longitudinal convex ridge between the two wide elliptical venous foramina. I named the species indicated by these vertebræ *Plesiosaurus cœlospondylus*,* in reference to the hollow terminal articular surfaces. I hope to have, at a future opportunity, further means of illustrating this species.

The second series of vertebræ presented almost flat articular surfaces of the centrum (Tab. V, figs. 3 and 6); the inferior surface was devoid of a median ridge, or had only a slight rising (fig. 4, *v*) between the venous foramina, which were smaller and more narrowly elliptical (ib., figs. 4 and 7) than in *Pl. cœlospondylus*; the middle of the surface was bounded laterally by the costal surfaces (ib., *pl*), and was nearly flattened, being very slightly concave, both lengthwise and transversely. The costal surface is of a narrow elliptical form, with the long axis parallel with that of the centrum; the dividing line or fissure is not conspicuous; it is situated, as usual, rather nearer the back than the front end of the centrum (Tab. V, fig. 2, *pl*); and a space more than twice its vertical diameter intervenes between it and the neurapophysis (ib., *np*), or

* Κοῖλος, hollow, σπόνδυλος, vertebra.

neurapophysial surface. A low, longitudinal rising, or obtuse ridge, traverses the free surface of the side of the centrum midway between the pleur- and neur-apophysial articular surfaces.

The following were dimensions of the centrum of a cervical vertebræ answering, or nearly so, in position, to that of the *Plesiosaurus cœlospondylus* selected for measurement—

	In.	lines.
Length	2	0
Breadth of the articular surface	1	10
Height of ditto	1	6

These dimensions showed the greater proportional length of the cervicals of the present species; and, concurring with the more obvious difference in this shape of the terminal articular surfaces, I thereupon devised the name of *Plesiosaurus homalospondylus*,* indicative of the even or level character of those surfaces, for the species so characterised.

I have subsequently received several additional vertebral evidences of both these species of the Upper Lias, or Alum Shale of Whitby, and, finally, have had the opportunity of studying two almost entire skeletons of the *Plesiosaurus homalospondylus* from that locality, one of which (Tab. VIII) is now in the Museum of the Philosophical Society of York, and the other (Tab. V) has been purchased by the Trustees of the British Museum, where it is now exhibited in the Geological Department. Both of these specimens exhibit the striking character of the genus PLESIOSAURUS in a maximised degree, viz., in the length of the neck and the smallness of the head.

I propose, first, to describe the specimen in the British Museum, Tab. V.

This specimen gives indications of the same conditions of interment in its matrix, and of the operation of subsequent gradual pressure, as that of the species last described, from the lias of another part of the kingdom.

It has sunk into the mud, which afterwards became petrified, either prone or supine; for I have been unable to obtain evidence as to whether the present exposed part of the skeleton was wrought out from the upper or under surface of the block, as removed from the quarry; but we may assume the former, and consider that the animal was originally imbedded with the upper or dorsal surface toward the observer. Both fore and hind paddles were outstretched at right angles with the axis of the trunk, but only their proximal bones or segments have been preserved. The skull and cervical vertebræ have maintained their original position. At the base of the neck, where the neural spines, from their height and breadth, began to afford a surface upon which the dislocating force could operate, they have begun to yield toward the left

* Ὁμαλός, planus; σπόνδυλος, vertebra.

side, and, in the dorsal region, D 1 — 60, are turned flat in that direction. At the base of the tail, where these flattened surfaces again become diminished in extent, the vertebræ gradually resume their vertical or prone position, the summits of the spines being uppermost, as far as the seventieth (counting from the head), beyond which some dozen of the terminal caudals are jumbled together in an irregular group, as if that part of the carcass, supporting perhaps a caudal expanse of integument or fin, had been subject to some disturbing influence prior to complete imbedding in the matrix.

I conclude that this partial rotation of the dorsal series took place before the petrifaction of the bones and bed; because the ribs of the right side have slipped from their attachments to the diapophyses, in a degree corresponding with the extent of the rotation. For, had they been cemented in their natural connections by the Lias stone, *i. e.*, after the petrifaction of the mud, and prior to the operation of the extraneous pressure, they might have been expected to have been bent or broken, when pressed into the same plane with the neural spines, without any slipping from their previous joints; whereas this dislocation implies a rotting away of the articular ligaments, and a certain yielding of the surrounding bed.

The chief characteristics of the skeleton of the *Plesiosaurus homalospondylus* are, the length of the neck, the height and breadth of the dorsal and contiguous cervical and caudal spines, with the smallness of the head. The length of the neck is due both to the number of vertebræ—thirty-eight, and to their proportionate length individually, and chiefly to the latter character, as compared with *Plesiosaurus dolichodeirus* (Tab. I).

I caused to be carefully removed from the matrix of the present skeleton the thirteenth and fourteenth (Tab. V, figs. 2—4) of these instructive vertebræ, the length of the centrum in which agreed with that on which I had made notes and drawings in 1842. They corresponded in every other particular with these vertebræ. The low, longitudinal ridge or rising (Tab. V, figs. 2, 5, *r*) on the side of the centrum may be traced throughout the neck. Fig. 7, Tab. V, gives a view of the under surface of the eighth cervical vertebra; fig. 6 gives an end view, and fig. 5 a side view of the centrum of the third cervical vertebra, all of the natural size. The specific characters are well exemplified in these, which may be profitably compared with the figures of the corresponding vertebræ of the *Plesiosaurus planus*, in a former Monograph,* as exemplifying the degree in which vertebral characters are developed in the different species of the genus.

The cervical ribs, as indicated by the articular surface (Tab. V, figs. 2, 7, *pl*), are of small size in proportion to the rest of the vertebra, until about the thirtieth, in which the transverse outstanding part of the stem is two inches three lines in length, and the longitudinal part two inches six lines. In the thirty-fourth vertebra this has attained

* Volume of the Palæontographical Society for 1862, issued in 1864. 'Supplement No. II to the Monograph of the Fossil Reptilia of the Cretaceous Formations' (Tab. I, figs. 20, 22, 25).

a length of four inches; the production, anterior to the transverse stem, being nearly an inch in length. In the thirty-fifth vertebra (Tab. VII, C 35) the costal surface projects, the rib begins to ascend, the anterior production to shorten, the posterior one to lengthen. In the thirty-seventh (ib., 37) the rib is supported in equal proportions by the centrum and by a diapophysial growth of the neurapophysis. In the thirty-eighth (C, 38) the rib has passed almost wholly upon the diapophysis, and has assumed a simple rib-like character, slightly bent, with a length of six inches. In the thirty-ninth vertebra (ib., D 1) the transit from centrum to neurapophysis, *np*, is complete, denoting the first of the dorsal series. In the second dorsal vertebra of the present skeleton the rib has slipped forward from its joint, *d*. In the forty-third (Tab. V, fig. 1) it is depressed an inch below the diapophysis. In the forty-sixth to the fiftieth vertebræ the heads of the ribs lie beneath the centrums, and the side view of the whole of those vertebræ is obtained. In the succeeding dorsals the ribs gradually approximate their suspending processes, and have resumed their articulation at the twentieth dorsal, or the fifty-eighth vertebra, counting from the atlas.

The ribs of the forty-seventh to the fifty-first vertebræ are from sixteen to seventeen inches in length; they are the longest of the series. The articular head presents a diameter of one inch and a half; the anterior surface is convex transversely; the outer part of the posterior surface is rather concave in the same direction, so that the outer margin of the proximal half of the rib, to near its head, presents the character of an obtuse rim or ridge. They gradually decrease in size as the vertebræ recede in position from the fiftieth; and, at the sixtieth, are reduced to a length of four inches: this and the two succeeding ribs seem to have become anchylosed to the diapophyses. In the sixty-second vertebræ the rib suddenly augments in thickness, extends its articulation downward upon the centrum, and represents a sacral vertebra (Tab. I, s). That of the sixty-first vertebra is somewhat less thick, but it may have assisted in affording attachments to the ilium (ib., 62), the proximal end of which bone is in contiguity with the converging terminations of the ribs of the sixty-first and sixty-second vertebræ. The anchylosed condition, with shortening of the caudal ribs, or pleurapophyses, give them the usual character of transverse processes in the caudal region.

The neural spines, thin and antero-posteriorly extended in the neck (Tab. V, fig. 2, *a*, 2, *ns*), have been more or less broken away, in the operation of exposing the specimen, from the anterior three fourths of the vertebræ in that region. Their height gradually decreased as they approached the head and receded from that of the thirtieth vertebra (ib., 30), which rises four inches from the summit to the neural arch, having a fore-and-aft diameter of two inches three lines, and a thickness of three lines. The former diameter is least a little above the origin of the spine, and gradually increases toward the summit, where the spines are in contact. In the thirty-third vertebra the neural spine is five inches in length, and its breadth of two inches three

lines is maintained through nearly the whole of that length, in corresponding close contact with the contiguous spines. In the thirty-seventh vertebra (Tab. VII, 37) the length of the neural spine is five and a half inches; it has a little increased in thickness; the fore-and-aft diameter continues the same. In the second dorsal the neural spine is six inches four lines in length, with a thickness of six lines. These dimensions are continued to the fifty-eighth vertebra, save that, in the posterior half of the dorsal series, the spines have less fore-and-aft breadth at their proximal third, and leave correspondingly wider intervals; they are in contact at their more expanded distal portions. From the fifty-eighth vertebra they gradually decrease in length to the sixty-second, or sacral vertebra, showing a height of less than four inches, with a terminal fore-and-aft extent of two inches, and a thickness of six lines. They decrease in all dimensions as the caudals recede from the trunk, and most so in fore-and-aft extent, leaving wider interspaces; by which character, with the higher position on the centrum, and anchylosed condition of the pleurapophyses, a caudal vertebra may be distinguished from a cervical of similar size. The caudal centrums are also thicker in proportion to their length, and the under surface, if exposed, would doubtless also yield the character of the hæmapophysial pits.

The dorsal diapophyses progressively increase from the first (Tab. VII, D 1, 2, *d*), and attain, at the fifth dorsal vertebra (Tab. V, fig. 1), a length of two inches three lines along the upper border. The rib-surface is cut from above downward and inward, shortening the under extent of the process. A low ridge is continued from the posterior angle of the neurapophysis upon the back part of the diapophysis, which expands to the truncate articular surface. After the sixteenth dorsal the diapophyses gradually shorten to the sacral vertebræ, where they have almost subsided.

The zygapophyses in the neck (Tab. V, fig. 2, *z*, *z'*) and greater part of the back are nearly horizontal, the anterior ones looking a little inward as well as upward, the posterior ones the reverse; they are given off nearer the base of the neurapophysis than usual (compare Tab. V, fig. 2, *z*, *z'* with Tab. III, fig. 4, *Plesiosaurus dolichodeirus*, with Tab. X, fig. 1, *Pl. rostratus*, and Tab. IV, fig. 11, *z*, *z'*, 'Monogr.,' 1862, *Pl. Bernardi*); towards the end of the back their aspect gradually changes; and, in the tail, the articular surface becomes almost vertical; that of the anterior ones, which are most developed and longest retained in the vertebral series, looking inward. The terminal articular surfaces of the centrum of the last dislocated caudal vertebræ are, as usual, more concave than in the neck.

The development of the neural spines throughout the trunk and base of the neck is such as to impede inflection in the vertical direction. At the anterior half of the long and slender neck this bend would, indeed, take place in some degree; but the greatest flexibility would be from side to side. The provision for the attachment of the vertebral muscles in the trunk is very great, indicative of corresponding power of regulating the movements and position of the body during the application of the

lengthened, slender neck, and small head, in the capture of fishes or other active marine prey.

The whole framework of the trunk is singularly massive, and the character of this part of the skeleton, as shown in the specimen (Tab. V), is especially striking in contrast with the slender neck and small head of the animal.

Of the Skull (Tab. VI).

The skull (Tab. VI), from the occiput to the end of the snout, is 9 inches long; it measures 4 inches 4 lines across the middle of the temporal depressions, 3 inches 6 lines across the occiput, which rises but 1 inch in height above the foramen magnum; the intertemporal part, or parieto-frontal crest, rises into a sharp ridge; the length of the temporal fossa is 2 inches 9 lines, the breadth is 2 inches. The diameter of the orbit is 1 inch 6 lines; from the fore-part of the orbit to that of the snout is 4 inches. The elliptical nostril shows a long diameter of about 6 lines, it is situated about 8 lines in advance of the orbit, and about the same distance from its fellow. The inter-narial portions of the nasal and premaxillary bones rise into an obtuse ridge. The teeth are small, slender, slightly recurved at the fore-part of the jaw, where the enamelled crown of the longest does not exceed 10 lines. No sutural evidence of cranial structure is discernible; the bones about and between the orbits show the effects of pressure. Estimating the length of the skull by that of the lower jaw, about two inches should be added to that taken from its exposed and visible part.

This part of the skull (Tab. V) is susceptible of satisfactory comparison with the corresponding region of the skull in the *Plesiosaurus dolichodeirus* (Tab. III, fig. 1), the species which most resembles the *Plesiosaurus homalospondylus* in the length of the neck and the small proportional size of the head.

By comparing Tab. III with Tab. VI, in which the skulls of the two species are figured of the natural size, from probably mature individuals of average size, and from the same aspect, the difference of proportion and form is such, and so obvious, that, were two skulls of existing lizards to be so contrasted, it is probable that some Erpetologists would be led to sever them more widely than by specific bounds. The composition of the cranium, the position and relative size of its principal cavities, and especially of the nostrils, the character of the dentition, are, however, so strictly Plesiosaurian in the two fossil skulls here compared, that there is no sufficient ground for encumbering the Sauropterygian group with one or two additional generic names.

The skull of *Plesiosaurus homalospondylus* is longer in proportion to its breadth, more oblong in shape, more obtusely terminated anteriorly. It is possible that the skull of the *Plesiosaurus dolichodeirus* compared (Tab. III) may have suffered more horizontal pressure, but not such as to have affected its triangular shape due to the

more rapid convergence of the sides of the upper jaw to the more pointed muzzle. The temporal fossæ may appear broader than natural in this crushed skull, but with due allowance this shape was square, not oblong, as in *Plesiosaurus homalospondylus.* The intervening parieto-frontal crest is relatively longer, and we may infer that the biting muscles were larger and more powerful in relation to the more massive proportions of the dentigerous parts of the jaws in *Plesiosaurus homalospondylus:* the orbits are relatively less; their antero-posterior diameter is less than one fifth of the same diameter of the skull taken from the back part of the parietal (7) in *Pl. homalospondylus;* it is more than one fifth in *Pl. dolichodeirus;* the orbits are equidistant from the two extremes of this diameter in *Pl. homalospondylus;* they are nearer the back part of the head in *Pl. dolichodeirus.* In *Pl. rostratus* (Tab. IX) the temporal fossæ present somewhat intermediate proportions between those in the two foregoing species; but the rostral production of the maxillary part of the skull sufficiently distinguishes the cranium of *Pl. rostratus* from that of previously known species in a comparison of detached skulls; whilst its greater relative size to the body more especially distinguishes it from that in *Pl. homalospondylus* or *Pl. dolichodeirus.*

In *Pl. Hawkinsii* * the longitudinal diameter of the temporal fossa exceeds the transverse diameter, but not in so great a degree as *Pl. homalospondylus,* and the upper jaw is relatively narrower than in that species. This is also the case in *Pl. macrocephalus,*† in which there is a more marked constriction of that part, anterior to the orbits, showing a tendency to the "rostral" character, which is exaggerated in *Pl. rostratus.*

Pectoral and pelvic arches and limbs (Tabs. V and VIII).

Of the limbs only the humeri and femora have been preserved in the skeleton (Tab. V); these bones show the usual form, with their respective characteristic modifications, as exemplified in the different contour of the anterior border, which is straight or partly convex in the humerus, and is concave in the femur. The length of the humerus is 12 inches, that of the femur 13 inches; the distal breadth is nearly the same in both, namely, 6 inches. In the right femur, the coarse fibrous texture which pervades the whole thickness of the bone is exposed. A portion of the extensive scapulo-coracoid arch comes into view from beneath the anterior dorsals on the right side (Tab. V, 52). The ilium (ib., 62) presents the usual form; straight, slender at its proximate end, with a slightly twisted, subcylindrical shaft, expanding to a breadth of nearly three inches at its acetabular end. The entire length of the

* 'Geol. Trans.,' 2nd series, vol. v, pl. 45.

† Ibid.

skeleton (Tab. V) is fourteen feet, which would be increased by several inches were the tail entire and outstretched.

