PALÆONTOGRAPHICAL SOCIETY.

VOL. XVIII.

OOLITIC ECHINODERMATA.

VOL. II, PART II.

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TRILOBITES.

PART III.

CAMBRIAN AND SILURIAN.

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PART I.

INTRODUCTION; FELIS SPELÆA.

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ISSUED FOR 1864.

PALÆONTOGRAPHICAL SOCIETY.

VOLUME XVIII.

ISSUED FOR 1864.

MARCH, 1866.

LIST

OF

The Council and Secretaries

OF THE

PALÆONTOGRAPHICAL SOCIETY,

AND

A CATALOGUE OF THE WORKS ALREADY PUBLISHED; WITH A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED, IN PREPARATION, AND IN COURSE OF PUBLICATION.

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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 1, 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. I, Oolitic and Liassic, by Mr. Davidson, 13 plates.
,, V.	,, 1851	The Reptilia of the Cretaceous Formations, by Prof. Owen, 39 plates.
		The Fossil Corals, Part II, Oolitic, by Messrs. Milne-Edwards and Jules Haime, 19 plates.
		The Fossil Lepadidæ, by Mr. Charles Darwin, 5 plates.
,, VI.	,, 1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne-Edwards and Jules Haime, 16 plates.
		The Fossil Brachiopoda, Part I, Tertiary, by Mr. Davidson, 2 plates.
		The Fossil Brachiopoda, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates.
		The Fossil Brachiopoda, Part III, No. 2, Oolitic and Liassic, by Mr. Davidson, 5 plates.
		The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates.
		The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates.
,, VII.	,, 1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne-Edwards and Jules Haime, 10 plates.
		The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates.
		The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates.
		The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates.
		The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates.
		The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen, 9 plates.
,, VIII.	,, * 1854	The Fossil Brachiopoda, Part II, No. 2, Cretaceous, by Mr. Davidson, 8 plates.
		The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen, 20 plates.
		The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates.
		The Fossil Corals, Part V, Silurian, by Messrs. Milne-Edwards and Jules Haime, 16 plates.
		The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates.
		The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates.
		The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates.
,, IX.	,, † 1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates.
		The Reptilia of the Wealden Formations, Part III, by Prof. Owen, 12 plates.
		The Eocene Mollusca, Part III, No. 2, Prosobranchiata continued, by Mr. F. E. Edwards, 4 plates.
		The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates.
		The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates.
		The Fossil Echinodermata, Part I, Oolitic, by Dr. Wright, 10 plates.

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

CATALOGUE OF WORKS—Continued.

Volume	Year	Works
Vol. X. Issued for the Year	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 Formations, Part IV, by Prof. Owen, 11 plates. The Reptilia of the London Clay (Supplement), by Prof. Owen, 2 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 Formations, 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 Formations, 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.
„ XVIII. „	1864	The Fossil Echinodermata, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright, 6 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter, 11 plates. The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips, 7 plates. The Pleistocene Mammalia, Part I, Introduction, Felis Spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford, 5 plates. Title-pages, &c., to the Reptilia of the London Clay, Cretaceous, and Wealden Formations.

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 Entomostraca, 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, Carboniferous, and Devonian 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.

MONOGRAPHS which are in course of Preparation :*—

The Flora of the Carboniferous Formation, by Professor Morris and Mr. E. W. Binney.
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 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 Phyllopoda of the Palæozoic Rocks, 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 Silurian Brachiopoda, by Mr. Davidson.
The Post-Tertiary Mollusca, by Mr. J. Gwyn Jeffreys.
The Cretaceous Mollusca (exclusive of the Brachiopoda), by the Rev. T. Wiltshire.
The Purbeck Mollusca, by Mr. R. Etheridge.
The Ammonites of the Lias, by Dr. Wright.
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lancaster.
The Crag Cetacea, by Professor Owen.
The Inferior Oolite Mollusca, by Mr. R. Etheridge.
The Rhætic Mollusca, by Mr. R. Etheridge.
The Liassic Gasteropoda, by Mr. Ralph Tate.

MONOGRAPHS in course of Publication :*—

The Echinodermata of the Oolitic and Cretaceous Formations, by Dr. Wright.
The Trilobites of the Mountain-Limestone, Devonian, and Silurian Formations, by Mr. J. W. Salter.
The Eocene Mollusca, by Messrs. F. E. Edwards and S. V. Wood.
The Belemnites, by Professor Phillips.
The Reptilia of the Liassic Formations, by Professor Owen.
The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.

THE PALÆONTOGRAPHICAL SOCIETY was established in the year 1847, for the purpose of figuring and describing the whole of the British Fossils.

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

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* MARCH, 1866); *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, 1864	1862, 1866	1863, 1866	154	19	218	29
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	1864, 1865, 1866	1864, 1865, 1866	176	25	606	95
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, 1853, 1854	1851, 1852, 1853, 1855	409	42	1855	160
" " Vol. II. The Permian and Carboniferous Brachiopoda, *complete*	1856*d*, 1857, 1858, 1859, 1860	1857, 1858, 1860, 1861 †	1858, 1859, 1861, 1861, 1863	331	59	1909	157
" " Vol. III. The Devonian and Silurian Brachiopoda, 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. E. Edwards, in course of completion	1848, 1852, 1854, 1855, 1858	1849, 1852, 1854, 1856, 1860	1849, 1852, 1855, 1857, 1861	332	33	578	161
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood, in course of completion	1859, 1862	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, 1864	1865, 1866	1865, 1866	52	7	179	15
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, 1857, 1858, 1862	1851, 1859, 1860, 1864	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden, and Purbeck Formations, by Prof. Owen, *complete*‡	1853, 1854, 1855, 1856, 1857, 1858, 1862	1853, 1854, 1856, 1857, 1859, 1860, 1864	1853, 1855, 1857, 1858, 1859, 1861, 1864	155	62	251	17
The Reptilia of the 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
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and Mr. W. A. Sanford	1864	1866	1866	70	5	43	1
			TOTAL	5,296	796	14,562	3,085

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. ‡ Title-pages and Index will be found in the 1864 Volume, or may be had separately.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1864.

LONDON:

MDCCCLXVI.

A MONOGRAPH

ON THE

BRITISH FOSSIL

ECHINODERMATA

FROM

THE OOLITIC FORMATIONS.

BY

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

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

VOLUME SECOND.

PART SECOND.

ON THE OPHIUROIDEA.

Pages 131—154; Plates XIII—XVIII.

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1866.

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J. E. ADLARD, BARTHOLOMEW CLOSE.

A MONOGRAPH

ON THE

FOSSIL ECHINODERMATA

OF THE

OOLITIC FORMATIONS.

THE OPHIUROIDEA.

THE OPHIUROIDEA were long united with the true Star-fishes, ASTEROIDEA, from the circumstance that in both groups the arms proceed from the circumference of the disk; they are now, however, separated into a distinct order, as they possess certain permanent organic characters by which they are distinguished from them.