The specimen of *Pl. homalospondylus* in the Museum of the Yorkshire Philosophical Society is larger than the one in the British Museum, but has been lithographed on a smaller scale in Tab. VIII; it measures 16 feet 6 inches in total length. It lies in a somewhat similar posture to that in the British Museum, but with the long and slender neck and anterior dorsals bent so as to give a concavity to the dorsal contour of the animal; the caudal vertebræ, which are better preserved, are also bent in the same direction, and all the vertebræ follow in their consecutive undisturbed juxta-position in both skeletons. The numbers of the vertebræ in the cervical and dorsal series respectively appear to be the same. The diapophysis has got entire possession of the rib at the fortieth vertebra, counting from the head; and the costal surface begins, with its process, to sink again upon the centrum, at the sixty-seventh vertebra, which the thickness of the diapophysis indicates to be a sacral vertebra. Beyond this may be counted twenty-seven caudal vertebræ, and it is not probable that their number exceeded thirty.

The cervical vertebræ show the same distinctive characters of the species which have been already defined; the neural spine is preserved in a much greater proportion of the cervical series; in the fifteenth cervical it shows a height of two inches, and a nearly equal antero-posterior breadth; with a broadly truncate summit, having the angles rounded off. The vertebræ keep their proportion of length from this point to the end of the dorsal series; they then grow shorter to the end of the tail, throughout the greater part of which the centrum is deeper, and the neural spines longer and narrower, than in the neck, indicative of the greater mass of muscle operating on the tail, and also its greater flexibility in a given extent. The costal series has suffered much more displacement and loss in the York specimen than that in the British Museum; the larger ribs are a good deal jumbled and broken in the region of the trunk or thoracic abdominal cavity, but they show the same massive character. The ischio-pubic part of the pelvis has been drawn away, at an acute angle, from the ilium and sacrum; its inner or upper surface is exposed at 63, 64, Tab. VIII. The right pelvic limb has been moved forward, with the head of the femur lying upon the lower end of the right coracoid. The right pectoral limb extends forward from near its normal place of articulation with the coracoid; but it has been turned bodily over, showing its inner or palmar surface. The limbs of the left side are huddled in a dislocated and incomplete state beneath the hinder part of the trunk.

The presence of both these limbs, in an excellent state of preservation, supplies the chief deficiency in the specimen in the British Museum previously described.

The pectoral limb, as in *Pl. dolichodeirus*, is rather shorter than the pelvic one; its entire length is 3 feet 8 inches, equalling sixteen vertebræ towards the base of the neck. The humerus, 13 inches in length and $7\frac{1}{2}$ inches in distal breadth, is broader

there, in proportion to its length, than in the *Pl. dolichodeirus* or than in the *Pl. rostratus;* its anterior margin, as in the skeleton Tab. V, is more straight than in those species. The antibrachial bones (54, 55) show intermediate proportions of length and breadth between those in *Pl. dolichodeirus* (Tab. I, fig. 2) and *Pl. rostratus* (Tab. IX). They present the usual characteristics of radius (54) and ulna (55) in the present genus, and they are of equal length. The hand measures two feet in length, and is somewhat longer in proportion to the arm and forearm than in the two above-cited species; it also shows rather more breadth. The carpus consists of six bones, three in each row, and with less inequality of size. The distal bones occupy an equal breadth with those of the proximal row, and do not allow the base of the fifth metacarpal to extend backward to the proximal row, as in the species of which the carpus is figured in Tab. XIV. The bases of the five metacarpals (in Tab. VIII, 57) are on the same transverse line; and if this specimen should truly exhibit the relative position of the bones of the pectoral fin, characteristic of the species, it adds a well-marked distinction of the *Pl. homalospondylus.* The first, or radial, or innermost metacarpal (57), supports a short digit of three phalanges; the second a digit of seven phalanges; the third the same; the fourth has a digit of six phalanges; the fifth is obviously imperfect.

The pelvic limb (Tab. VIII, 65, 69) is 3 feet 9 inches in length; the femur (65) is 14 inches long and $7\frac{1}{2}$ inches across the distal end. The tibia and fibula are respectively longer than their homotypes the radius and ulna; the foot is 2 feet in length and $7\frac{1}{2}$ inches in basal breadth. The tarsal bones are similar in number and arrangement to those of the carpus; and as the bases of the five metatarsals (69) are in this limb also on the same transverse line, I have the greater confidence in the natural structure being here shown in both limbs, and that they thus exhibit a distinctive character, of specific value, from the other Plesiosauri described in the present Monograph.

Plesiosaurus rostratus, *Owen.* Tabs. IX—XIII.

The specimen on which this species is founded was obtained, in 1863, by Edward C. Hartsinck Day, Esq., F.G.S., from the Lower Lias at Charmouth, Dorsetshire, by whom it was transmitted to London for inspection, and it has been purchased by the Trustees of the British Museum, where it is now exposed in the gallery of Geology. It is figured, one ninth of the natural size, in Tab. IX.

This skeleton, like most of the plesiosaurian ones that have come under my observation, indicates the ordinary and tranquil character of the death and burial of the individual; it has sunk entire, relaxed, and prone, with outstretched limbs, in its matrix, when this was soft and yielding; and, as decomposition loosened the liga-

mentous attachments of the vertebræ and of their elements, they have yielded to external pressure or movement of the matrix, and have rotated on their axis—some of the long-spined vertebræ to the right, some to the left—with a slight displacement of the longer ribs from their attachments.

The third cervical vertebra is displaced about three inches below the axis and atlas, which remain in connection with the occipital tubercles, the third to the fifteenth cervicals are prone with the spines uppermost, and the pleurapophyses in natural connection with the sides of the centrum, the lower part of which is buried in the matrix. Except a slight dislocation between the seventh and eighth, these cervicals have retained their natural sequence and relative position. As the spines grew longer and larger they offered a surface upon which the superincumbent pressure could operate, so as to rotate the vertebræ sideways; and from the sixteenth to the twenty-eighth inclusive, they are turned half round, with the spines downward or to the left; but all these vertebræ retain their natural mutual connections. The twenty-ninth vertebra is dislocated, exposing the anterior articular surface of the centrum; the thirtieth has suffered fracture of its spine; the thirty-first and thirty-second are partly bent to the left; the thirty-third and thirty-fourth are turned with the spines to the right side; that of the thirty-fifth is broken from its neural arch; the thirty-sixth to the forty-eighth vertebræ have the neural spines turned to the right, retaining almost their natural relative positions. The forty-ninth vertebra has kept the original prone position, as when imbedded; the next ten show the side view, with the neural spines to the right; the sixty-first to the sixty-fifth are prone, but with a slight deviation of the neural spines, some to the right, some to the left; the next six vertebræ have yielded in the opposite direction; there is then a deeper space, equal to the extent of five vertebræ, in which there are the centrums of three vertebræ and some hæmapophyses irregularly scattered. Beyond this part the terminal caudal vertebræ resume their position and natural connections, and are preserved, seven in number, to the last. The antecedent exceptional violence shown in the caudal series has probably been due to the tugging and gnawing of some predatory animal, whilst this part of the dead and partly decomposed Plesiosaur continued to be exposed at the sea-bottom.

The scapulæ (51) and articular ends of the coracoids (52) appear parallel with the twenty-fifth to the twenty-seventh vertebræ, the left being rather further back than the right. Both humeri (53) have been dislocated at the shoulder-joint by superincumbent pressure, and the articular ends of the scapulæ overlap their heads. The rest of the bones of the pectoral fins have retained their natural relative position, protected by the tough, closely-fitting dermal sheath, until this slowly dissolved away. The iliac bones (62) lie by the sides of the forty-seventh to the fiftieth vertebræ, almost in the axis of the spine, with their proximal ends turned backward, and their acetabular end forward, having become detached from the thick, converging pleura-

pophyses of the forty-seventh and forty-eighth vertebræ (s, s) which overlie the ischium (63) on the left side of the body. The articular ends of the ischium (63) and of the pubis (64) are exposed, retaining their connection with the ilium (62) opposite the forty-third to the forty-seventh vertebræ on both sides. The femora (65) have been slightly dislocated forward, and part of the acetabula is thus exposed.

The bones of the hind fins have preserved their natural relative positions; those of the left side, with their part of the pelvic arch, being a little more backward in position than those of the right, agreeing, in this respect, with the pectoral limbs, and indicating some general movement of the matrix as the cause of such displacement.

Including the atlas and axis there are twenty-four vertebræ before that in which the pleurapophyses have risen, to articulate wholly with the diapophyses (Tab. XII, D). At the forty-fifth vertebra the rib again begins to articulate with the centrum; in the forty-sixth the parapophysis forms the lower half of the costal surface; in the forty-seventh it forms a larger proportion, and the whole costal surface is here suddenly increased in size, giving attachment to a short, slightly bent pleurapophysis of correspondingly and abruptly increased thickness; that of the forty-eighth vertebra is thicker and straighter, and, as the preceding riblet inclines towards its extremity, I conclude that their thick, abrupt, digital ends were ligamentously connected with the iliac bone, and that they therefore may be regarded as sacral vertebræ (Tab. IX, s, s). The remaining vertebræ, from the forty-ninth to the eighty-fourth, will be caudal; thus there may be reckoned 24 cervical, 24 dorsal, 2 sacral, and 34 caudal vertebræ, in the present species.

Perhaps the two vertebræ antecedent to the sacral, in which the centrum shows part of the costal surface, might be regarded as lumbar vertebræ.

The total length of the vertebral column, from the third cervical to the last caudal, following its slight undulations, is 9 feet 9 inches. The skull, from the hind end of the mandible to the fore end of the symphysis, or snout, is 1 foot 11 inches.

The first five or six cervicals, from the third, are more or less obscured by pyritic matter; their neural spines show intervals of from three to six lines; the upper margin of the spine rises obliquely from before backward, with the angle rounded off; it is thickest at the middle part, where it measures two lines; that of the fourth vertebra has a fore-and-aft diameter of seven lines, the same diameter of the ninth is one inch. The pleurapophyses of the tenth vertebra are about an inch in length, with a subcylindrical body, bent obliquely backward, and slightly tapering to an obtuse end. In the eleventh vertebra, the centrum of which is an inch in length, about five lines of free surface intervene between the costal and neurapophysial articulations. From the pleurapophysis to the summit of the neural spine it measures 2 inches 5 lines. At the twelfth cervical the pleurapophyses begin to send forward the process which marks what may be termed the neck or pedicle of the cervical rib.

At the fourteenth cervical the length of the centrum is 1 inch 5 lines; that of its pleurapophysis is 1 inch 9 lines; the fore-and-aft extent of the base of the neural spine is 1 inch 2 lines; the height of the spine is 1 inch 6 lines, and its thickness is 3 lines. The total height of the vertebra is 4 inches. These dimensions are gained by gradual increase from the tenth vertebra. In the nineteenth cervical the length of the centrum is 1 inch 6 lines, the space between the pleur- (ib. *pl*)) and neur- (ib. *np*) apophysial surfaces is 7 lines. From the lower part of the centrum to the summit of the neural spine (*ns*) is 5 inches; the length of the pleurapophysis is 2 inches.

The *Plesiosaurus rostratus* ranks with the section of its genus characterised by broad and short cervical vertebræ. The instructive characters derivable from this region will here be described as they appear in the fifteenth of the series (Tab. X, figs. 1—3). This vertebra gives the following dimensions:

	In.	lines.
Length of centrum	1	6
Height of terminal surface of ditto, or vertical diameter	1	7
Breadth of ditto	2	6
Breadth of the middle of centrum	2	3
From the under part of centrum to the summit of neural spine	4	0
Fore-and-aft extent of neural spine at its middle	1	2
,, ,, neural arch from the end of one zygapophysis to that of the other	2	4
,, ,, neural arch below the zygapophyses	1	1
,, ,, costal surface	0	10
From the costal surface of the base of the neurapophysis	0	8

The terminal articular surface of the centrum is nearly flat, very slightly convex towards the circumference, and similarly concave at the centre; it is transversely elliptical, with a rather thin border, pretty closely co-adapted to that of the contiguous centrum. The sides of the centrum are moderately concave, the under surface is more deeply so; and this is further excavated on each side of an obtuse median ridge (*r*), near which the venous canals open into the large and deep ellipsoid fossæ. The outer boundary of these fossæ is formed by the lower border of the costal articular surface (Tab. X, fig. 3, and Tab. XI, fig. 2 *pl*). The costal surface (Tab. X, fig. 1, *pl*) presents an oval form, with the long axis parallel with that of the centrum, 10 lines in length by 8 lines in breadth, situated at the angle between the lateral and inferior surfaces, and divided by a smooth, non-articular trait of the lateral surface, of 8 lines in vertical extent from the neurapophysial surface of the centrum; this is defined below by a slightly curved subangular border, convex downward. The fore surface of the centrum presents a slightly fibrous character, not so smooth as in some other species, nor so irregular as in the *Pl. rugosus*, for example.

The neural arch is broad and low; the zygapophyses project from nearer the base

of the arch and centrum than in the *Pl. dolichodeirus* (Tab. III, fig. 4) or in *Pl. Bernardi* (for example, Monograph, 1862, Tab. IV, fig. 11), and their articular surfaces are more horizontal, the anterior ones (Tab. X and XI fig. 1, *z*) looking almost directly upward, the posterior ones (ib. *z'*) downward; in this character the present species resembles the *Pl. homalospondylus*. The neural spine is of subrhomboid figure, its height hardly exceeding the fore-and-aft breadth; the anterior border is convex, and rounded off into the upper one, with a scarcely marked angle; the posterior one is slightly concave, the angle between it and the upper border is blunted; the antero-posterior extent of the base of the spine is 1 inch 4 lines, the height of the spine is 1 inch 6 lines. The parapophyses (Tab. X, figs. 1 and 3, Tab. XI, fig. 1, *pl*) are not anchylosed to the centrum. Their head, or articular surface (ib. fig. 2 *pl*), forms the thickest part; the bone decreases as it stands outward, especially in vertical diameter, becoming flattened or depressed; it then bends backward, sending a short process forward, like the tubercle of the Crocodile's cervical rib, but developed from the same plane as the head; the backwardly contained body of the rib decreases in horizontal and increases in vertical breadth, presenting a broadly convex surface outwardly (Tab. X, fig. 3 *pl*). The length of the cervical pleurapophysis in the fifteenth cervical here described from the fore part of the head to the posterior point, is 2 inches; from the end of the tubercle to the posterior point is 1 inch 8 lines. The increase in the succeeding vertebræ is most in the pleurapophyses, next in the neural spines, then in the breadth of the vertebra, and least in the length of the centrum; this, indeed, varies somewhat, but not so much as appears in the figure 2 of Tab. XI, in which the matrix is left upon part of the inferior surface in two of the vertebræ.

Resuming the consecutive examination of the spinal column we find, in the twentieth vertebra (Tab. XII, 20), the costal surface rises nearer the neurapophyses (*np*); the rib has attained a length of 2 inches 8 lines. In the twenty-first (ib. 21) the costal surface reaches the neurapophyses (*np*), which contributes a little to its upper part by a diapophysial projection. The vertical extent of this costal surface is 1 inch, the length of the pleurapophysis is nearly 3 inches. In the twenty-second vertebra half the costal surface is formed by the diapophysis. The length of the rib (*d*) is 3 inches 9 lines; the anterior process or tubercle becoming shortened. It is shorter in the next rib (*pl*), the body of which is longer; and on the rib of the twenty-fourth vertebra it has disappeared. In the twenty-fifth vertebra (ib. D 1) the diapophysis (*d*) is prominent, and forms the entire costal surface. The ribs of this instructive series of six consecutive vertebræ have been dislocated from their articulations, apparently by the operation of the pressure which rotated the rest of the vertebræ from the vertical to the lateral position, but they retain their relative positions to each other, the end of one extending beyond and below the fore part of the next, and, in a greater degree, as the vertebræ approach the back. The sides of the neural spines of these vertebræ are roughened by irregular or granulate ridges, directed toward their

summit, which is bent backward. The dorsal vertebræ continue to increase in the length and size of the diapophyses, in the height of the neural spines, in the breadth and depth of the centrum, and, in a still greater degree, in the length of the ribs ; in every dimension, in short, except that of the length of the centrum, which, in the tenth dorsal, is 1 inch 10 lines, and in no dorsal vertebra exceeds 2 inches. The breadth of the centrum in the tenth dorsal is 3 inches ; the height, 2 inches 3 lines ; the articular surface is moderately hollow at the middle, and gently convex towards the periphery ; the neural spines gradually attain the height of $3\frac{1}{2}$ inches towards the end of the series, the fore-and-aft extent being about $1\frac{1}{2}$ inch near the summit, which is more thickened and truncate than in the neck, measuring, in some of these vertebræ, 9 lines in thickness. Both margins are concave at the lower half of the spine, and the intervals between those of different dorsal vertebræ average about three fourths of an inch at the narrower parts of the spines. The length of the diapophysis is about $1\frac{1}{2}$ inch ; it expands to its extremity, which is abruptly truncate, looking obliquely outward, backward, and a little downward ; it is flat, and rather rough, for ligamentous union with the rib ; subquadrate in form, averaging about an inch across. The ribs attain their greatest length from the twelfth to the fifteenth dorsal, where they are 1 foot 6 inches in length, with a simple expanded end, corresponding in shape and size with the diapophysial surface ; the body of the rib is subcylindrical, then subtrihedral, and again subcylindrical in shape, about 6 lines in diameter at the narrower part, and gradually enlarging at the distal third to the truncate extremity, which was ligamentously connected with the sternal rib. Some of the longest ribs have suffered fracture, and some contortion at their middle slender part, in the course of the cosmical pressure which has spread them out flat ; but they retain much of their natural curvatures on each side the vertebral column. After the thirteenth, the ribs gradually decrease to a length of $3\frac{1}{2}$ inches, in the last vertebra, in which the rib articulates wholly with the diapophysis (twenty-second dorsal), the breadth of this rib is 5 lines. Where the rib begins again to descend from the centrum, it continues to decrease in length in the first and second, in the latter of which it begins to gain in thickness. In the forty-ninth vertebra, counting from the skull, which vertebra I have indicated (Tab. IX, s) as the first sacral, the rib is 2 inches 6 lines in length, and 9 lines in least diameter ; its head is partly buried in the matrix, but the articular surface next the vertebra from which it is detached is 2 inches in vertical and 1 inch in longitudinal diameter, and the surface projects below, from the centrum, as it does above, from the neural arch. The borders of the terminal articular surfaces of the centrum are thicker and rougher than those of the dorsal or caudal vertebræ, indicating a stronger connection between the vertebræ from which the pelvic arch was suspended. The rib of the second sacral is straight, $2\frac{3}{4}$ inches in length, and 13 lines in the smallest diameter.

In the caudal vertebræ the neural spines gradually decrease in length, but more so in antero-posterior breadth, being longer, and with wider intervals at the basal half of

the tail than in the neck. The pleurapophyses continue to articulate in part with the neural arch to the tenth or twelfth caudal vertebra; the pleurapophyses are straight, and have gradually diminished to a length of $1\frac{1}{2}$ inch in the tenth caudal; they are flattened, and slightly expand towards the fore extremity, which, in the one above cited, there measures 10 lines across; the hæmapophyses are distinctly shown, those of each pair being separate, beneath the centrums of the seventeenth, eighteenth, and nineteenth caudals, forming part of that series where the neural spines are turned to the left. The first of these hæmapophyses has a length of 1 inch 9 lines, and a fore-and-aft breadth of 6 lines at its compressed, dilated, free extremity. The articular surface of the centrum of the twentieth caudal vertebra is exposed; it is gently concave, with a central depression, 1 inch 3 lines in vertical and nearly the same in transverse diameter, with an inferior border bevelled off at the fore part, for the articulation of the hæmapophyses. The ten terminal caudals show the lateral compression and flattening, with suppression, first of the posterior then of the anterior zygapophyses; next of the neural spine, and, in the last three or four, of the neural arch itself. Traces of hæmapophyses may be distinguished as far as the twenty-ninth caudal. This compression of the centrums would indicate, by cetacean analogy, some development of the terminal dermal expanse, but in a vertical, not horizontal, direction.

Reckoning the dorsal series of vertebræ as twenty-four in number, it constitutes rather more than one third of the whole extent of the spinal column; the thirty-four caudal vertebræ, of smaller proportions, constitute another third; the twenty-four cervicals are rather less than a third. The skull is equal in length to three fourths of the neck and to one sixth of the entire skeleton. The total length of the vertebral column is 9 feet 9 inches, the total length of the skeleton being 11 feet 8 inches.

The skull (Tabs. IX and XIII) is 1 foot 11 inches in length, 9 inches in breadth across the mastoids, $7\frac{1}{2}$ inches across the back of the orbits, but here it appears to have been somewhat flattened out by pressure. It is 5 inches 3 lines broad in front of the orbits, 2 inches across the narrowest part of the snout, which, from the fore part of the orbit, is $11\frac{1}{2}$ inches in length, and expands at its extremity to a breadth of $2\frac{1}{2}$ inches. This is the proportion of the snout, which gives the peculiar and distinctive character to the present species of *Plesiosaurus*, and which suggested *rostratus* as the specific name; in fact, the head, from the aspect exposed, resembles rather that of the Muschelkalk *Pistosaurus* than that of any of our heretofore known Liassic *Plesiosauri*.

The temporal fossæ are oblong, contracting anteriorly, and are there outwardly rounded off; in length 5 inches; in breadth, posteriorly, 3 inches. The subcircular orbits are 2 inches in diameter. The narrow elliptical nostrils are $1\frac{1}{2}$ inch in advance of the orbits. The upper and hinder boundary of the cranium, formed by the bifurcate parietal, and strong, overlapping mastoids, is convex superiorly, expanding as it proceeds outward. The middle part of the parietal rises into a sharp crest

between the temporal fossæ, and a continuation of the same crest, whose sides slope away from each other at a right angle, characterises the upper part of the frontal to midway between the orbits. The postfrontal bar, or flattened tract, dividing the orbital from the temporal fossæ, is an inch in breadth. The narrow nasals are divided by a medial suture, and, with the prefrontal and lacrymal, separate the orbit from the nostril.

The lower jaw has slipped from beneath the cranium, and, by the effect of the gradual pressure, has been turned, with the flatter left side upward. The angle projects beyond the articular surface 2 inches 3 lines, terminating obtusely, slightly bent, with the concavity upward, and 1 inch in thickness. The great part of the articular cavity of the right ramus is exposed, showing a transverse diameter of 1 inch 3 lines, and a fore-and-aft diameter of 10 lines: it is concave lengthwise, sinuous across. In advance of the articulation the ramus shows a depth of $1\frac{1}{2}$ inch, gradually increasing to that of 2 inches 3 lines, and then contracting vertically toward the dentary part; the deepest portion, formed by the angular and sub-angular elements, is situated about four inches in advance of the articular cavity, and there the thin outer parietes of the ramus have been crushed in, yielding to the superincumbent pressure.

The length of the dentigerous part of the jaw is 1 foot 2 inches; externally the dentary descends vertically from the sockets containing the teeth, but internally it swells out into a strong, convex, longitudinal tract, strengthening the alveoli, until the two dentaries meet at the symphysis. There is a longitudinal groove at the middle of the inner surface, below which the bone again swells out and is continued into the thick under surface of the dentary. The length of the symphysis is nearly 7 inches; and here the vertical extent increases, and terminates more sharply below. The vertical extent of the dentary, behind the symphysis, is 1 inch, the deepest part of the symphysis is $1\frac{1}{2}$ inch; the outer surface of the symphysis is coarsely and irregularly rugose; its upper border is scooped out at the alveoli for the larger teeth; on the left side there are about twenty-two sockets for teeth of different sizes; the smallest are behind, and the hindmost shows a straight crown (Tab. IX, fig. 6), sloping forward, from 4 to 5 lines long, with the usual longitudinal ridges of the enamel. The tooth in advance is slightly bent; the eighth in advance shows a crown, 9 lines in length; the fifteenth in advance (Tab. IX, fig. 4) shows a sudden increase of size, and greater degree of backward curvature; including this, eight teeth occupy the rest of the alveolar surface, which is coextensive with the symphysis. Here the teeth are divided by intervals of rather more than their own basal breadth; the largest tooth (ib., fig. 3), following the curvature, has a crown two inches in length. The longitudinal enamel-ridges begin at from one to two lines above the base of that covering of the crown, where it is smooth, and they terminate about the same distance from the apex; they are least developed at the outer, convex part of the upper half of the crown. Two of these large, laniary teeth project from the anterior alveolus, the outer and

anterior tooth being about to be shed. The right side of the symphysial part of the jaw (Tab. IX, fig. 2) contains nine teeth, the third, fifth, and seventh being the largest. The fifth (Tab. IX, fig. 5) measures 2½ inches in length of crown, following the curve. The fourth and sixth teeth were emerging from sockets larger than themselves, and are successional teeth. The unusual length of the symphysis corresponds with the prolongation of the premaxillary above.

In the same locality and formation with the skeleton above described was discovered the portion of skull, corresponding in size, and, so far as it is preserved, in shape with that of the skeleton of the *Plesiosaurus rostratus*, to which species, therefore, I provisionally refer the specimen (Tab. XIII). It includes the basi-occipital, right ex-occipital, basi-sphenoid, portions of pterygoids, ecto-pterygoids, palatines, with fragments of the maxillary and of the right ramus of the mandible. In the figures of this specimen (Tab. XIII) the mandibular part is omitted. The left ex-occipital is wanting; the right (ib., 2) is displaced, so that the whole of the upper part of the basi-occipital (ib., 1) is exposed. This shows that the bases of the ex-occipitals are divided from each other by a narrow tract, and that the basi-occipital forms the whole of the condyle and of the median part of the floor of the epencephalic compartment of the cranium; this part of the bone (1) measures across its most contracted portion about three lines. The condyle is subhemispheric, with the transverse diameter rather the longest, and with a slight and irregular depression a little above its centre. The upper border of the condyle (fig. 1) is on a level with the advanced epencephalic surface (1) of the basi-occipital, from which it is divided by a shallow and narrow transverse channel; the lower border (fig. 2, *o*) projects abruptly downward, and is divided from the more advanced surface of the basi-occipital by a transverse furrow, three lines wide and four or five lines deep. The surface of the basi-occipital is covered by the posterior border of the pterygoids (24) which underlie it, extending backward, so as to leave only parts of the pair of rough and tuberous basi-occipital processes (*h*, *h*) exposed. The posterior part of the epencephalic surface of the basi-occipital (Tab. XIII, fig. 1, 1) is smooth and concave transversely; but, as it advances, it becomes irregular and expands, and apparently is divided by an irregular protuberance at the middle part. The neurapophysial surfaces (*n*, *n*) on each side are, as in the succeeding centrums, triangular, with the angles rounded off. About a line in advance of these is the 'harmonia,' or straight suture, indicating the flat synchondrosis by which the epencephalic unites with the mesencephalic centrum (basisphenoid, ib., 5), thus repeating the kind of union which attaches the centrum of the atlas to that of the axis vertebræ. The neural surface (5) expands to a greater breadth than it had attained in the basi-occipital, measuring fourteen lines across; it has a smooth, undulating surface, moderately concave in the middle, where it sinks below the level of the epencephalic surface (1). The sides of the mesencephalic surface are bounded by a narrow ridge, seemingly an exogenous growth from the centrum, as in some modern

Lacertilia, to which 'neurapophysial' ridges (Tab. XIII, fig. 2, *n*, *n*) may have been attached the neurapophyses, but retaining, as in these *Lacertilia*, more or less of their primitive histological fibro-cartilaginous condition. The under and lateral parts of the mesencephalic centrum, called 'basisphenoid,' are covered by the largely developed 'pterygoids' (ib., fig. 1, 24),—the diverging appendages of a more advanced cranial segment. The back part of the third or 'prosencephalic' centrum has coalesced with the second, the boundary-line being indicated by a shallow depression, which may have lodged the vascular appendage of the brain called 'hypophysis,' or 'pituitary gland.' The sides of this part of the centrum rise, neurapophysially, and terminate with a fractured and worn surface, and the rest of the centrum, answering to the cetacean 'presphenoid' (9), has been broken away. Beneath the fractured end of the presphenoid is the nasal 'meatus,' or canal (ib., fig. 1, *r*), which is divided below by the junction of the palatines (ib., fig. 2, 20, 20) with the pterygoids (ib., 24, 24), so as to open upon the roof of the mouth by a pair of posterior or palatal nostrils 'palatonares' (ib., *r*, *r*). These are of a narrow, elliptical form, with the long axis longitudinal, but slightly, inclined 'mesiad,' or converging anteriorly, pointed behind, 1 inch 6 lines in long diameter, 7 lines across their widest part, and separated anteriorly by a tract of bone 9 lines across; from the posterior end of the 'palatonares' to the same part of the basi-occipital tuberosity is 1 inch 5 lines. The palatines (ib., fig. 2, 20, 20), where they give attachment to the pterygoids, are narrow, rather thick, with a shallow median channel, bounded by low, lateral, obtuse risings; external to these the palatines form the anterior ends of the 'palatonares,' and thence expanding, and flattening as they stretch forwards, they unite laterally with the ectopterygoids (25, 25). The pterygoids (24, 24), which form the inner and posterior boundaries of the palatonares, expand as they pass backward, become thinner and flatter, and retain a sutural union along the mesial line until they reach the precondyloid fossa of the basi-occipital; underlying and concealing from view, inferiorly, the basi-presphenoid and major part of the basi-occipital. These 'basilar' plates are slightly concave from side to side, and are divided from the 'tympanic' processes (24′, 24′) by a rising of bone, hardly to be called a ridge; this is chiefly formed by the concavity or sinking of the surface at the commencement of the under part of the 'tympanic' process, which also gradually contracts in breadth as it extends backward and outward to abut against the tympanic pedicle (28), which is wedged at its upper or cranial half between the pterygoid (24) and par-occipital (3).

The ectopterygoid (ib., fig. 2, 25) articulates with the pterygoid near the posterior part of the palatal nostril, where it is about seven lines in breadth; this joint has been put out by pressure on the right side and the ectopterygoid dislocated downward; the corresponding part is broken off on the left side, where it overlaps the pterygoid, forming the outer boundary of the palatal nostril. The ectopterygoid expands as it advances forward; curving, mesially, round the fore part of the nostril to join the

palatine (20), and laterally to join the maxillary (21), of which a fragment is preserved in this crushed specimen. The lower opening of the temporal fossa is bounded mesially in nearly equal proportions by the pterygoid and ectopterygoid.

Estimating the length of the skull in the present specimen at two feet, about six inches in length of the hind part is here preserved; and the palatal nostrils open chiefly upon the hinder half of this part. In their posterior position, therefore, they agree with those in *Teleosaurus,* but differ in being divided by the medial productions of the palatines and pterygoids, and in not being confluent, as a single aperture, as in the *Crocodilia;* thus they exemplify the more general Reptilian character as it is preserved in our modern *Lacertilia.*

In the *Nothosaurus* the palatonares are two; but they open upon the anterior fourth part of the bony palate, having their hinder boundary formed by the palatines instead of their front one. In *Pistosaurus* the palatonares are situate about midway between the fore and back part of the long and narrow bony palate. In all *Sauropterygia* the pterygoids present much of their crocodilian character in their posterior extension and expansion, underlying the posterior cranial centrums and covering, in this way, in *Plesiosaurus,* more of the basi-occipital than in the crocodiles. Some portions of long, slender, subcompressed bones adhering to the present instructive fragment of the plesiosaurian cranium may have belonged to the hyoidean arch; one of them (40) adheres to the bony palate, and partly conceals the left palatal nostril in fig. 2.

Pectoral and pelvic arches and limbs (Tab. IX).

The scapula (Tab. IX, 51) is 5 inches in length; smooth and convex externally at its narrow upper part, where it shows a breadth of 10 lines; it rapidly expands to a breadth of 3 inches at its humero-coracoid extremity, which overlaps, as before mentioned, the head of the dislocated humerus. The outer surface of the articular end of the scapula is roughened by longitudinal ridges.

The humerus (ib., 53), showing a breadth of 1 inch 9 lines where it emerges beneath the scapula, expands to a breadth of 4 inches where it is articulated to the antibrachial bones; its anterior border is straight, less convex at the distal half than in *Pl. dolichodeirus;* less expanded at the distal end than in *Pl. homalospondylus.*

The radius (ib., 54) is 3 inches 2 lines in length, 2 inches broad at its proximal end, 1 inch 9 lines at its distal end; with a thin, straight, somewhat irregular anterior border, and a thicker, smooth, concave posterior border. The ulna (ib., 55) presents the usual reniform figure, with the concavity toward the radius; it is of the same length as the radius, but is flatter; 2 inches 3 lines across its middle part; the margin next the radius is rather more concave than that which it opposes; the

opposite margin of the ulna is very convex; the distal end is divided by a low angle between the surfaces for the outer and middle carpals of the proximal row.