The Ophiuroidea have a central discoidal body, which is either naked or covered with granules, spines, or scales; in this is contained all the viscera, and from the mouth proceed five long very flexible, simple, or ramified arms, sustained by a series of internal vertebra-like pieces, covered by a naked integument or having granules, scales, or spines, developed from the lateral or inferior parts thereof. The arms of the Ophiuroidea are widely different from the rays of true Star-fishes, which are simple prolongations of the body of the animal, whereas the arms of the Ophiuroidea are superadded to the body, and there is no excavation in them for any prolongation of the digestive organs. There are no ambulacral grooves in the floor of the arms, nor any retractile tubular feet, nor pedicellariæ, in this order.

The mouth, situated in the centre of the under surface of the disk, opens directly into the stomach; this is a sac with one aperture, the mucous membrane of which is covered with vibratile cilia.

The ovaries are placed near the arms, and open by orifices situated at the basal surface of the interbrachial spaces near the mouth.

The oral opening is surrounded by five re-entrant angles, which correspond to the intervals of the five arms; from the peristome proceed five buccal fissures, in a line with the axis of the arms; their borders are in general covered with a series of papillæ or plates, and they terminate in a cone of calcareous pieces which perform the part of a jaw. Pl. XIII, figs. 1, 3, 4, 5, 6, show various forms of these dental instruments. At the extremity of each fissure a series of osselets, occupying the interior of the arms, take their origin; their under surface is grooved for lodging a vessel, and between their lateral expansions spaces are formed to receive the base of the fleshy tentacules near the disk.

HISTORY.

The older naturalists united the OPHIURIDÆ to the ASTERIADÆ. Linck[1] first described certain species under the common name *Stella marina,* and designated two species, *S. lacertosa,* and *S. longicauda,* to express the resemblance their arms had to the tail of a lizard; another species, provided with long spines proceeding from the lateral parts of the arms, he called *Rosula scolopendroides,* from the resemblance of the rays to the body of a Scolopendra. The OPHIUROIDEA with ramified arms, as the *Asterophydiæ,* were distinguished by Linck from the simple-rayed forms under the name *Astrophyton.* Seba[2] figured many Ophiuræ among the Star-fishes. Pennant[3] in his 'British Zoology,' and O. F. Müller[4] in his 'Zoologia Danica,' have described many in the genus *Asterias;* and it is under this generic name that all the species of *Ophiuridæ* and *Asterophydiæ* known to Linnè[5] were described, in the thirteenth edition of the 'Systema Naturæ,' by Gmelin. Lamarck,[6] in his 'Système des Animaux sans Vertèbres,' 1801, and in his larger work on the same subject, 1816, established the genera *Ophiura* and *Euryale,* taking *Asterias ophiura,* Müll., as the type of the first, and *Astrophyton scutatum,* Linck, for that of the other. These generic distinctions, first made by Lamarck, were preserved by Delle Chiaje,[7] Risso,[8] and De Blainville;[9] it was not until Professor Agassiz's 'Prodrome'[10] appeared that new generic subdivisions of the order were proposed; in this essay the *Ophiuridæ* were thus defined and classified.

The OPHIURIDÆ differ from the Asteriadæ in this, that the central part of the body

1 Linck, 'De Stellis Marinis,' fol., 42 plates. Lypsiæ, 1733.
2 Seba, 'Locupletissimi Rerum Naturalium, &c.,' 3 vols. folio, pl. x—xv, 1734.
3 Pennant, 'British Zoology,' vol. iv, p. 60, 1776.
4 O. F. Müller, 'Zoologia Danica,' 2 vols. folio. Lips., 1779—1784.
5 Linnè, 'Systema Naturæ,' ed. 13, par Gmelin. 1789.
6 Lamarck, 'Système des Animaux sans Vertèbris,' 1 vol. 8vo. Paris, 1801.
7 Delle Chiaje, 'Memorie sulla storia e notomia,' &c. Napoli, 1825.
8 Risso, 'Hist. Naturelle de l'Europe Merid.,' 5 vols. Paris, 1826.
9 De Blainville, 'Manuel d'Actinologie,' 1 vol. 8vo, plates. Paris, 1834.
10 Agassiz, 'Mém. Soc. Sc. Nat. Neuchatel,' vol. i, p. 168. Neuchatel, 1835.

forms a disk, distinct and flat, to which are annexed the rays, more or less elongated, simple, or ramified, and without grooves at their under surface.

1. OPHIURA, Lam., Ag. = (Sect. A, De Blainville).—Disk much depressed; rays simple, squamous; spines very short, embracing the lateral plate.

Types.—*Ophiura texturata*, Lam., *O. lacertosa*, Lam.

2. OPHIOCOMA, Ag., = *Ophiura*, De Blainville (Sect. B).—This genus differs from the preceding by the long moveable spines which arm the rays. Pl. XIII, fig. 4.

3. OPHIURELLA, Ag.—Disk indistinct. All the species are fossil.

O. carinata, Ag. (*Ophiura carinata*, Münst.), *Ophiura Egertoni*, Ag. (*Ophiura Egertoni*, Brod.), Pl. XVII, fig. 4.

4. ACROURA, Ag.—This genus approaches much to the Ophiura properly so called, but it differs in this, that the small scales placed on the sides of the rays replace the spines. The rays themselves are very slender. One species fossil.

A. prisca, Ag. (*Ophiura prisca*, Münst.) Pl. XIV, fig. 5.

5. ASPIDURA, Ag.—A star of ten plates covers the superior surface of the disk, whilst the rays, large in proportion, are surrounded with imbricated scales. One species fossil.

A. loricata, Ag. (*Ophiura loricata*, Goldf.) Pl. XIV, fig. 6.

6. TRICASTER, Ag.; EURYALE, Auct.—Rays bifurcate at their extremity.

T. palmifer, Ag. (*Euryale palmifera*, Lamk.)

7. EURYALE, Lamk.; ASTROPHYTON, Linck; GORGONOCEPHALUS, Leach.;—Disk pentagonal; rays branched from the base.

E. verrucosa, Lam., *E. costata*, Lam., *E. muricata*, Lam.

Müller and Troschel,[1] in 1840, published their first memoir on the classification of the Asteriadæ, in which they grouped the living Ophiuræ into five genera:—1, *Ophiolepis;* 2, *Ophiocoma;* 3, *Ophiothrix;* 4, *Ophioderma;* and 5, *Ophionyx;* comprising twenty-nine species. The same year they added three new genera:—6, *Ophiopolis;* 7, *Ophiomyxa;* 8, *Ophiocnemis.* In 1842 the 'System der Asteriden, by the same authors, appeared, in which three new genera—9, *Ophiarachna;* 10, *Ophiacantha;* and 11, *Ophiomastix,* were added. The EURYALIDÆ comprised three genera—*Asteronyx, Trichaster,* and *Astrophyton,* making in all fourteen genera, and comprising eighty-three species of living OPHIUROIDEA, besides fourteen extinct species distributed in seven genera.