The carpal bones are six in number, three in each row. The proximal ones are the largest, but, of this row, the radial carpal, or 'scaphoid,' is least; it is of a transversely oblong figure, with its distal border divided by a low angle between the radial and the middle bones of the second row; this relation is better shown in the right than in the left pectoral fin. The middle proximal carpal, or 'lunare,' is the largest, of a sub-hexagonal form; the shortest side, toward the radius, is concave; the side opposite the radial carpal is rather convex; the other facets for the ulna, ulnar carpal ('cuneiforme') and the two larger carpals of the second row, are nearly straight. The three carpals of the second or distal row increase in size from the radial to the ulnar side of the waist; the outermost being surrounded by three carpals and three metacarpals; the metacarpal of the fifth digit extending along its ulnar side to articulate with the ulnar carpal of the first row. In its relations to the metacarpals, the largest of the second row resembles the 'magnum' and 'unciforme' combined, of the mammalian carpus. The next in size answers to the 'trapezoides,' supports the second metacarpal, and, at its opposite border, fills the interspace between the radial and middle carpals of the first row. The radial carpal of the second row is the smallest of all; it is wedged between that of the first row, the first metacarpal and the middle carpal of the second row: it answers to the 'trapezium.'

The first metacarpal (ib., 56) is the shortest, 1 inch in length, it supports two phalanges, the last of which is 10 lines in length; the whole length of this digit, including the metacarpal, is 2 inches. The second metacarpal is 1 inch 9 lines in length, and supports six phalanges, the last being 4 lines long; the total length of this digit, including the metacarpal, is 10 inches 6 lines. The middle metacarpal is 1 inch 10 lines in length, it supports eight phalanges; the total length of this digit, including the metacarpal, is 10 inches 6 lines. The fourth metacarpal is 2 inches in length, it supports seven phalanges; the total length of the digit, including the metacarpal, is 10 inches. The metacarpal of the fifth digit is $1\frac{1}{2}$ inch in length, its proximal breadth is 1 inch; that of the first metacarpal being half an inch, and that of each of the three intermediate metacarpals ranging from 9 to 10 lines; the outermost metacarpal supports seven phalanges: the total length of the digit, including the metacarpal, is $9\frac{1}{2}$ inches; the fifth metacarpal, besides being shorter and broader than the three middle ones, is more convex, and obliquely bevelled off at its proximal end, the radial side being shorter than the ulnar one. The phalanges of the fifth digit are more concave at their outer or ulnar border than the others. The first metacarpal is more concave at its radial border. All the phalanges are flattened and expanded at their extremities, the outer surface showing linear impressions, the middle part being smooth. The total breadth of the carpus is 4 inches 5 lines. The total length of the hand is 1 foot 1 inch. The total length of the pectoral limb seems to have been about

2 feet. It is much shorter in proportion to the trunk (as reckoned from the first dorsal (ib., fig. 1, D) to last sacral (ib., S) than in the *Plesiosaurus homalospondylus* (Tab. V), and differs in the more proximal position of the metacarpal of the fifth digit, and in the smaller size of the radial carpal of the distal row.

Like the scapula in the pectoral arch, the ilium (Tab. IX, 62) is the smallest bone of the pelvic one; it is 5 inches in length, $1\frac{1}{2}$ inch across the obliquely truncate upper (proximal or sacral) end, it contracts to a diameter of 9 lines at its middle, and then expands to a breadth of 2 inches 4 lines, with proportional thickness, at its lower acetabular end. The stem is subcompressed, convex transversely, and also longitudinally at the upper half, which shows a low ridge externally, and is longitudinally striate near the margin of the surface connected with the sacral pleurapophyses, from which, as before stated, it has been dislocated. The acetabular end preserves its natural connections with the corresponding thickened part of the ischium (ib., 63), which on both right and left sides is interposed between the ilium and pubis. The rough acetabular surface is nevertheless continued from the ischium upon the pubis, for about two inches of the contiguous border. The head of the femur is applied to the ischio-pubic surface in both limbs, yet the better proportioned articular depression is that formed by the ilium and ischium, from which it seems as if the femur had been dislocated forward. As, however, the mode of attachment has been by a ligamentous mass, this may have converged from the whole of the antero-posteriorly extended acetabular surface to the head of the thigh-bone, allowing a certain freedom of play of the bone forward and backward; the diameter of such acetabular surface, lengthwise, is 5 inches, the greatest vertical diameter is 3 inches.

The ischium (Tab. IX, 63), as it passes from the acetabulum mesiad, loses its thickness and expands into a plate of the usual triangular form, the posterior apex of which is seen on the left side behind the two overlying sacral ribs, stretching as far back as the ilium (ib., 62); from this apex, or angle, to the acetabular junction with the pubis, the ischium measures 8 inches. Pyritic matter intervenes between the ischium and sacral ribs, on the left side.

So much of the pubis (Tab. IX, 64) as is visible on the left side exhibits the usual subcircular discoid shape, with the two facets on the thickened part of the margin, one for articulation with the ischium, the other completing the fore part of the acetabular tract. The broadest part of the exposed pubic disk measures 6 inches lengthwise.

The femur (Tab. IX, 65) is 9 inches 9 lines in length. A longitudinal notch feebly marks out a trochanteric part of the thick, convex, articular head; this is coarsely pitted for the ligamentous insertions. The shaft contracts, chiefly losing thickness, and becoming lamelliform as it expands in breadth to the distal articular surface. This is convex, curving in a greater degree at its hinder part. Both anterior and posterior borders of the shaft are concave; the former least so, but to that extent differentiating the femur from the humerus, in which it is straight, or rather convex.

The distal breadth of the femur is 4 inches 8 lines; the non-articular surface is smooth, except near the two ends, where there are rough, longitudinal ridges and depressions, indicative of ligamentous insertions.

Both tibia (Tab. IX, 66) and fibula (ib., 67) are broader in proportion to their length than their homotypes in the fore limb. The posterior distal angle of the fibula is more decidedly truncate, for articulation with the middle tarsal, than is the corresponding part of the ulna. The inter-osseous space is a long ellipse with pointed ends, about an inch in width across the broadest part.

The tarsus (Tab. IX, 68), like the carpus (ib., 56), consists of six bones, in two rows of three each. The tibial bone of the first row is broader, in proportion to its length, than its homotype in the carpus; and this is the proportional character of all the bones of the tarsus, save that which intervenes between the fibula (67) and the fifth digit (69), the metatarsal of which passes outside the distal tarsal series.

The metatarsal of the innermost tibial, or first digit, is 1 inch 4 lines in length, 10 lines in breadth, and supports three phalanges; the total length of the digit, including the metatarsal, is 4 inches 8 lines. The metatarsal of the second digit is 1 inch 9 lines in length, and supports six phalanges, the last being 4 lines in length; the total length of this digit, including the metatarsal, is 8 inches 6 lines. The metatarsal of the mid-digit is 2 inches in length, and supports nine phalanges; the total length of this digit, including the metatarsal, is 1 foot. The metatarsal of the fourth digit is 1 inch 11 lines long; the fibular side of its base is more produced than in the others; it supports a digit of eight phalanges, and this, including the metatarsal, is 1 foot 1 inch in length; the metatarsal of the fifth digit is 1 inch 10 lines in length, and supports six phalanges, the last of which is broader and flatter than in the other digits; the total length of the fifth digit, including the metatarsal, is 10 inches 2 lines. The breadth of the leg is 5 inches 5 lines; the length of the tibia 3 inches; that of the fibula 2 inches 9 lines. The breadth of the metatarsus is 4 inches 7 lines. The total length of the hind limb is 2 feet $4\frac{1}{2}$ inches. The hind limb, though longer and larger than the fore limb, repeats the character of relative shortness in proportion to the trunk, as engraved with the same parts in *Plesiosaurus homalospondylus*. The neural spines of the trunk are shorter, with wider intervals, exemplifying the superior vigour and locomotive power of the longer-necked and larger-finned species (Tab. VIII.)

We see in *Pl. rostratus* a correlation of the size of the head with that of the anterior laniary teeth, and with the shortness of the neck. But the head is proportionally less compared with the trunk, and the neck is shorter, and has fewer vertebræ, than in the *Pl. macrocephalus*.* These characters, with the greater lengthening and attenuation of the muzzle in *Pl. rostratus*, indicate a nearer step in affinity toward the Teleosaurian marine reptiles.

* 'Geological Transactions,' 2nd series, vol. v, pl. xliii.

PLESIOSAURUS RUGOSUS, *Owen.* Tabs. XIV and XV.

This species, originally indicated by characters of detached vertebræ,* has received ample elucidation from the fine specimen (Tab. XIV) presented by His Grace the Duke of Rutland, K.G., to the British Museum. It was obtained from the zone of Lower Lias of Leicestershire, characterised by the *Ammonites stellaris,* in the neighbourhood of Granby.

This specimen of the *Plesiosaurus rugosus* presents a similar condition to that of the *Pl. dolichodeirus* decribed by Conybeare,† save that the head is not preserved in advance of the small, scattered vertebræ of the anterior part of the neck; about five-and-twenty vertebræ of this region preserve their consecutive arrangement, most of them in almost a straight line. The vertebræ of the trunk have suffered a greater degree of dislocation, and, the specimen having been exposed in a prone position, they are so dispersed as to permit to be seen the upper or inner surface of the coracoids, the abdominal ribs, and the pubic and ischial bones. Two thirds of the caudal vertebræ show the same scattered and dislocated condition; but nine near the end of the tail have preserved their natural position, as consecutively articulated, and apparently their true relative position to the trunk. The four paddles are preserved outstretched, as naturally articulating with their respective arches of support, with the superior or external surface of the bony framework exposed.

The cervical vertebræ, which have retained their natural consecutive arrangement and juxtaposition, have undergone the same partial rotation as is observable in most Plesiosaurian skeletons from Liassic beds, presenting their broadest surface or sides to view; the neural spines have here rotated toward the left side. Besides the twenty-five cervical vertebræ which are more or less consecutive, three or four are huddled in a heap at the base of the neck, and five or six are scattered at its fore part. From the size of the articular surface of the foremost of these, which measures but six lines in diameter, as well as from so much of the length of the neck as is demonstrated, it may be inferred that the head was small, as in the *Pl. dolichodeirus.*

Cervical vertebræ (Tab. XV).

One of these vertebræ, corresponding in position to the fifteenth cervical of the *Pl. rostratus* (Tab. X), was carefully wrought out of the matrix of the specimen Tab. XIV, and is represented of the natural size in Tab. XV. Its proportions show that the present species, like *Pl. dolichodeirus* and *Pl. Hawkinsii,* belongs to the section

* 'Report on British Fossil Reptiles,' 1839; 'Reports of the British Association,' 8vo, 1840, p. 82.

† Tom. cit.

characterised by intermediate proportions of the centrum, neither "long," as in *Pl. homalospondylus*, nor "short," as in *Pl. rostratus* and *Pl. planus*. The following are the dimensions of this vertebra:

	In.	lines.
Length of centrum	1	9
Height or vertical diameter of terminal surface of ditto	1	9
Breadth of ditto	1	10½
,, the middle of centrum	1	7
From the under part of centrum to the summit of neural spine	4	4
Fore-and-aft extent of neural spine at its middle	1	4
,, ,, ,, arch from the end of one zygapophysis to that of the other	2	6
,, ,, ,, arch below the zygapophyses	1	3
,, ,, costal surface	0	7
From the costal surface to the base of the neurapophysis	0	11

The free or non-articular surface of the centrum shows near the margins of the terminal surfaces the strongly marked rugous character which originally suggested the specific name in the detached vertebræ. The irregular risings of bone lie chiefly in the direction of the axis of the vertebra, and project so as to come into view exterior to the articular surface in an end-view of the centrum, as in Tab. XV, fig. 2. The sides and under part of the centrum are moderately concave lengthwise. The contour of the terminal articular surface is circular; its border is thick and convex, leading to a moderate concavity, with the central part rising into a slighter convexity. The costal pits (*pl*) are of a full elliptical form, with a slightly prominent margin, situated near the lower surface of the centrum, a little nearer the hind than the fore end, and with twice their own vertical diameter intervening between them and the base of the neurapophysis (*np*). This part of the side of the centrum is traversed by a low, longitudinal rising, a little nearer the neur- than the pleur-apophysis. The venous orifices on the under surface of the centrum (Tab. XV, fig. 4) are two and a half lines apart, with an intervening low, obtuse, longitudinal ridge, and are not situated in definite depressions. The lower border or base of the neurapophysis has not the angular form seen in *Pl. Hawkinsii* and *Pl. dolichodeirus*, but is curved. The neurapophysis rises, with both fore and hind borders vertically concave, transversely convex, about five lines above the centrum before giving off the anterior zygapophyses (*z*); the posterior arcs (*z'*) come off, as usual, a little higher. The neural spine is subquadrate, more angular between the fore and upper margins than in *Pl. rostratus* (Tab. X, fig. 1); the thickness of the spine is shown in Tab. XV, fig. 2; the front border is sharp. The chief variety observable in cervical vertebræ of the present species is the presence of the longitudinal groove bisecting the costal surface. The articular surface of the centrum in every cervical vertebra where it is exposed in the present skeleton repeats

the character of the one described; but some, at the base of the neck, have the central rising rough, and with a small pit in the middle. The same character is continued throughout the dorsal series, and the concavity is exaggerated in the vertebræ of the tail, which are, however, more concave than the others in all *Plesiosauri*.

	Ft.	In.
The total length of the specimen preserved is	10	6
The length of the cervical region preserved is	4	0
From the fore part of the coracoid to the hind part of the ischium	3	6
From the ischium to the end of the tail as far as preserved	3	3
The transverse breadth of the pubic bones across their broadest part is	1	$1\frac{3}{4}$
The fore-and-aft diameter of pubis at its middle part is	0	$5\frac{1}{2}$

Scapular arch and appendages (Tab. XIV).

The humerus (Tab. XIV, 53) is 10 inches long, $2\frac{1}{4}$ inches across its middle narrowest part, and $4\frac{3}{4}$ inches across its distal broadest part. The outer part of the head is somewhat produced, with a slight longitudinal depression on each side; its surface is tuberous and rough; there is a low tuberosity on the hind part of the humerus, below its head. The contour of the anterior border of the bone is nearly straight, slightly wavy, first concave, then convex, again concave and more convex as it is rounded off to the lower border. The posterior margin is more deeply concave from the upper tuberosity to the posterior angle, which is rounded off. The distal margin, convex in a general way, has its two surfaces sufficiently defined for the radius and ulna; they do not, however, meet at so well-defined an angle as in some species; a space of about an inch intervenes here between the radius and ulna in both right and left limbs, whereas they meet and touch each other in the *Pl. dolichodeirus* (fig. 5) and *Pl. Hawkinsii* (fig. 6). The shaft of the humerus shows a tolerably smooth and longitudinally fibrous surface, but has a rough tuberculate character for about an inch and a half from the distal articulations.

The radius (Tab. XIV, figs. 1 and 2, 54), 4 inches in length, is 2 inches 9 lines across the proximal end, 1 inch 10 lines across the distal end, 1 inch 6 lines across the middle. The radial or anterior margin is produced and somewhat thickened below the head, making the margin beyond it concave half way towards the distal end; the posterior or ulnar border is uniformly and moderately concave; the distal border of the radius is straight from its ulnar angle to near its radial one, where it becomes convex, that angle being, as it were, cut off. This distal border is most closely articulated, seems, indeed, partially confluent, with the scaphoid. The ulna (Tab. XIV, figs. 1 and 2, 55) would present its usual reniform shape, were it not that the proximal angle of the posterior or ulnar border is produced into a sort of olecranon (fig. 2, 55′). This process is separated by a fissure or fracture from the body of the bone; but as this

occurs in the same place and with the same course in both forearms, I infer it to be natural, and that the quasi-olecranon was of the nature of a sesamoid, closely articulated with the body of the ulna. The extreme length of the ulna, from the apex of this part or process (55′) is 5 inches; the greatest breadth of the ulna 3 inches. The proximal articular surface joins the ulnar facet of the humerus, beyond which the olecranon projects. The distal surface of the ulna articulates with the lunare (*l*), the cuneiforme (*c*), and with an ossicle (*p*) wedged into the interspace posteriorly between it and the ulna, which ossicle may represent the pisiforme. With the exception of about one third of the middle of the shaft, the exposed surface of both radius and ulna is roughened by coarse rugæ and small tubercles.

The carpus includes eight ossicles. The scaphoid (fig. 2, *s*) is an oblong bone, with its dimension greatest transversely, viz., 2 inches, longest at its ulnar side, which is 1 inch 3 lines, with a slight angular projection at its free radial border. The lunare (ib., *l*) is subreniform, with the concavity, representing the "pelvis of the kidney," completing the lower part of the inter-osseous space, for the radius and ulna are separate below as well as above, and for a greater extent, the radius extending for nearly an inch below or beyond the ulna. The rest of the circumference of the lunare is divided more or less distinctly into its articular surfaces for the radius, scaphoides (*s*), trapezoides (*z*), magnum (*m*), cuneiforme (*c*), and ulna. The ulnar surface has a sigmoid form. The lunare (*l*) is larger than the scaphoid. The cuneiforme (*c*), about the size of the lunare, has a subhexagonal shape; the two proximal sides articulate with the ulna and pisiforme (*p*), the radial side with the lunare, the ulnar side with the unciforme (*u*), the two distal sides with the magnum (*m*), and the base of the fifth metacarpal (*v*), which, as in some other *Plesiosauri*, ascends above the rest to this connection, severing, so to speak, the unciforme (*u*) from the magnum (*m*). The pisiforme (*p*) is a subtriangular small bone, wedged into the outer interspace between the ulna and cuneiforme. In the distal row of carpals the trapezium (*t*) is subquadrate, broader toward the scaphoid, narrower where it supports the first metacarpal (I); it is about half the size of the scaphoid. The trapezoides (*z*) is also subquadrate, but of larger size, articulating with the scaphoid, trapezium, the ulnar angle of the base of the first metacarpal, wholly sustaining the second metacarpal, articulating with the radial side of the base of the third metacarpal, with the os magnum (*m*), and with the lunare (*l*). The os magnum (*m*), of similar size, is hexagonal; the two proximal surfaces articulate with the lunare and cuneiforme, entering the angle which they leave; the two distal surfaces articulate with the third and fourth metacarpals; the radial side with the trapezoides, the ulnar side with the corresponding part of the base of the fifth metacarpal; the displaced outermost bone of the distal row is limited to its articulation with the ulnar border of the cuneiforme (*c*); it is the smallest of the carpal series.

The bones of the digits are small in comparison with those of the carpus and forearm. The entire breadth of the carpus being 6 inches 5 lines, that of the middle of

the metacarpus is 5 inches in the left hand, and but $4\frac{1}{2}$ inches in the right, both being preserved in their natural connections as they were buried, but one showing a more expanded, the other a more contracted, condition of the fin.

The first metacarpal (Tab. XIV, fig. 2, I) is 1 inch 9 lines in length, and supports two phalanges; the total length of that digit, including the metacarpal, being 4 inches 3 lines. The second metacarpal (ib., II) is 2 inches 3 lines in length; it supports five phalanges; the total length of the digit, including the metacarpal, is 9 lines. The third metacarpal (ib., III) is 2 inches 8 lines in length; it supports five phalanges; the total length of the digit, including the metacarpal, is 9 inches 9 lines. The fourth metacarpal (ib., IV) is 2 inches 5 lines in length; it supports four phalanges, and is the same length with the preceding. The fifth metacarpal (ib., V) is 3 inches 3 lines in length, with its ulnar margin more deeply concave than in the others; it supports four phalanges, most of which show the same deeper concavity, with a greater production of the ulnar ends of the articular expansions; the total length of this digit is 8 inches 6 lines; a distal phalanx is wanting in it, and the same may likewise be the case with the others.

There is a want of precise symmetry in the proportions of the right and left fore paddles, those of the right being longer and somewhat slenderer than those of the left.

The whole of the outer surface of the carpal bones is rugose, as is the chief part of that of the metacarpals and phalanges. The total length of the bones of the right pectoral limb, as here preserved, is 2 feet 3 inches; the breadth of the antibrachium is 6 inches 6 lines; that of the carpus 6 inches; that of the metacarpus 5 inches; the interspace between the heads of the two humeri is 1 foot 6 lines.

Pelvic arch and limbs (ib.).

The iliac bones (Tab. XIV, fig. 1, 62), dislocated by pressure, lie in the axis of the trunk, parallel with the ischia (ib., 63); the vertebral end of the ilium is broader but less thick than the acetabular one; the length of the bone is 4 inches 10 lines, the breadth of the vertebral end is 3 inches 6 lines; the breadth of the acetabular end is 2 inches. The surface here exposed, probably the outer or posterior one, shows a slight concavity on the vertebral expansion, where the bone is smooth; beyond, it becomes longitudinally striate, and rugose or tuberculate near the acetabular extremity; this is thickened and obscurely divided into the rough synchondrosal surface for the ischium, and the corresponding somewhat smaller surface for the ligamentous attachment of the femur.

The ischium (ib., 63) is flat, and of the usual elongate, triangular form; it joins its fellow by its straight inner side having the posterior angle rounded off; the outer, obtuse, non-articular border presents a sigmoid curve, concave near the ilium. The anterior shorter border is emarginate in the middle, where it forms the posterior boundary of the obturator foramen (ib., o), the straight articular parts of this side

joining the corresponding parts of the pubis; the outer acetabular angle is produced, and terminally expanded and thickened to form the articular surfaces for the ilium and femur.

The pubis (ib., 64), as in other *Plesiosauri*, is broader and larger than the ischium, with the medial or symphysial margin straight, measuring six and a half inches in extent; the anterior and external free margin is convex; the posterior margin is more deeply excavated than the opposite one of the ischium, forming a greater part of the circumference of the obturator foramen; the angle between the posterior and outer borders is thickened, to contribute the anterior part of the acetabulum. This rough and ill-defined articular surface for the femur is thus formed, as usual, by the three constituents of the pelvis.

The femora (ib., 65) here, as in some other *Plesiosauri*, have the head resting against the ischio-pubic part of the acetabulum, the ilia being placed about an inch further back. The femur, 10 inches in length, is 1 inch 9 lines across the narrowest part of the shaft, and expands to a breadth of 4 inches 9 lines distally; the outer (here the upper) part of the head is produced, and behind it is a longitudinal depression. The surface, for two inches or more from the distal end, is rugose, with longitudinal ridges breaking up into tubercles; both anterior and posterior borders are concave; the latter is the shorter border. The distal border is more regularly convex, and in a greater degree than in the humerus.

There is an interval between the proximal ends of the tibia and fibula, and a wider one between their distal ends, the interosseous space being considerable, as in the forearm. Here, also, the tibia (ib., 66), like its homotype (ib., 54), has a more distal extension. Its length is 3 inches 11 lines, its proximal breadth 2 inches 8 lines. The anterior proximal angle is somewhat produced; the anterior orbital border is slightly concave; the posterior one is more so. The fibula (ib., 67), like the ulna, departs from the ordinary reniform figure by the production of its fibular proximal angle (67′); this is not separated from the rest of the bone in the left leg, but it is so by what appears to be a crack in the right leg, and yet so as to indicate that such crack is in the place of an original epiphysial junction. The length of the fibula, including this process, is 4 inches 4 lines; the length of the concave tibial border of the fibula in a straight line is 2 inches 3 lines. As great a proportion of the exposed surface of the leg bones is rugose as is that in the bones of the forearm. Between the tibia and the tarsal bone supporting the first metatarsal there is a vacant space in both limbs, which, in the right limb, is partially occupied by a tubercle of bone. This we may regard as the beginning of ossification of a fibro-cartilaginous homologue of a naviculare (Tab. XIV, fig. 3, *s*). The homotype of the lunare (*a*) completes, by a free concave part of its border, the distal end of the inter-osseous space. This tarsal (*a*), which we may call "astragalus," articulates with the tibia (66); but to a greater extent and by a more definite straight border, with the fibula (ib., 67); posteriorly with the

calcaneum (*cl*), distally with the two outer bones of the distal row of tarsals. The bone (*cl*) which I have called "calcaneum" is the homotype of the cuneiforme in the carpus, which it resembles in size and shape; it articulates chiefly with the astragalus (*a*) and ecto-cuneiforme (*ec*); it seems to touch the fibula (67) by a small part of its periphery; and in the angle between it and the fibula is wedged an ossicle (*cl'*), answering to the pisiforme in the wrist and to the apophysial part of the calcaneum in the higher Vertebrates. The distal row of tarsals includes but three bones. The first (*ci*), the homotype of the trapezium, I call "ento-cuneiforme;" it articulates with the rudiment of the naviculare (*s*), and supports the metatarsal of the tibial or first toe (*i*). The next bone, "meso-cuneiforme" (*cm*), of larger size, supports the second and part of the third metatarsal, articulates with the ento-cuneiforme (*ci*), and more intimately and largely with the ecto-cuneiforme (*ce*). This (*ce*) is the largest of the three; it supports the fibular half of the base of the middle metatarsal, the whole of the base of the fourth metatarsal, and the tibial side of the base of the fifth metatarsal; it articulates also with the meso-cuneiforme (*cm*), astragalus (*a*), and calcaneum (*cl*); it is plainly the homotype of the os magnum in the wrist. The homotype of the unciforme, if it existed, must have articulated with the posterior or fibular margin of the calcaneum, but it is not present in either limb.

If we regard the largest of the distal tarsal series, supporting the fourth and part of the third and fifth metatarsals, as the "cuboides," we must then consider its obvious homotype in the wrist (*m*) to be the unciforme. The bone here called "meso-cuneiforme" (*cm*), which articulates with both second and third metatarsals, will then be the "ecto-cuneiforme," and the bone (*ci*) will be the two other cuneiform bones connate; in like manner its homotype, called "trapezoides" in the wrist, which has a similar relation to the second and third metacarpals, will be the trapezoid and trapezium connate, but in that case the outermost ossicle (fig. 2, *u*) of the distal part of the carpus would be a supernumerary without a name. I therefore prefer and adopt my first homologies.

The outer surface of the tarsals, except the middle of the calcaneum, is rugose. The first metatarsal (ib., *i*) is 1 inch 9 lines in length; it supports two phalanges; the total length of the toe, including the metatarsal, is 4 inches 9 lines. The length of the second metatarsal is 2 inches 3 lines; three of its phalanges are preserved; it is more distal in position than the first by about 4 lines. The middle metatarsal is 2 inches 5 lines in length; four of its phalanges are preserved. The fourth metatarsal, 4 inches 6 lines in length, has the fibular part of its base more extended, and that margin of the shaft is more concave; four phalanges are preserved, and the length of the digit, including the metatarsal, is 10 inches. The fifth metatarsal is 2 inches 5 lines in length; the tibial angle of its base is truncate, the fibular one is much produced and tuberous; the fibular margin is deeply concave; only one phalanx is preserved.

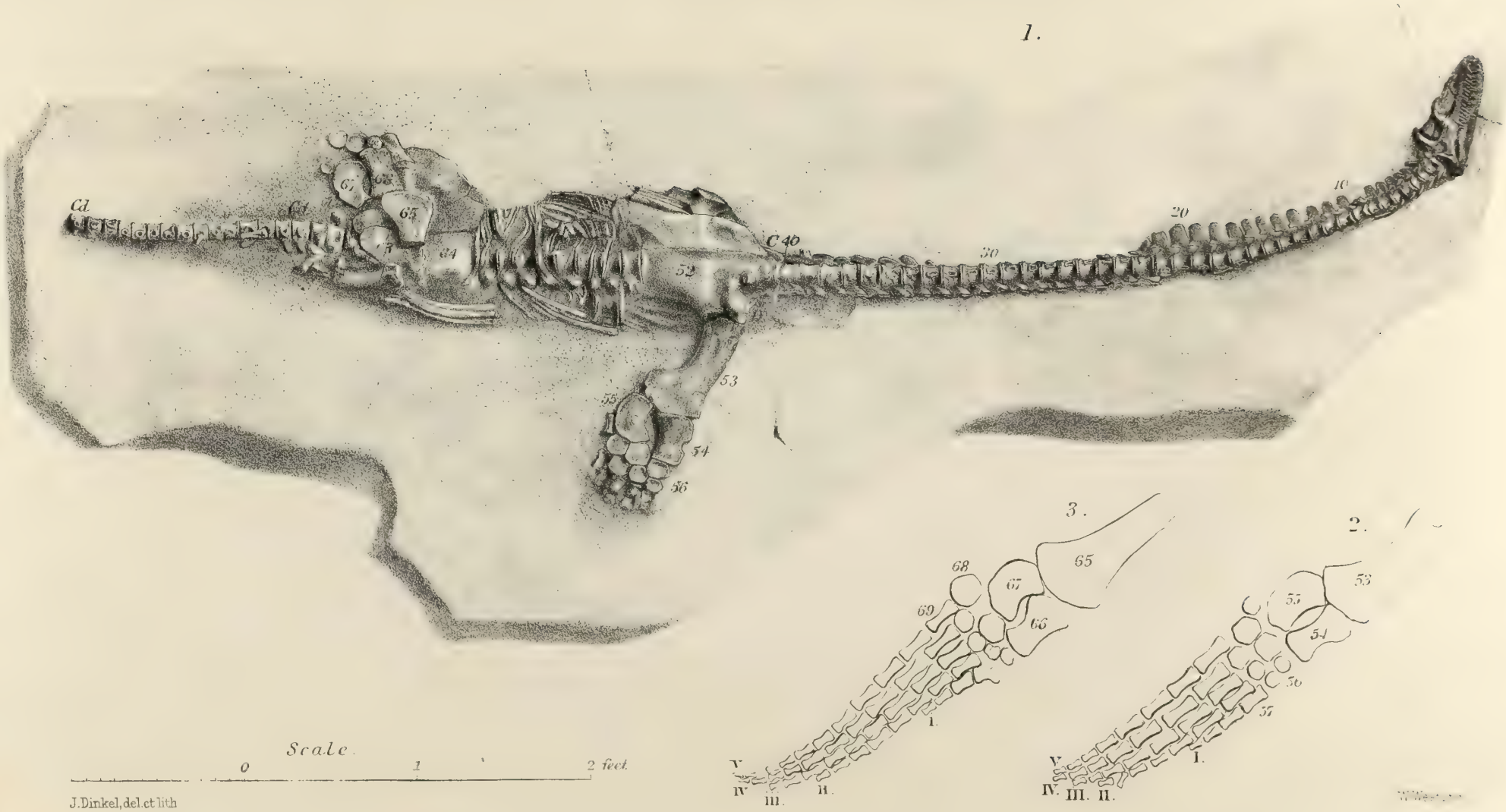
TAB. I.

Plesiosaurus dolichodeirus.

Fig.

1. Skeleton (No. 3), 1-10th nat. size.
2. Outline of bones of fore paddle of the skeleton described by CONYBEARE (p. 1), 1-8th nat. size.
3. Outline of bones of hind paddle, ib., ib.

From the Lower Lias of Lyme Regis. In the British Museum.



J. Dinkel, del. et lith

PLESIOSAURUS DOLICHODEIRUS.

TAB. II.

Plesiosaurus dolichodeirus.

Side view of the skull of the skeleton in Tab. I, nat. size.

From the Lower Lias of Lyme Regis. In the British Museum.

J. Dunker, del. et lith.

W. Kohler, imp.

PLESIOSAURUS DOLICHODEIRUS.