In 1841 Professor Edward Forbes, in his 'History of British Star-fishes,' described thirteen species of OPHIURIDÆ as SPINIGRADE ECHINODERMATA, which he distributed in the genera *Ophiura*, *Ophiocoma*, *Astrophyton*, and in 1843,[3] in a memoir communicated to the Linnean Society, he proposed several new genera—1st, *Pectinura* which nearly corresponds to the genus *Ophiarachna;* 2, *Amphiura*, which resembles *Ophiolepis;* and 3, *Ophiopsila*, which comes near *Ophiothrix.* He retained the name

[1] 'Archiv für Naturgeschichte,' p. 326.

[2] Edward Forbes, 'History of British Star-fishes.' Van Vorst, 1841.

[3] 'Transactions of the Linnean Society,' London, vol. xix, p. 144.

Ophiura to some of the species placed by Müller and Troschel in their genus *Ophiolepis*.

Many new species have been discovered and described by Sars, Lütkin, Grube, and Philipi, and a few new genera to include the same have been proposed by them as *Ophioplus*, Sars, which also includes *Amphiura*, Forbes, *Ophiocten*, and *Ophiactis*, Lütkin, besides *Ophiopholis* and *Ophiopeza*, Peters.

The fossil species belong to existing genera, as *Ophioderma*, *Ophiolepis*, *Amphiura*, *Ophiocoma*; and to extinct genera, as *Ophiurella*, *Acroura*, *Aspidura*, *Geocoma*, *Palæocoma*, *Aplocoma*, and *Protaster*. (See Plate XIV.)

On the Skeleton and tegumentary Framework of the Ophiuroidea.

The framework of the *Ophiuridæ* consists of a calcareous or internal, and a tegumentary or external, skeleton. The former is composed of a number of calcareous osselets of the uniformly reticulate structure common to all the Echinodermata. These pieces are variously arranged in the different genera. The disk, in this order, forms the entire visceral cavity, no prolongation of the same extending into the arms, as in the *Asteriadæ;* on the under surface of the disk five pairs of bones occupy the interbrachial spaces, and form a series of arches that afford attachment to the delicate osselets constituting the skeleton of the upper surface; they are likewise covered with large plates carrying conical-pointed processes, with short spines, which project inwards towards the mouth, and perform the part of jaws and teeth. Several forms of these dental organs are seen in Pl. XIII, figs. 1, 4, 5, 6.

From the interbrachial spaces five long arms proceed; these organs are supported on a series of osselets resembling the bodies of caudal vertebræ in the tails of lizards; the scaly character of the tegumentary membrane covering the same increases the resemblance between the ray of *Ophiura texturata*, Lamk., and a lizard's tail. The brachial osselets have on their anterior and posterior surfaces transverse processes or kinds of articular condyles directed in opposite directions, the one vertical, the other horizontal; two of these transverse condyles always cross each other, so that the lateral flexion of the arms is in nowise impeded; these pieces carry likewise discoidal expansions more or less flexed, which form spaces to receive the base of the fleshy tentacles near the disk.

To the internal skeleton likewise appertain the elongated processes found in the visceral cavity at the base of the arms in relation to the reproductive organs, and the many small osselets arranged on the border of each of the five fissures leading from the mouth-opening to the centre of the base of the arms (Pl. XIII, figs. 4, 5, 6). Belonging to the same class are the many small pieces piled upon each other at the extremity of the interbrachial bones, and forming the five projecting cones or jaws surrounding the mouth, and which perform the office of teeth (Pl. XIII, fig. 6).

The tegumentary or external skeleton exhibits many interesting modifications in the *Ophiuridæ*. It consists of delicate calcareous plates or scales developed on the disk and arms, the various forms of which and their mode of arrangement afford good characters for generic subdivisions, and constitute the basis of the classification of this natural Order.

In the clothing of the disk we find the character of the tegumentary skeleton, exhibiting many modifications; for example, in *Ophioderma* the surface is covered with numerous granules, and the sides of the arms are furnished with delicate papillæ or fine regular spines; the body is smooth, and the arms resemble the body of a small snake (Pl. XIII, fig. 1).

In *Ophiolepis* (Pl. XIII, fig. 2) the upper surface of the disk is covered with naked scales, having some resemblance in their arrangement to those found on the bodies of lizards. In *Ophiura texturata*, Lamk., the orbicular disk is covered above with a number of small unequal-sized plates, arranged in an imbricated manner, without intermediate smaller pieces. The five pairs of large heart-shaped radial plates are placed close together, the mesial suture of each pair being overlapped by a central imbricated series, which occupy a position above the insertion of the arms. A circle of imbricated scales fills the centre of the disk, and from its circumference a column of round and imbricated scales extends through the centre of the interbrachial spaces to the border, the intermediate area being compactly filled with small elliptical-shaped scales, closely pressed together, as in *Ophiolepis ciliata* (Pl. XIII, fig. 3).

Ophiocoma has the disk more or less uniformly granular in the different species, and even the radial plates (Pl. XIII, fig. 4) are covered with minute granulations. The buccal fissures are entirely bordered with hard papillæ, as in *Ophiocoma dentata* (Pl. XIII, fig. 4), where they form only one range between the teeth and buccal papillæ; in other species they present many varieties of structure. The lateral spines of the arms are smooth and very much developed.

Ophiarachna has the disk granular throughout, except on the ovarial plates, which are naked (Pl. XIII, fig. 5). The buccal plates are divided transversely into a small external piece, and into a larger internal piece. The buccal fissures are provided with dental papillæ, and the arms with delicate, conical, unequal spines, which lie close upon the lateral plates (fig. 5).

Ophiomastix has the disk covered with small imbricated scales, and it likewise supports isolated cylindrical spines. The buccal plates are simple, and the buccal fissures provided with hard papillæ, which are grouped above the dentary pile, as in *Ophiomastix annulosa* (Pl. XIII, fig. 6). The arms are very spinous, and the lateral plates above the rows of spines support a series of claviform pieces with denticulated extremities.

Ophiomyxa has the disk pentagonal, soft, flat, and without granules, and a few obscure scales are observed in the naked integument of *Ophiomyxa pentagona* (Pl. XIII, fig. 7). The buccal plates are nearly round, being a little longer than they are wide.

Ophiothrix has the orbicular or pentagonal disk covered with very fine spines, more or less developed; sometimes they are so delicate that the clothing has quite a villous character; the radial plates are divergent and naked, or partially covered near their base with the general clothing of the disk. *Ophiothrix Rammelsbergii* (Pl. XIII, fig. 8) belongs to the group in which the disk is provided with small short cylinders; the sides form a prominence between the arms; the radial plates are divergent and naked, except near the base, where they are provided with small granulations.