T. II.

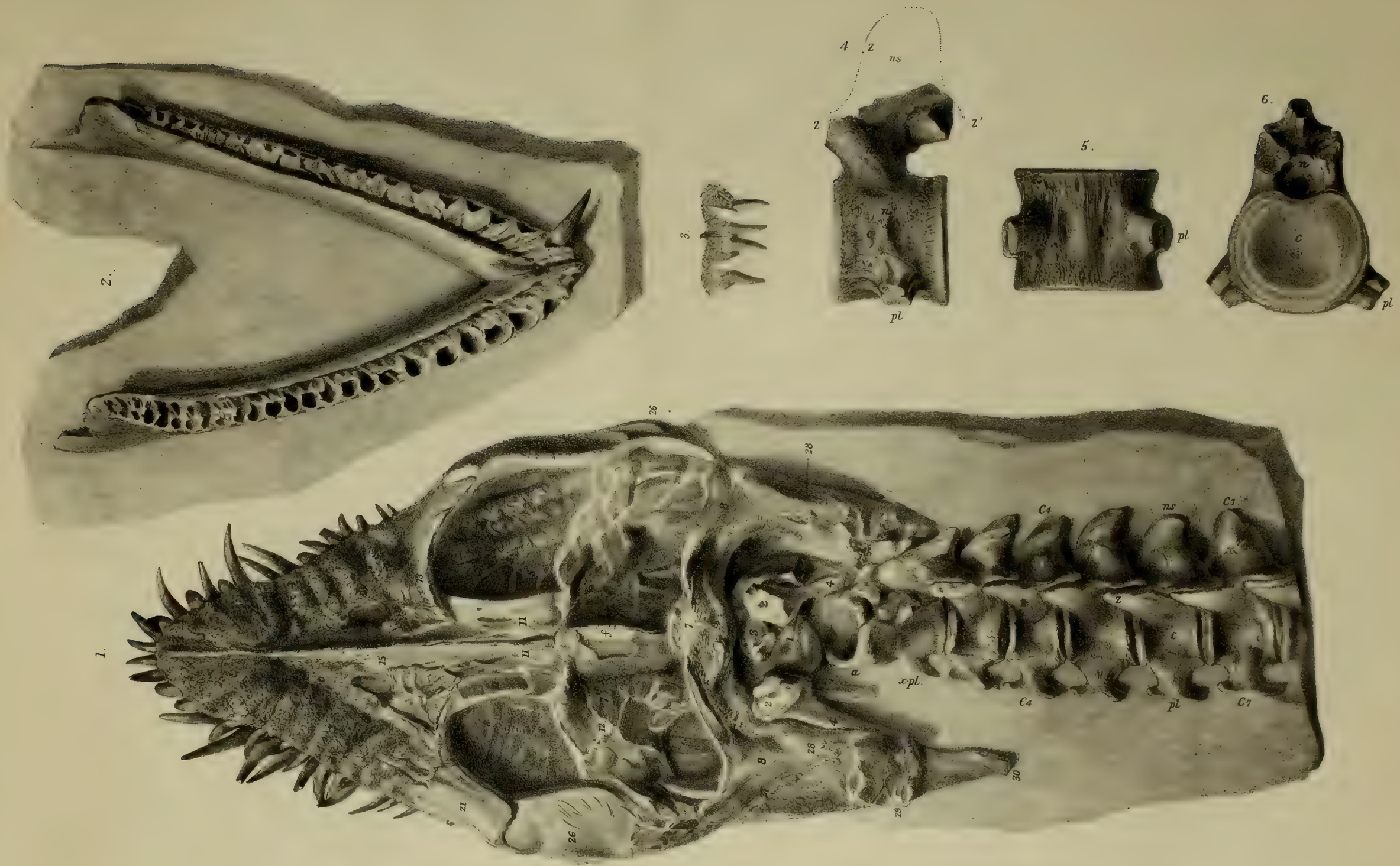
TAB. III.

Plesiosaurus dolichodeirus, nat. size.

Fig.

1. Skull and seven cervical vertebræ.
2. Dentary elements of lower jaw.
3. Front view of premaxillaries and interlocked fore teeth of both jaws, those of the lower in outline.
4. Middle cervical vertebra, side view.
5. Ib., under view.
6. Ib., front view.

From the Lower Lias of Charmouth. In the British Museum.



J. Dinkel, del et lith.

W. West, imp

PLESIOSAURUS DOLICHODEIRUS, Cb.

TAB. IV.

Plesiosaurus dolichodeirus, nat. size.

Fig.

1. Dorsal vertebra, side view.
2. Ib., back view.
3. Tenth caudal vertebra, side view.
4. Ib., under view of centrum.
5. Ib., back view.
6. Twelfth caudal vertebra, side view.
7. Ib., under view of centrum.
8. Ib., back view.
9. Thirtieth caudal vertebra, back view.

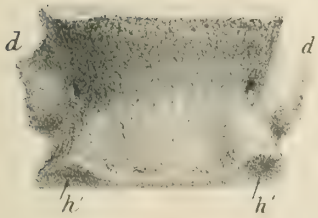
From the Lower Lias of Charmouth. In the British Museum.

3.

1.

5.

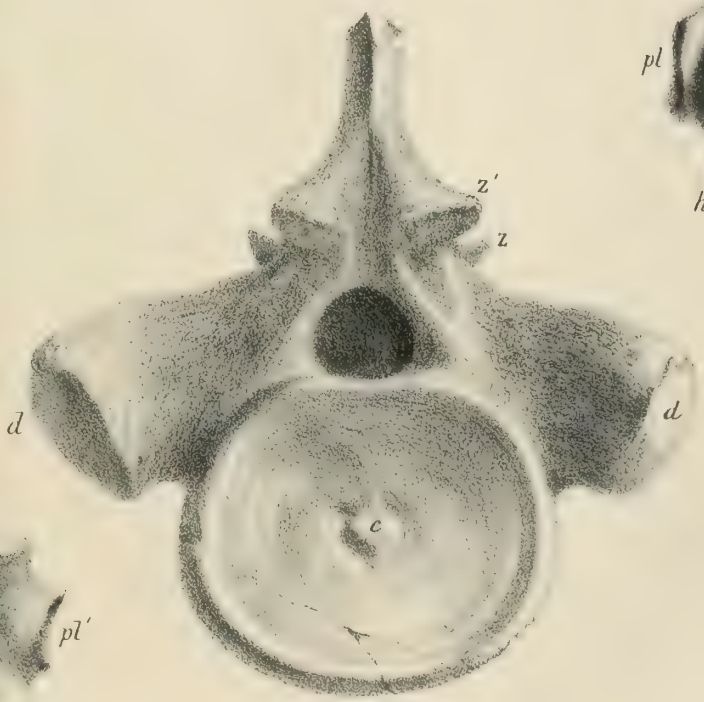
4.



8.

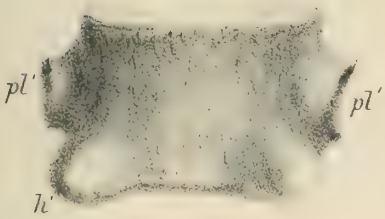
6.

2.



9.

7.



J. Dinkel, del. et lith.

W. West, imp.

PLESIOSAURUS DOLICHODEIRUS.

TAB. V.

Plesiosaurus homalospondylus.

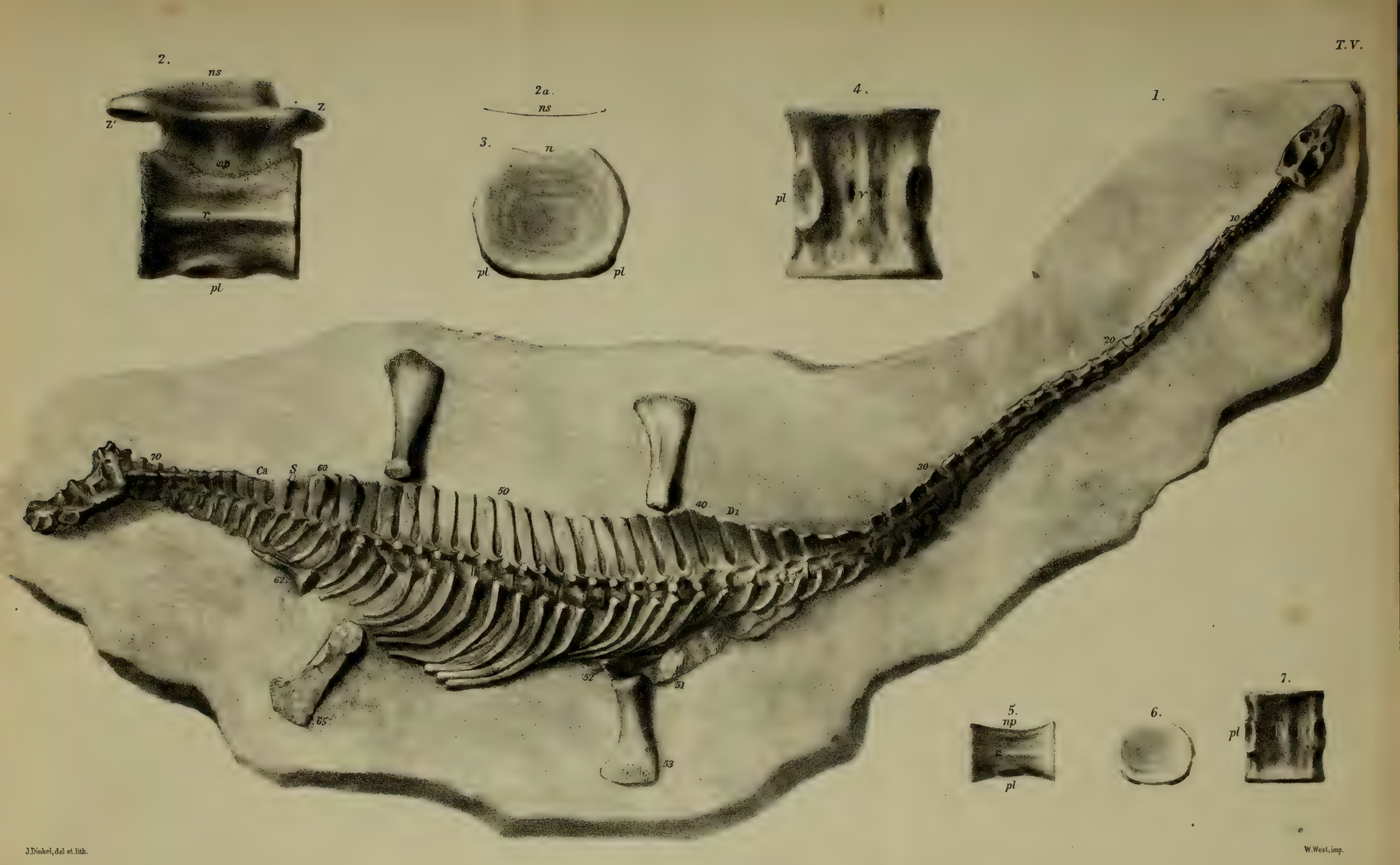
Fig.

1. Skeleton, about 1-10th nat. size.
2. Thirteenth cervical vertebra of ditto, side view., nat. size.

2A. Ib., section of neural spine, ib.

3. Ib., posterior surface of centrum, ib.
4. Fourteenth cervical vertebra, under view, ib.
5. Centrum of third cervical vertebra, side view, ib.
6. Ib., posterior surface, ib.
7. Centrum of eighth cervical vertebra, under view, ib.

From the Upper Alum Shale, Lias, Whitby. In the British Museum.



J.Dinkel, del et lith.

W.West, imp.

0 1 2 Fuß.

PLESIOSAURUS HOMALOSPONDYLUS.

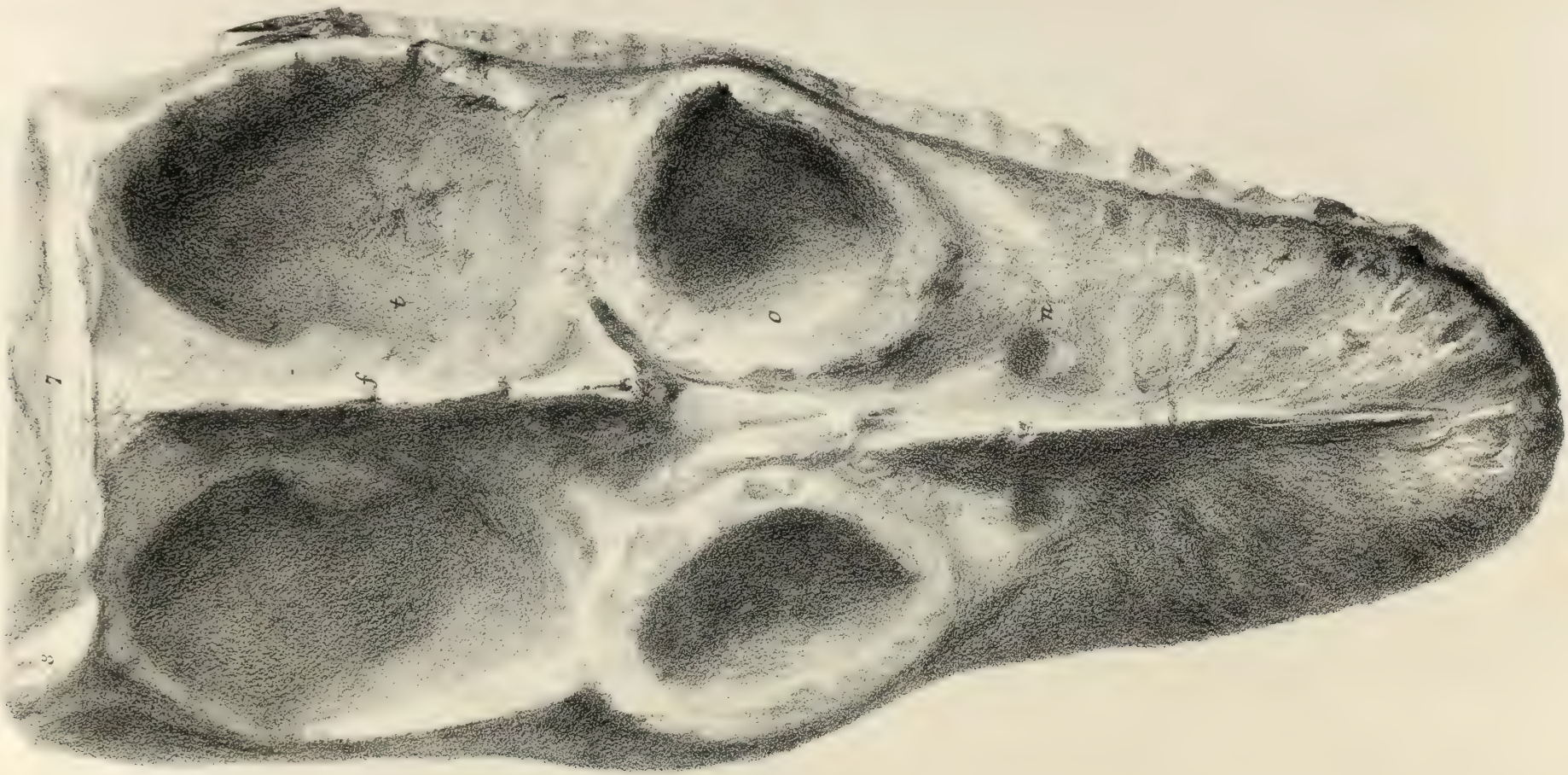
TAB. VI.

Plesiosaurus homalospondylus.

Upper view of the skull of the skeleton, Tab. V, nat. size.

From the Upper Alum Shale, Lias, Whitby. In the British Museum.

T. VI.



J. Linkel. del. et lith.

W. West, imp

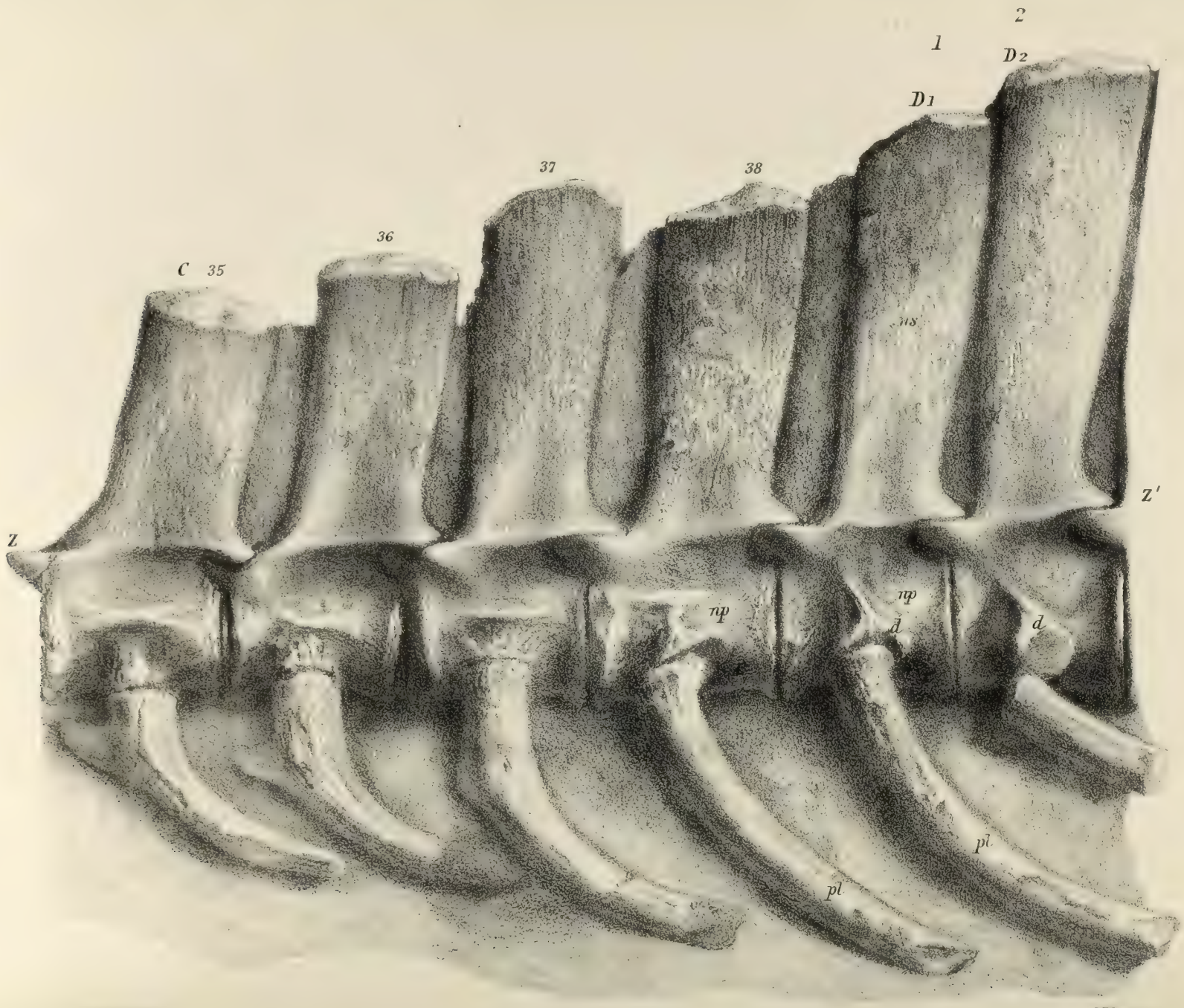
PLESIOSAURUS HOMALOSPONDYLUS.

TAB. VII.

Plesiosaurus homalospondylus, half nat. size.

Four last cervical and first two dorsal vertebræ of the skeleton, Tab. V, half nat. size.

From the Upper Alum Shale, Lias, Whitby. In the British Museum.



3.

J. Dinkel, del. et lith.

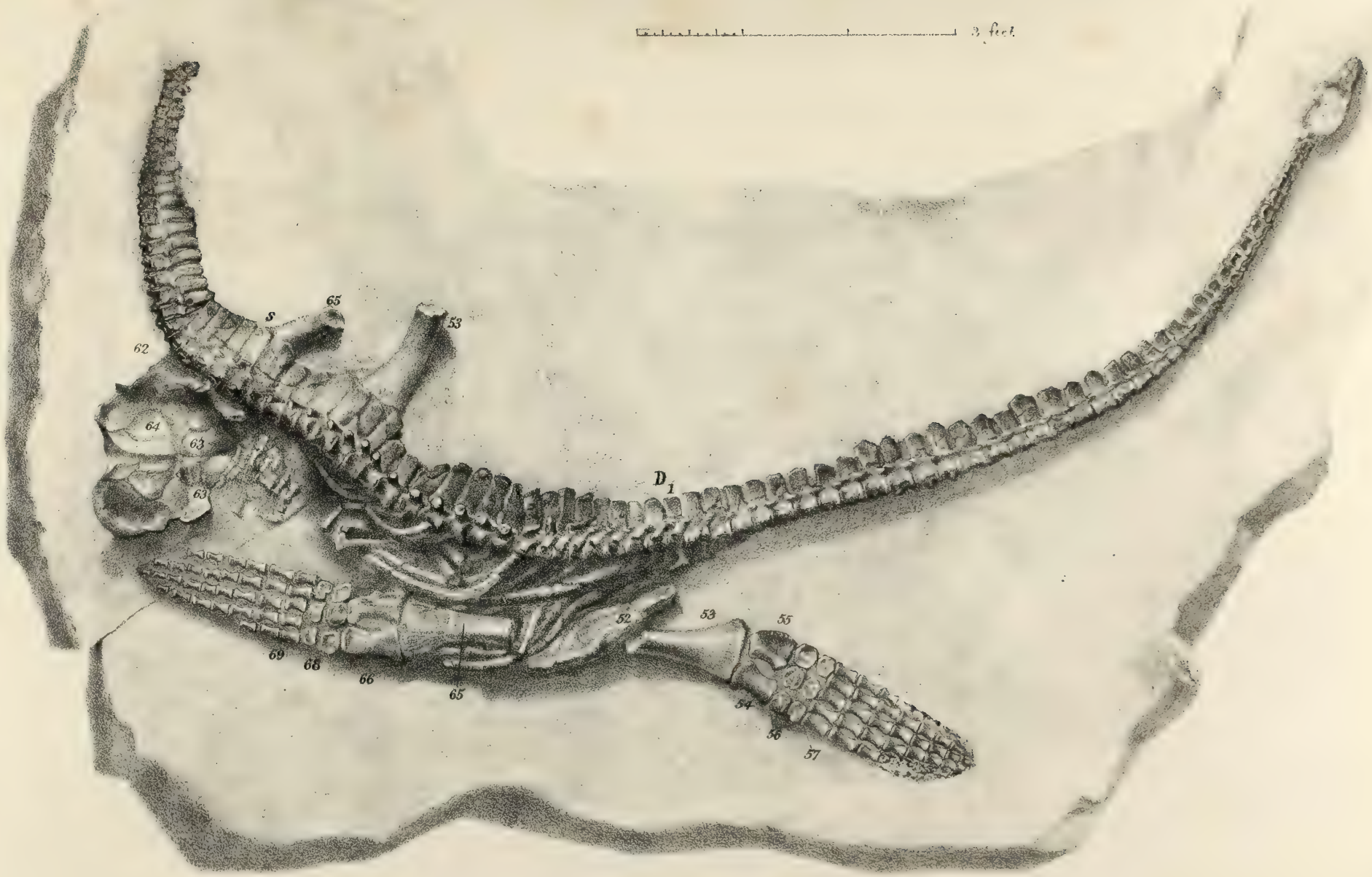
W. West, imp.

PLESIOSAURUS HOMALOSPONDYLUS.

TAB. VIII.

Plesiosaurus homalospondylus (reduced to scale).

From the Upper Alum Shale, Whitby. In the Museum of the Philosophical Society, York.



PLESIOSAURUS HOMALOSPONDYLUS

W. West imp.

TAB. IX.

Plesiosaurus rostratus.

Fig.

1. Skeleton (reduced to scale).
2. Right dentary bone and teeth, external and internal surfaces of lower jaw, ib.
3. Crown of the tooth of left dentary, nat. size.
4. Crown of the tooth of left dentary, nat. size.
5. Crown of fourth tooth of right dentary, nat. size.
6. Crown of hind tooth of left dentary, nat. size.
7. Crown of sixth tooth of right dentary, nat. size.
8. Crown of hind tooth of right dentary, nat. size.
9. Crown of ninth tooth of left dentary, nat. size.

From the Lower Lias of Charmouth. In the British Museum.

J. Dinkel, del et lith

W West, imp

PLESIOSAURUS ROSTRATUS

TAB. X.

Plesiosaurus rostratus, nat. size.

Fig.

1. Side view of the fifteenth cervical vertebra.

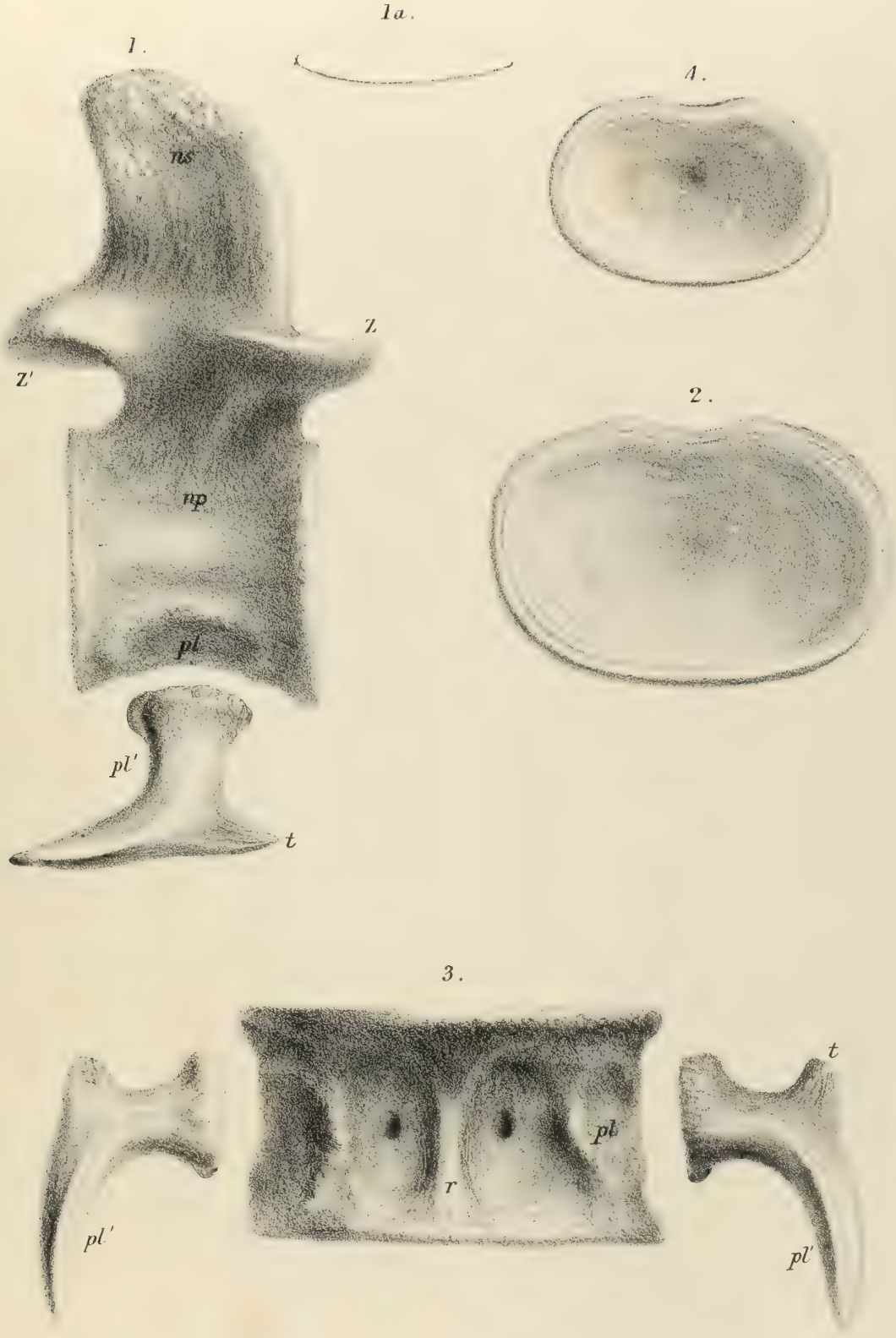
1A. Section of neural spine.

2. Posterior articular surface of centrum of cervical vertebra.

3. Inferior surface of centrum and pleurapophyses.

4. Posterior articular surface of centrum of cervical vertebra.

From the Lower Lias of Charmouth. In the British Museum.



J. Dinkel, del. et lith.

W. West, imp.

PLESIOSAURUS ROSTRATUS.

TAB. XI.

Plesiosaurus rostratus, nat. size.

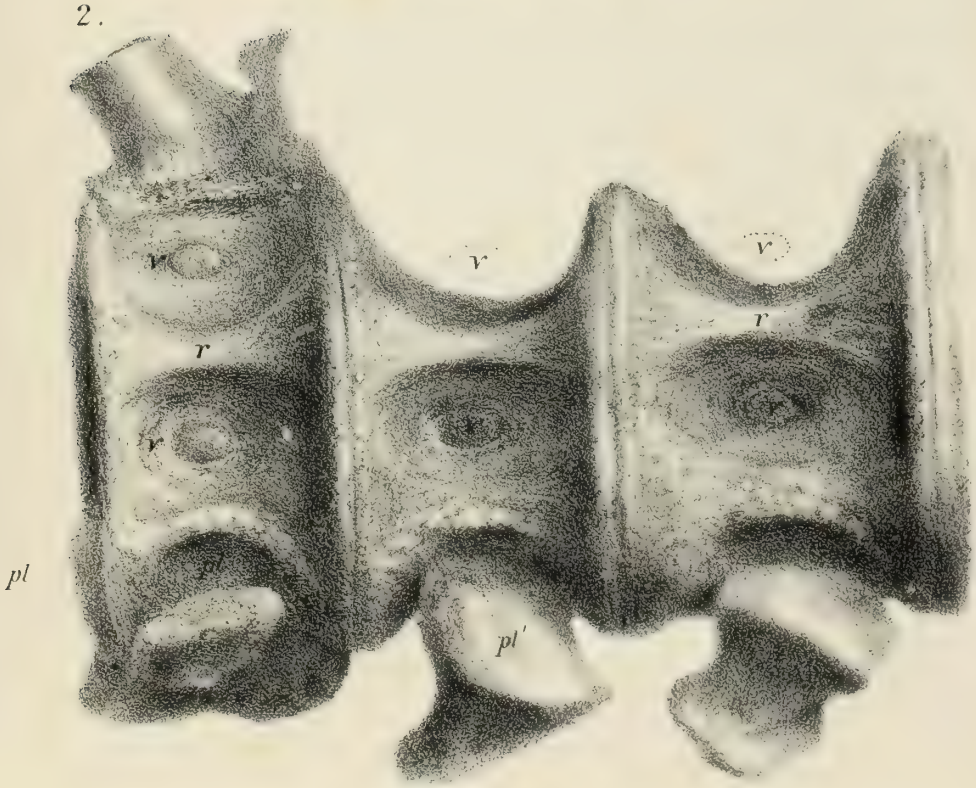
Fig.

1. Side view of the sixteenth, seventeenth, and eighteenth cervical vertebræ, partially dislocated.
2. Under view of ditto.

From the Lower Lias of Charmouth. In the British Museum.

1.

2.



J. Dinkel, del. et lith.

W. West, imp.

PLESIOSAURUS ROSTRATUS.

TAB. XII.

Plesiosaurus rostratus, nat. size.

Side view of the five last cervical and first dorsal vertebræ.

From the Lower Lias of Charmouth. In the British Museum.

J. Dinkel, del. et lith.

W. West imp

PLESIOSAURUS ROSTRATUS.

TAB. XIII.

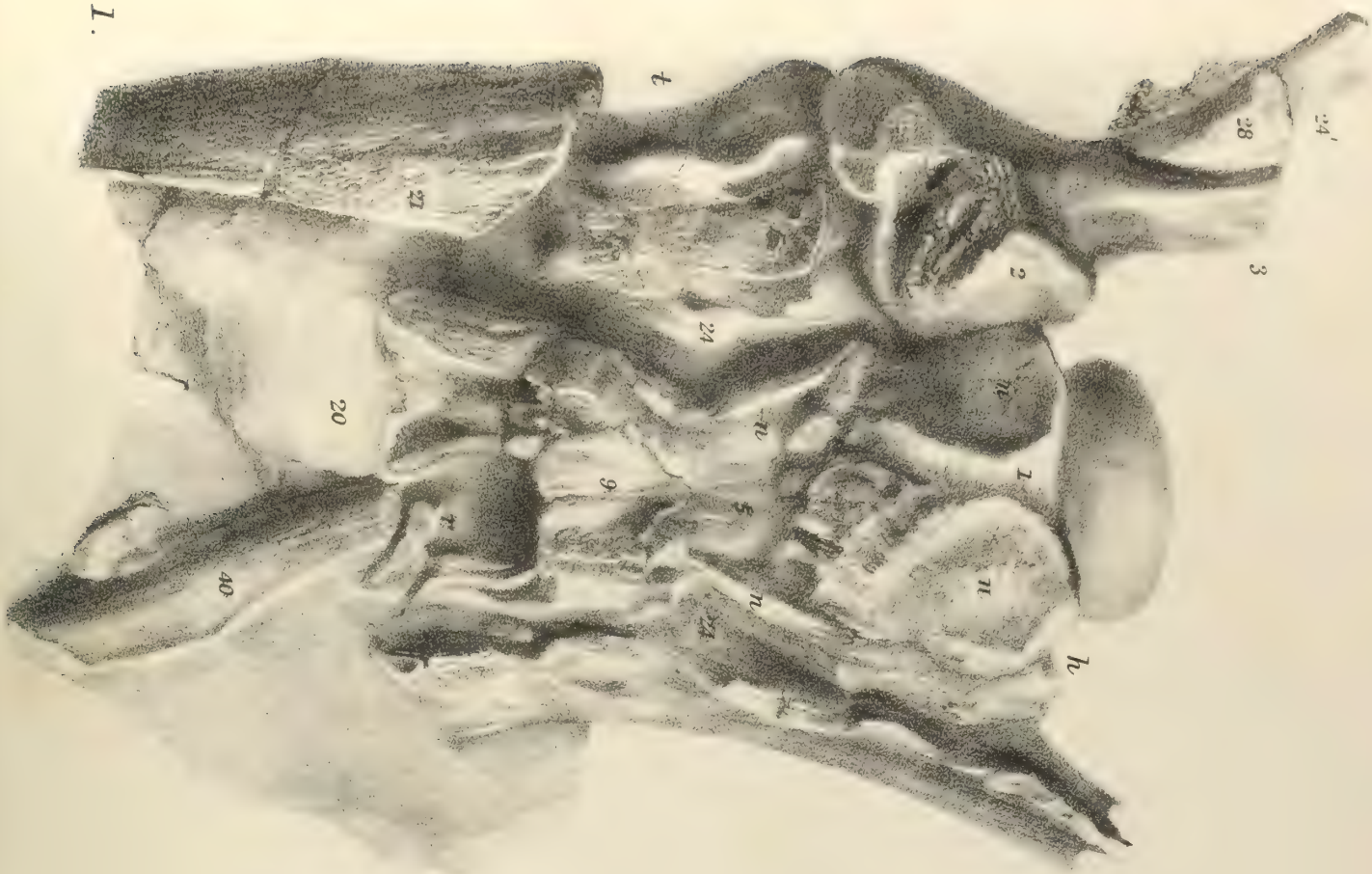
Plesiosaurus rostratus, nat. size.