Protaster, an extinct genus, has the circular disk covered with squamiform plates; the genital openings are in the angles of junction of the rays beneath, and the arms are formed of alternating ossicula. Plate XIV, fig. 9, exhibits these characters as shown in *Protaster Sedgwickii*, from the Ludlow rocks of the Upper Silurian series.

Amphiura has an orbicular disk, having its upper surface covered with small smooth scales, the six central plates forming a rosette. The arms, simple and scaly, arise from the centre of the disk, and are provided with lateral subcarinated plates carrying simple lanceolate spines. In *Amphiura tenera* (Plate XIV, fig. 10, *a*, *b*) the disc is small and not lobed, the short delicate arms are surrounded with tri-radiate spines; the radial plates are small, the ventral plates pentagonal, and both are naked.

Aspidura, an extinct form from the Muschelkalk of Germany (Pl. XIV, fig. 6, *a*, *b*) has the upper surface of the body covered with fifteen plates; ten of these form the outer and five the inner circle of the small disk; the arms are furnished with four rows of plates of unequal sizes.

In most genera the upper surface of the disk supports at the base of the arms two large calcareous pieces called radial plates, which are sometimes placed close together, as in *Ophiura texturata*, or apart, as in *Ophiolepis annulosa* (Pl. XIII, fig. 2). They are either entirely naked, as in *Ophiolepis* and *Ophiarachna*, or partly clothed with the general covering of the disk, as in *Ophiothrix*. The radial plates are well preserved *in situ* in many fossil species, as *Ophioderma Milleri* and *O. Gaveyi* (Pl. XVI and XVII).

On the under surface of the disk are five interbrachial spaces between the arms (Plate XIII, figs. 1, 3, 4, 5, 6). In each of these are large smooth pieces, called buccal plates (Mundschilde, scuta buccalia) of authors. They have different forms in different genera; in general, they are single, as in *Ophiolepis* (Pl. XIII, fig. 3), and sometimes they consist of an inner larger and an outer smaller portion, as in *Ophiarachna* (Pl. XIII, fig. 5). In one of these five buccal plates is found, when present, the *umbo*, a small depression in the middle of the plate, the homologue, perhaps, of the madreporiform body of Asteroidea.

Each interbrachial space terminates in a triangular-shaped body, and the five form a star-shaped opening, having the oral aperture for its centre and the buccal fissures for its rays. The terminal process is a narrow cone which rises high up within the mouth, and forms a jaw (maxilla), armed with numerous calcareous pieces piled upon each other, which perform the part of teeth. Plate XIII, fig. 1, shows the form of the maxillæ in *Ophioderma longicauda;* fig. 3, in *Ophiolepis ciliata;* fig. 4, in *Ophiocoma dentata;* fig. 5, in *Ophiarachna septemspinosa*. The lateral parts of the triangular body forming the boundary of the oral fissures (fissuræ buccales) are armed with plates, papillæ, or spines of various forms in the different genera; an inspection of the figures already cited will afford a better idea of the structure and disposition of these parts than any description, however detailed. The border of the fissures is either naked, as in *Ophiothrix* and *Ophionyx*, or provided with hard plates or papillæ (papillæ buccales) arranged in a single row, as in all other genera (see Pl. XIII, figs. 1, 3, 4, 5, 6, 7).

The masticating surface of the maxillæ in all the *Ophiuridæ* carries teeth or papillæ. The teeth occupy the entire breadth of the jaw, and form a perpendicular series of dental processes which extend upwards from the peristome into the interior of the disk. In the genera *Ophioderma* (Pl. XIII, fig. 1), *Ophiolepis* (fig. 3), *Ophiomyxa* (fig. 7), the teeth reach to the mouth-papillæ; but in other genera they are limited to the superior part of the maxillæ, the lower portion being furnished with papillæ, as in *Ophiocoma* (fig. 4) and *Ophiarachna* (fig. 5). The teeth consist of calcareous osselets in general, having a smooth border; seldom is the surface serrated as in *Ophiomyxa pentagona* (fig. 7).

Upon each of the interbrachial spaces, on the under surface of the disk, are found either two or four genital openings (fissuræ genitales); when there are only two, they form long slits, which lie close to the arms. In *Ophiura texturata* the inner extremity of the slit touches the buccal plate, and the outer reaches the circumference of the disk, the internal border of the fissure is finely pectinated with small spines, which fringe the aperture. In the genera with four openings, as *Ophioderma* (Pl. XIII, fig. 1), they are disposed in two behind each other, in the same radial line, or they lie close together, side by side, as in *Ophiocnemis*.

The arms, whether simple, as in *Ophiuridæ*, or ramified, as in *Asterophydiæ*, consist of a great number of jointed osselets, which have been already described; they are clothed externally by a series of plates arranged in an imbricated manner throughout the entire ray, and disposed into dorsal, ventral, and two lateral rows. The dorsal and ventral plates resemble each other in form and covering, and the lateral plates support the spines which arm the rays of most *Ophiuridæ*. The spines are longer or shorter in different genera; they are sometimes stout, or slender, with the surface covered by fine lateral processes, as in *Ophiothrix* (fig. 8); sometimes they are small, short, and closely applied to the arm, as in *Ophioderma* (fig. 1); or they are large, strong, and projecting crosswise, as in *Ophiocoma* (fig. 4), and with additional claviform processes superadded, as in *Ophiomastix* (fig. 6). The character of the spines varies in each genus, and forms a valuable aid in the determination of species. They are moved in general by the contraction of the tegumentary membrane which unites them to the lateral plates.

Classification of the Ophiuroidea.

The Ophiuroidea are all provided with five arms; in the greatest number they are simple, but in a few they are branched; this character enables us to form a binary division of the order into two families, the Ophiuridæ and the Asterophydiæ. From the number and position of the genital fissures in the interbrachial spaces, we obtain a character for the division of the families into tribes. The structure of the disk, the presence or absence of scales, plates, or other clothing on the same, the structure and development of the rays and the spines which arm its lateral plates, the structure of the mouth and oral fissures with their armature, the development of the maxillæ and their dentary plates, afford collectively good generic characters.

OPHIUROIDEA.

Characters.	Families.
A. Two or four genital fissures. *a.* Arms, five, always simple.	Ophiuridæ.
B. Ten genital fissures. *b.* Arms, five, simple or ramified.	Asterophydiæ.

1st. Family Ophiuridæ.

	Genera.
Four genital fissures in each interbrachial space.	*Ophioderma.* *Ophiocnemis.*
Two genital fissures in each interbrachial space. A. Disk covered with hard plates.	*Ophiolepis.* *Ophiopeza.* *Ophionereis.* *Ophiura.* *Ophiocten.* *Amphiura.* *Ophiactis.* *Ophiostigma.* *Pectinura.* *Ophiocoma.* *Ophiarachna.* *Ophiacanctha.* *Ophiomastix.* *Acroura.* *Aspidura.* *Aplocoma.*

Two genital fissures in each interbrachial space. B. Disk membranous and naked.	*Ophiomyxa.* *Ophioblenna.* *Ophioscolex.* *Ophiopsila.* *Ophiothrix.* *Ophiurella.* *Protaster.*

2nd. Family Asterophydiæ.

Characters.

A. Arms simple.	*Asteronyx.* *Asterochema.* *Asteroporpa.*
B. Arms ramified and divided.	*Trichaster.* *Asterophyton.*

DESCRIPTION OF THE FOSSIL SPECIES.

Genus Ophioderma, *Müller and Troschel*, 1842.

The disk covered with small, close-set granulations; arms long, smooth, and slender; the lateral borders provided with short papillæ or spines closely applied to the lateral plates. Four genital slits in each interbrachial space, disposed in pairs behind each other; two are situated behind the buccal plates, from whence they diverge outwards, and two are placed near the border of the disk. The slits always lie behind each other in the same radial line. The buccal fissures are furnished with small strong papillæ. Pl. XIII, fig. 1, is the disk and rays of *Ophioderma longicauda,* Linck, which exhibit very satisfactorily the organic characters of this group.

The genus *Ophioderma* was established by Müller and Troschel for certain species of *Ophiura* which had for their type the *Stella lumbricalis longicauda*, Linck, tab. xi, No. 17 = *Ophiura lacertosa,* Lamarck.

The Ophiodermas are remarkable for possessing a very smooth body and arms, the granulations and spines are so fine and regular that the rays resemble the skin of an Ophidian reptile, hence the specific name given by Lamarck to Linck's type. Of the fourteen living species, one is found in the Mediterranean and the others in the warmer seas of the globe. The fossil species have, at the present time, been found only in the Lias formation.

Ophioderma Milleri, *Phillips, sp.* Pl. XVI, figs. 2, 3, *a*, *b*, 4.

Asterias sphærulata, *Young* and *Bird*. Geological Survey of the Yorkshire Coast, pl. v, fig. 6, 1822.
Ophiura Milleri, *Phillips*. Geol. of Yorkshire, pl. xiii, fig. 20, p. 169, 1829.
— Milleri, *Charlesworth*. London Geological Journal, pl. viii, 1847.
Ophiurella Milleri, *Agassiz*. Mém. Sc. Nat. Neuchatel, p. 192, 1836.
Ophioderma Milleri, *Wright*. Ann. and Mag. of Nat. Hist., 2nd series, vol. xiii, 1854.
— Milleri, *Forbes*. Morris, Cat. British Fossils, 2nd ed., p. 84, 1854.
— Milleri, *Wright*. Brit. Association Report for 1856, p. 402, 1857.
Palæocoma Milleri, *d'Orbigny*. Prodrome de Paléontologie, tome i, p. 240, 1850.
— Milleri, *Oppel*. Der Juraformation, p. 190, 1856.
— Milleri, *Dujardin et Hupé*. Hist. Nat. des Zoophytes Échinodermes, p. 294, 1862.

Disk flat, circular, with ten radial plates, nearly equidistant around the margin; a short series of transverse plates extending between each pair towards the centre of the disk; arms long, round, smooth, tapering from the base to the apex; spines very small, and closely applied to the lateral plates.

Dimensions.—Disk, one inch and three tenths in diameter; arms, four and a half inches in length.

Description.—A very imperfect figure of this Ophiura, under the name *Asterias sphærulata*, was first given by Young and Bird in their 'Geological Survey of the Yorkshire Coast.' Professor John Phillips etched a good outline of it in his 'Geology of Yorkshire,' and named it in that work, without, however, giving any description thereof. Mr. Charlesworth, in the 'London Geological Journal,' 1847, published a beautiful drawing of the fine specimen contained in the museum of the Yorkshire Philosophical Society, and this fossil the council of that institution kindly communicated to me for Pl. XVI, fig. 4, of this work. Although this Ophiura is not uncommon in collections of Yorkshire fossils, still it is rare to find good specimens in which the details of its structure are well preserved.

The disk is flat, circular, or subpentagonal; the radial plates, forming pairs, are placed so far apart that the ten plates are nearly equidistant from each other (Pl. XVI, fig. 4). In this specimen the other parts of the disk are not preserved; in another the body is partly entire (fig. 3, *a*), and shows a series of small transverse plates extending between each pair of radial plates towards the centre of the disk. The arms are long, smooth, and nearly cylindrical; they are three and a half times as long as the diameter of the disk, and taper gently from the base to the apex; their upper or dorsal surface is covered with transverse plates, nearly four times as wide as they are deep (fig. 4); the ventral plates are deeper in proportion to their width, as shown in specimen (fig. 2); the lateral plates are large and imbricated, as seen in a ray from Dr. Bowerbank's specimen (fig. 3, *b*), magnified two and a half diameters. In this fossil the free outer margin of the plates is slightly pectinated, and so fine are the spines that they are only visible when magnified several diameters. In a specimen now before me, showing the base, I find the buccal plates are each composed of four pieces; one central element, which is the largest, is situated nearest the mouth, it has a square form rounded at the oral edge; two lateral pieces are placed on each side of the central element, and one triangular plate at the outer part of the centrum, having its base applied to the central plate, and its apex directed outwards towards the interbuccal spaces. The under surface of the disk, seen between this triangular portion of the buccal plates and the border, is clothed with small close-set imbricated scales. The buccal fissures are very narrow, but their structure is not, for anatomical description, sufficiently exposed.

Affinities and Differences.—In its general characters this species resembles *Ophioderma Gaveyi*, Wr. The disk, however, is proportionately smaller, and the rays are stronger and rounder; the dorsal and ventral plates of the arms are likewise longer transversely, and shorter; the lateral plates are less developed than the homologous parts in *Ophioderma Gaveyi*.

Section of the Marlstone at Rockcliff, near Staithes. (See p. 143.)