Fig.

1. Upper view of basal portion of skull.
2. Under view of ditto.

From the Lower Lias of Charmouth. In the British Museum.

1.



2.

J. Dinkel, del. et lith.

W. West, imp.

PLESIOSAURUS ROSTRATUS.

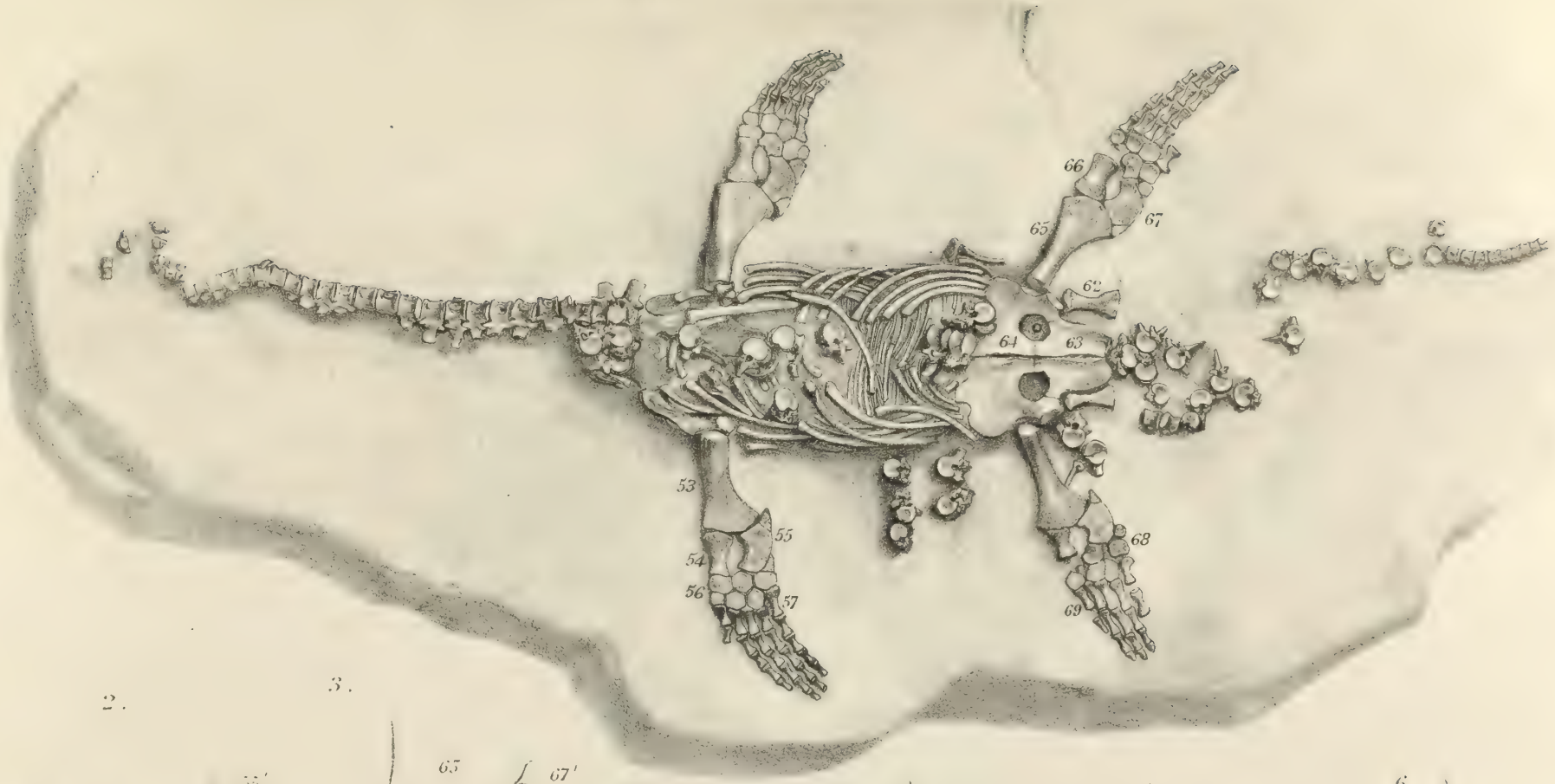
TAB. XIV.

Fig.

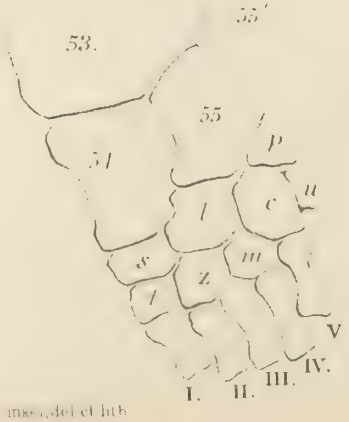
1. Skeleton of *Plesiosaurus rugosus,* 1-14th nat. size.
2. Bones of forearm, carpus, and metacarpus, of ditto; in outline, 1-6th nat. size.
3. Bones of leg, tarsus, and metatarsus, of ditto; in outline, 1-6th nat. size.
4. Bones of forearm, carpus, and metacarpus, of *Plesiosaurus macrocephalus;* in outline, 1-6th nat. size.
5. Bones of forearm, carpus, and metacarpus, of *Plesiosaurus dolichodeirus;* in outline, 1-6th nat. size.
6. Bones of forearm, carpus, and metacarpus, of *Plesiosaurus Hawkinsii;* in outline, 1-6th nat. size.

The skeleton of the *Plesiosaurus rugosus* is from the Lower Lias of Leicestershire. In the British Museum.

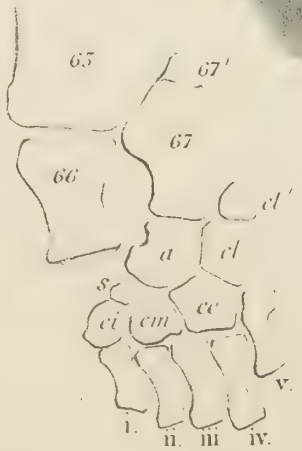
1.



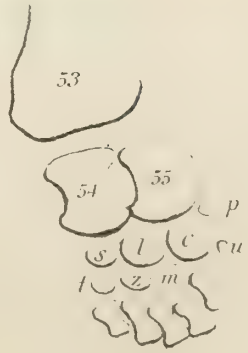
2.



3.

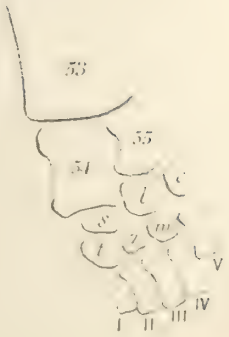


4.



5.

6.



PLESIOSAURUS RUGOSUS.

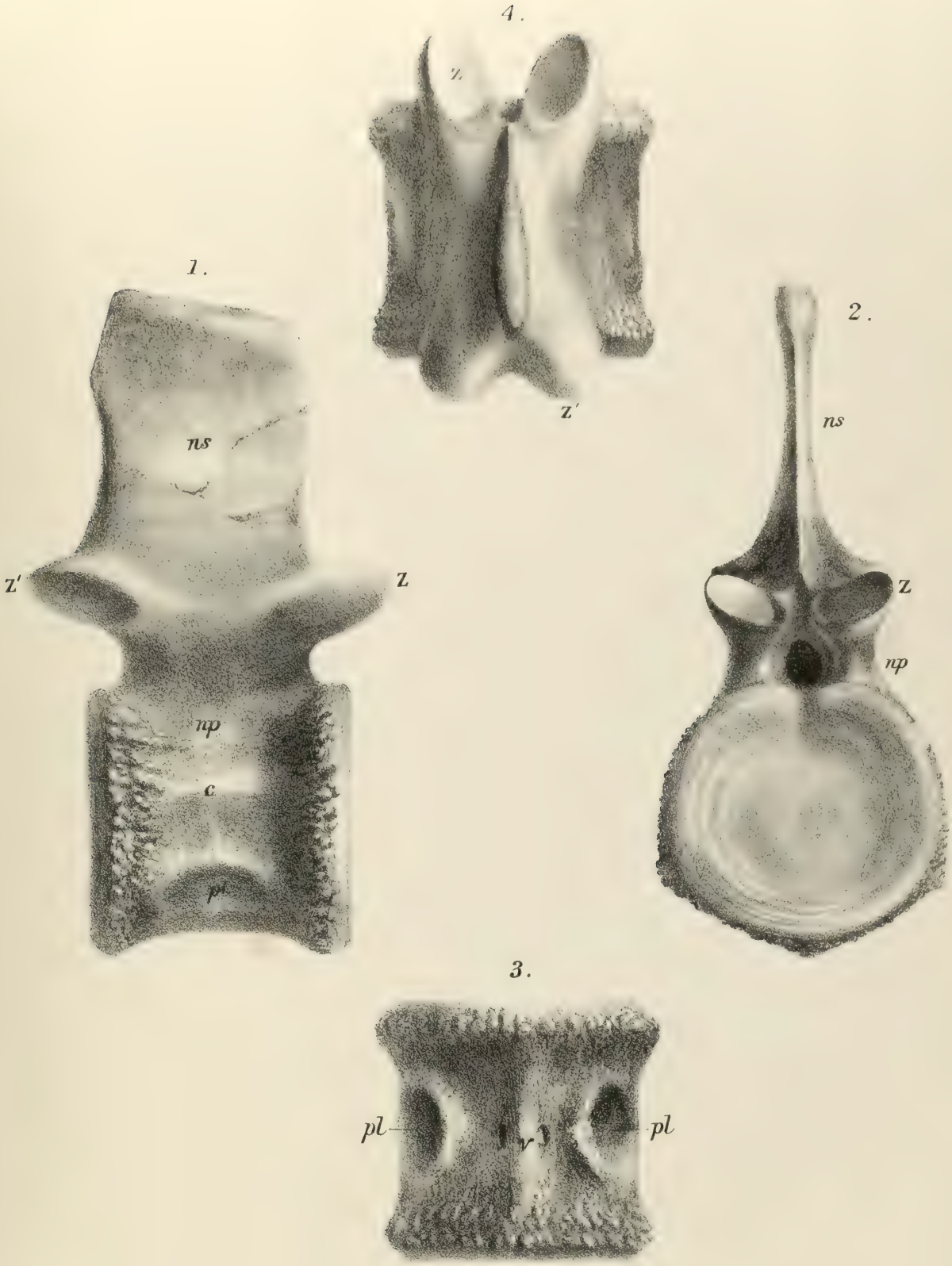
TAB. XV.

Plesiosaurus rugosus, nat. size.

Fig.

1. Side view of the fifteenth cervical vertebra.
2. Front view of ditto.
3. Under view of ditto.
4. Upper view of ditto.

From the Lower Lias of Leicestershire. In the British Museum.



J.Dinkel, del. et lith.

W.West, imp.

PLESIOSAURUS RUGOSUS.

TAB. XVI.

Plesiosaurus Hawkinsii, nat. size.

Fig.
1. Oblique side view of skull.
2. Under view of skull.

In comparison with the skull of *Plesiosaurus dolichodeirus*, Tabs. II and III, these figures exemplify the specific distinction of *Ples. Hawkinsii* in the greater longitudinal extent of the temporal fossæ, and in the greater relative length and slenderness of the muzzle or facial part of the skull, the sides of which converge at a more acute angle and are more concave. The symphysis of the mandible is longer in *Pl. Hawkinsii*. The teeth in both jaws are relatively larger and longer in *Plesiosaurus dolichodeirus*. As compared with *Plesiosaurus rostratus*, Tabs. IX and XIII, the facial part of the skull is relatively shorter in *Plesiosaurus Hawkinsii*; the pterygoids do not extend quite so far back; the "palatonares," Tab. XVI, fig. 2, *r*, *r*, are smaller, with more rounded ends of the ellipse.

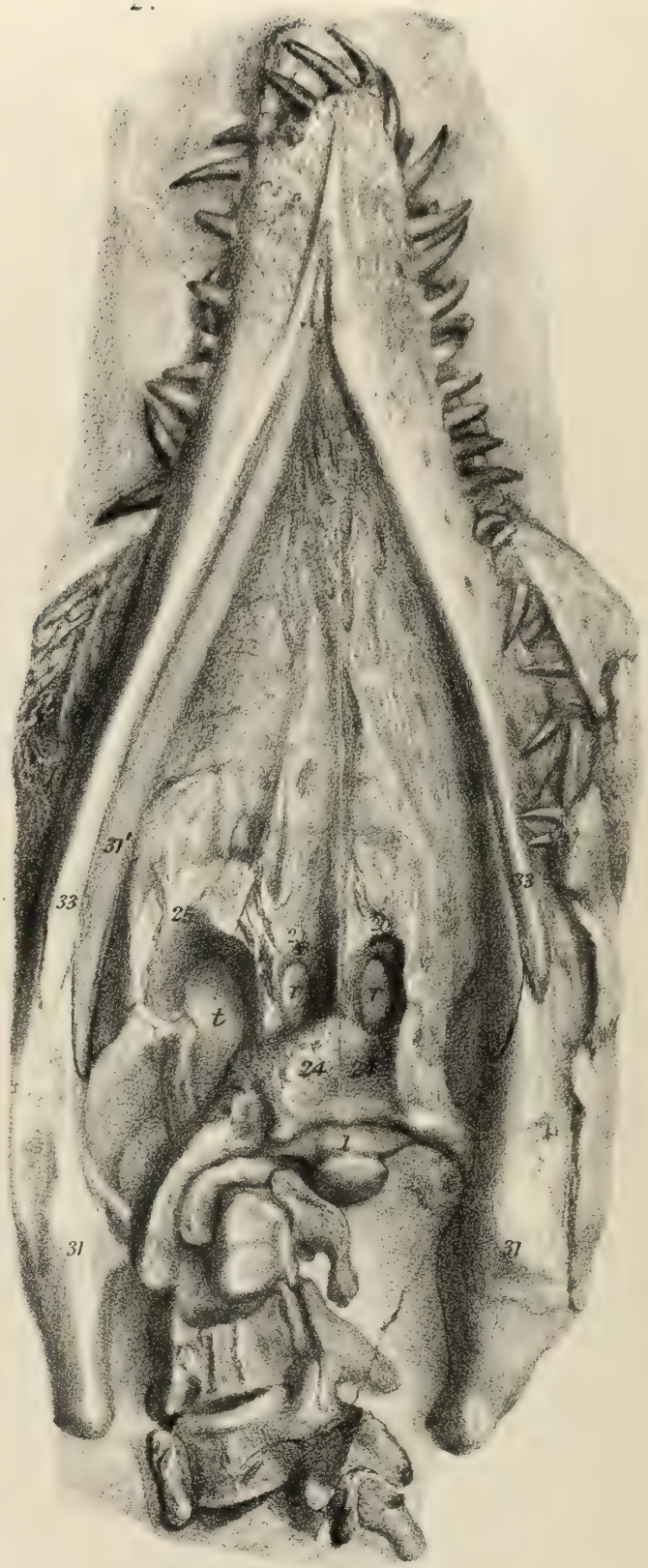
The following bones are indicated by the figures:

1. Basi-occipital.
2. Par-occipital.
7. Parietal (near the "foramen parietale").
7'. Ib., "supra-mastoid process."
8. Mastoid.
11. Frontal.
15. Nasal (above the external nostril).
20. Palatine.
24. Pterygoid.
25. Ecto-pterygoid.
26. Malar.
27. Squamosal.
28. Tympanic.
31. Angular.
31'. Splenial.
33. Dentary.

The skulls here figured are from the Lias of Street, Somersetshire. In the British Museum.

1.

2.



J.Dinkel, del. et lith.

W.West, imp

PLESIOSAURUS HAWKINSII.