No.	Lithology.	Thickness.	Organic Remains.
		Feet.	
	Jet Rock.		
	Lower part of the Upper Lias.	50	*Saurians, Fish, Cephalopoda.*
	Marlstone Beds.		
	Total thickness of the series . . . subdivided into—	160	
	Main Ironstone Bands.		
1	Connected blocks of hard ironstone, a foot and upwards in thickness, with thin seams of intervening shale.	25	*Terebratula trilineata*, Y. and B. = *T. punctata*, Sow.; very abundant.
2	Sandy shale.	5	
3	Iron dogger.		*Ammonites Clevelandicus*, Y. and B. = *A. margaritatus*, Montf. (nos. 3–9)
4	Sandy shale.	10	
5	Iron dogger.		
6	Sandy shale.	15	
7	Iron dogger.		
8	Sandy shale.	18	
9	Iron dogger.		
10	Shaley sandstone.	10	*Am. margaritatus* = *A. vittatus*, Y. and B.
11	Alternations of calcareous sandstone and sandy shale, generally one sandstone bed alternating with a similar bed; the seams covered with fossils.	40	*Belemnites paxillosus*, Schloth., *Pholadomya obliquata*, Phil., *Modiola scalprum*, Sow., *Lima Hermanni*, Voltz., *Ophioderma Milleri*, Phil., *Ophioderma carinata*, Wr., *Ammonites capricornus*, Sch. = *A. maculatus*, Y., *Avicula inæquivalvis*, Sow., *Pecten æquivalvis*, Sow.
12	Shaley marlstone.		*Ammonites maculatus*, *Cardium proximum*, Hunt.
13	Shaley sandstone, gradually partaking of the nature of Lower Lias shale.	20	*Avicula cygnipes*, Phil., *Cardium truncatum*, Phil., *Rhynchonella tetrahedra*, Sow., *R. acuta*, Sow.
	Lower Lias Shale.		
	Thickness above the level of the sea . . .	150	

Locality and Stratigraphical Position.—*Ophioderma Milleri*, Phil., is found in the same stratigraphical horizon in Yorkshire as *Ophioderma Gaveyi* occupies in the Middle Lias of Gloucestershire. The presence of *Ammonites capricornus*, Schloth. (*Am. maculatus*, Young and Bird), and *Avicula inæquivalvis*, Sow., in the rock containing the large specimen belonging to the museum of the Yorkshire Philosophical Society (Pl. XVI, fig. 4), determines the zone of life to which this Ophiura belongs. It is found in bands of shelly calcareous sandstone belonging to the main Ironstone series or lower portion of the Marlstone beds at Staithes, near Whitby, on the Yorkshire coast, with *Cardium truncatum*, Phil., *Avicula inæquivalvis*, Sow., *Modiola scalprum*, Sow., *Lima Hermanni*, Voltz, and *Pholadomya ambigua*, Sow. (See p. 142.)

The foregoing section, by Mr. L. Hunton,[1] of the Marlstone at Rockcliff, near Whitby, Easington Heights, Mudges Survey, clearly defines the position of the Ophiura-beds in Yorkshire.

History.—This Sea-star was first rudely drawn by Young and Bird, 1822, in their 'Geological Survey of the Yorkshire Coast.' 1829, Professor John Phillips named the species, and gave a good figure of it in his 'Geology of Yorkshire,' but did not describe it. 1836, M. Agassiz, in his 'Prodrome d'une Monographie des Radiares ou Échinodermes,' p. 193, proposed for this and other fossil species the genus *Ophiurella*, without defining the characters on which it was based. 1850, M. A. d'Orbigny, in his 'Prodrome de Paléontologie,' t. i, p. 240, proposed the genus *Palæocoma*, giving *P. Milleri* as the type of the same; this genus he thus described:—"Ophiures à quatre rangées de pièces aux bras, sans petites pièces intermédiares." 1852, in my 'Contributions to the Palæontology of Gloucestershire,' p. 42, I referred this species to Müller and Troschel's genus *Ophioderma*, associating it with other congeneric forms from the Middle Lias, as *O. Gaveyi*, *O. Egertoni*, *O. tenuibrachiata*. In 1854, Professor E. Forbes, in his additions to Morris's Catalogue of British Fossils, and 1857, M. Pictet, in his 'Traité de Paléontologie,' t. iv, p. 274, referred this species to the genus *Ophioderma*. 1862, Dujardin and Hupé, in their 'Histoire naturelle des Échinodermes,' adopted the genus *Palæocoma*, and recorded the species as *Palæocoma Milleri*.

OPHIODERMA EGERTONI, *Broderip*, sp. Pl. XV, fig. 4, *a*, *b*; fig. 5.

OPHIURA EGERTONI,	*Broderip.*	Trans. Geol. Soc., 2 series, vol. v, pl. xii, figs. 5, 6, 6*, 1835.
— —	*Forbes.*	Proceed. Geol. Soc., vol. iv, p. 233, fig. 4, 1843.
OPHIODERMA EGERTONI,	*Forbes.*	Morris, Cat. Brit. Fossils, 2nd ed., p. 84, 1854.
— —	*Oppel.*	Die Juraformation, p. 267, 1856.
— —	*Wright.*	Brit. Association Report for 1856, p. 403, 1857.
— —	*Pictet.*	Traité de Paléontologie, tome iv, p. 274, 1857.
— —	*Dujardin et Hupé,*	Hist. Nat. des Èchinod., p. 234, 1862.

[1] 'Trans. of the Geol. Soc. London,' p. 215, vol. v, second series, 1836.

Disk round, small, flat, subpentagonal, almost circular; arms long, smooth, cylindrical, tapering to a filiform termination; vertebral pieces trilobed above.

Dimensions.—Disk, half an inch in diameter; arms, three inches in length.

Description.—This is the most common of our fossil Ophiuridæ, and many fine specimens are obtained from the surface of the large blocks of micaceous sandstone which have fallen from the Star-fish beds of the Middle Lias at Down Cliffs, between Charmouth and Bridport Harbour, on the coast of Dorset. This species resembles *Ophiura texturata*, Lamk., of our present seas, but differs in several important characters from that form.

Some weathered specimens exhibit the structure of the rays in a most beautiful manner; others are so closely invested with the matrix, or covered with a ferruginous crust, that it is impossible to make out their organic details.

The disk is round, and slightly flattened at the interbrachial spaces; its dorsal surface is flat and smooth; the radial plates are large, the pairs closely united by a median suture, and to the adjoining plates by lateral sutures, so that the upper surface of the body appears to be formed entirely by them. The ventral surface exhibits a buccal opening with five rays (fig. 4, *b*); from the base of each arm two long narrow osselets project inwards towards the mouth (fig. 4, *b*). The arms, six times as long as the diameter of the disk, are slender, cylindrical, and taper gradually to the apex; they have on their dorsal surface a series of transverse scales, which, at the base of the arms, are nearly as broad as they are long, in the middle twice as long as they are broad, and proportionately more so towards the extremity; the lateral scales closely embrace the arm, and the spines, if present at all, must have been very short, as I have failed to observe any traces of lateral spines in several well-preserved specimens. The basal scales are nearly the counterpart of the dorsals as to form and structure. (Pl. XV, fig. 5.)

Affinities and Differences.—This species in its general form must have approached very near *Ophiura texturata*; it differed, however, in the size of the radial plates and structure of the disk. It closely resembles *Ophioderma tenuibrachiata* from the same bed, "but in this species the rays are much longer in proportion, and less tapering; they have a more flexible aspect than those of *O. Egertoni*, and present in their section a different form of the central ossicula; for these, instead of being trilobate, are oblong, with a triangular central anterior lobe."—Forbes, 'Proc. Geo. Soc.,' vol. iv.

Ophioderma Egertoni differs from *O. Gaveyi* in having a smaller disk, with much more slender arms, and still more from *O. Milleri*, which is proportionately more robust than *O. Gaveyi*.

Section of the Middle and Upper Lias at Down Cliffs, near Bridport Harbour, Dorset.
(See p. 146.)

	No.	Lithology.	Thickness.	Organic Remains.
			Feet.	
		Drifted gravel beds.		
Upper Lias, 230 feet.	1	Brown sands, sometimes micaceous, with inconstant layers of large sandstone nodules; the fossils are in the uppermost Cephalopoda-bed.	140	*Ammonites opalinus*, Rein., *A. Jurensis*, Zeit., *A. variabilis*, d'Orb., *Nautilus latidorsatus*, d'Orb., *Belemnites*, *Pecten barbatus*, Sow., *Rhynchonella cynocephala*, Rich.
	2	Dark-greyish clay and sandy marl.	70	
	3	Brownish marly limestone; many of the blocks on the shore are very full of fossils.	2	*Ammonites serpentinus*, Rein., *A. bifrons*, Brug., *A. Raquinianus*, d'Orb., *A. communis*, Sow., *Rhynchonella Bouchardii*, Dav., *Leptæna liassina*, Bouch.
	4	Dark-greyish sandy marl and clay.	15	*Ammonites margaritatus*, Mont.
Middle Lias, about 250.	5	Indurated sand, forming large sandstone blocks.	8	
	6	Light-brown sands, more or less indurated, and very micaceous.	60	
	7	Blue marl, forming a well-defined band in the section.	6—8	
	8	Greyish, sandy, laminated marls, with many fossils.	1	*Am. margaritatus*, Mont., *Am. fimbriatus*, Sow., *Pecten æquivalvis*, Sow., *Terebratula cornuta*, Sow.
	9	Foxy coloured, marly sands, with 12-16 inconstant bands of sandy nodules in tiers in the bed.	40	
	10	Thin inconstant band of Crinoidal limestone.	1 in.	*Pentacrinus Johnstonii*, Aust.
	11	Grey, sandy clay, passing into irregular laminated sandstone.	36	*Pecten æquivalvis*, Sow., *Gryphæa Maccullochii*, Sow., fragments of *Pentacrinus*.
	12	The Star-fish bed, hard, grey, micaceous sandstone, falling in large blocks. On the under side of some the Ophiuræ are exposed.	4—6	*Am. margaritatus*, Mont., *A. fimbriatus*, Sow., *Ophioderma Egertoni*, Brod., *Ophioderma tenuibrachiata*, Forbes.
	13	Grey micaceous marls; in the upper part are several rows of fossiliferous nodules.	90?	*Am. margaritatus*, *A. Normanianus*, d'Orb., *Belemnites clavatus*, Blain., *Pleurotomaria*, *Chemnitzia*, &c. &c.
		Base of the cliffs.		

Ophioderma tenuibrachiata, *Forbes*. Pl. XVIII, fig. 5, *a*, *b*, *c*.

Ophioderma tenuibrachiata, *Forbes*. Proc. Geol. Soc., vol. iv, p. 233, fig. 5. Read Nov., 1843.
— — *Charlesworth*. Lond. Geol. Journ., pl. xix, fig. 1, 1847.
— — *Morris*. Catalogue of British Fossils, p. 84, 1854.
— — *Pictet*. Paléontologie, tom. iv, p. 274, 1857.
— — *Wright*. Brit. Association Report for 1856, p. 403, 1857.
— — *Dujardin et Hupé*. Hist. Nat. des Échinod., p. 234, 1862.

Disk small, flat, subpentagonal; arms long, delicate, and tapering little.

Dimensions.—Disk, four tenths of an inch in diameter; arms, two inches and seven tenths in length.

Description.—The body of this species is smaller than that of *Ophioderma Egertoni*, and the rays in proportion are longer and less tapering. "They have a more flexible aspect than those of *O. Egertoni*, and present in their section a different form of the central ossicula; for these, instead of being trilobate, are oblong, with a triangular central anterior lobe."[1] In the fine specimen I have figured the ventral surface of the rays has the marginal angle much more acute than the homologous part exhibits in *O. Egertoni*.

Affinities and Differences.—This species may be readily mistaken for *O. Egertoni*; when carefully examined, however, it is found to possess a smaller disk, longer and less tapering rays, having a more acute angle at the margins of their ventral surface; a section of the central ossicula exhibiting a bilobed outline, whereas in *O. Egertoni* a similar section shows a trilobed form.

Locality and Stratigraphical Position.—This species, like the preceding, is found on the surface of the large blocks of hard micaceous sandstone described by me as the Star-fish-bed of the Middle Lias at Down Cliff, near Bridport Harbour, Dorsetshire. (See p. 145.) It is associated with *Ammonites fimbriatus*, Sow., *Amm. margaritatus*, Mont., *Belemnites elongatus*, Mill., and *Ophioderma Egertoni*, Brod.

History.—First discovered by my old friend the late Dr. Murray, of Scarborough, and communicated by Dr. Bowerbank, F.R.S., to the late Professor Forbes, who first described it in the 'Proceedings of the Geological Society' for 1843. The very fine specimen figured in Pl. XVIII belongs to my cabinet.

[1] Forbes, 'Proc. Geol. Soc.,' vol. iv, p. 233.

OPHIODERMA GAVEYI, *Wright*, 1852; Pl. XV, fig. 1, *a*, *b*, *c*, *d*, 2, 3; Pl. XVII, fig. 1, *a*, *b*.

OPHIODERMA GAVEYI, *Wright*. Annals and Mag. of Nat. Hist. 2nd series, vol. xiii, p. 183, pl. xiii, fig. 1, 1854.
— — *Forbes*, in Morris's Catalogue of Brit. Fossils, 2nd ed., p. viii, 1854.
— — *Wright*. Brit. Association Report for 1856, p. 402, 1857.

Disk large, flat, circular; radial plates large, the pairs closely approximated, and separated from the adjoining radial plates by an interval; arms long, slender, tapering gradually; dorsal and ventral plates narrow, the dorsal with a central carina; lateral plates support short, stiff, pectinated spines; base wide, oral opening small, surrounded by five pairs of very prominent tooth-like processes.

Dimensions.—Diameter of the disk, one inch and four tenths; diameter of the rays at their junction with the body, one fourth of an inch; length of the rays, four times the diameter of the disk.

Description.—This Ophiura is found as yet only in one horizon of the Middle Lias, and many fine specimens have been discovered in the original locality near Chipping Camden; the one showing the upper surface (Pl. XV) is in my cabinet, that showing the base belongs to the Museum of the Worcestershire Natural History Society, and I am indebted to my friend Sir Charles Hastings, the President, for his kindness in allowing this fine specimen to be figured in my work.

The disk is large, flat, and circular, slightly inclining to a pentagonal form; it is composed of ten thin, triangular, radial plates, arranged in pairs, each pair forming a heart-shaped shield, with an elevated central carina, formed by the rudimental dorsal plates of the rays covering the prominent vertebral osselets; each pair appear to have been firmly articulated together along the median line, and free from the adjoining pairs at their margins; their surface is smooth, and at the apex of the plates ten elevated eminences indicate the bifurcated terminations of the radial carinæ (Pl. XV, fig. 2). The rays are long, slender, and taper gently; the dorsal plates are small and hexagonal; they are nearly all absent, leaving the osselets thereby exposed (Pl. XV, fig. 1 *b*, 1, *c*). This defect gives a peculiar character to the dorsal surface of the ray, which might be mistaken for a kind of ornamentation; the lateral plates are rounded and closely imbricated, and their free border is toothed with five or six pectinated processes, which in the living state supported spines (Pl. XV, fig. 1, *c*, fig. 2, and fig. 3); the remains of these are sometimes seen attached to their supports; the lateral plates clasp the rays firmly and securely, and overlap the dorsal and ventral plates, the latter are well developed and much elongated transversely; their position and character is well seen in Pl. XV, fig. 1, *a, b, c.*

The buccal plates are absent, but the ten osselets by which the rays were articulated with the disk are well preserved in the specimen figured in Pl. XVII, fig. 1, *a.* These form a considerable star-shaped oral aperture, from the angles of which a tooth-like process projects inwards towards the mouth.

Affinities and Differences.—This Ophiura in its general contour resembles *Ophioderma Milleri;* it is distinguished from that species by having a larger disk, with more slender, tapering rays; the arm-plates are likewise much smaller, and the radial plates of the disk larger. The magnitude of the disk, the structure of the radial plates, and the size of the rays, distinguish it from *Ophioderma Egertoni.*

Locality and Stratigraphical Position.—This Sea-star was discovered by my friend Mr. Gavey, F.G.S., in the Middle Lias of Mickleton Tunnel, near Chipping Campden, Gloucestershire, whilst making the West Midland Railway; it came from the zone of *Ammonites capricornus;* with that Ammonite were associated *Cidaris Edwardsii,* Wr., *Hemipedina Bowerbankii,* Wr., *Uraster Gaveyi,* Forb., *Tropidaster pectinatus,* Forb., and *Pentacrinus robustus,* Wr. Besides these Radiata about sixty species of Mollusca were discovered in the same bed.

I must refer to Mr. Gavey's memoir and section of the cuttings for further details.[1] Fragments of the rays have been found at Hewletts Hill, near Cheltenham, in the same zone of the Middle Lias.

History.—First figured and described in the 'Annals and Magazine of Natural History' for 1852, from specimens kindly sent me by Mr. Gavey. I am not aware that it has been found in any other localities.

OPHIODERMA CARINATA, *Wright,* n. sp. Pl. XVI, fig. 1, *a, b.*

Disk small, flat, pentagonal; radial plates small, the pairs closely approximated, and separated from the adjoining radial plates by a smooth membranous space; arms long, slender, and gradually tapering; dorsal plates narrow, with an elevated central carina; membranous covering of the disk smooth, and extending like a web between the base of the rays.

Dimensions.—Diameter of the disk seven tenths of an inch; length of the rays, three inches, or about four and a half times the disk's diameter; breadth of the ray at its base one fifth of an inch.

[1] "Railway Cuttings at Mickleton Tunnel and Aston Magna," by G. E. Gavey, Esq., F.G.S.; 'Quart. Journ. Geol. Soc.,' vol. ix, p. 29, 1853.

Description.—This Ophiura resembles *Ophioderma Gaveyi*, Wr., in the general structure of the disk and rays; the disk, however, is proportionately smaller. The radial plates are closely approximated, and between each pair there is a smooth depressed space; the margin of the disk appears to have been membranous, and extended like a web between the base of the rays (fig. 1, *a*). In the centre of the disk the ten osselets, arranged in pairs, forming part of the buccal framework, are seen projecting upwards (fig. 1, *a*).

The long and slender rays taper gently to their apex; the dorsal plates are narrow, and form a well-marked carina on the middle of the rays. The lateral plates are large, rounded at their free margin, and closely imbricated; there are some obscure indications of small dentations on their outer border for the support of spines (fig. 1, *b*). None of the ventral plates are exposed in the only specimen of this species I have seen.

Affinities and Differences.—This species, in its general form, proportions, and structure, resembles *Ophioderma Gaveyi*, Wr.; it is distinguished from that form chiefly in having a much narrower disk and a stronger carina on the dorsal surface of the rays. The plates of the rays are so imperfectly preserved that their characters cannot be accurately determined, and therefore a comparison with those of *O. Gaveyi* is impossible. It is always prudent to write cautiously about supposed new forms of which we have only a solitary example to examine, for a series of specimens, were they forthcoming, might show that characters supposed to be specific were only varietal; it is with much hesitation, therefore, that I have separated this Ophiura from the preceding on such feeble characters as a narrower disk, and more largely carinated rays.

Locality and Stratigraphical Position.—This Ophiura was collected from the grey micaceous sandstone of the Marlstone at Staithes, where it is very rare; it appears to be the form which was figured by Young and Bird in plate v, fig. 5, in their work on the 'Geological Survey of the Yorkshire Coast,' of which they say—"This is a handsome Star-fish, having five long and bending arms, not unlike some of a smaller size found recently on our shores. It particularly resembles *Asterias sphærulata*, or rather we may venture to pronounce it the same, as it shows the five small beads encircling the mouth. Two of this species are in the Whitby Museum, both in clay-ironstone, occurring in the Alum Shale."[1]

The specimen I have figured belongs to the cabinet of my kind friend, John Leckenby, Esq., F.G.S., who has liberally contributed it with his other rare fossils to this work.

[1] 'Geological Survey of the Yorkshire Coast,' p. 210.

Genus—Ophiolepis, *Müller and Troschel*, 1842.

The upper surface of the disk provided with naked scales or shields (Pl. XIII, fig. 2); two genital slits on each side of the interbrachial spaces close to the arms; oral fissures bordered with a single row of hard papillæ; maxillæ armed with simple prominent dental processes (fig. 2); the lateral scutæ of the arms support papillæ or spines; one or two scales on each tentacule pore; the oral plates are simple and heart-shaped.

The genus *Ophiolepis* forms a natural group, composed of many species, which have been arranged by Müller and Troschel into three sections. The first includes those in which the radial or dorsal plates on the disk are surrounded with a circle of smaller scales; the second in which the small scales are absent; and third those which, besides scales, have rows of spines on the dorsal surface.

* *Species in which the dorsal plates of the disk are surrounded with small scales.* Type, O. annulosa, Pl. XIII, fig. 2.

** *Species in which the dorsal plates are not surrounded by scales.* Type, O. ciliata, Pl. XIII, fig. 3.

*** *Species in which the disk, besides scales, supports rows of spines.* Type, O. scolopendrica, Linck, tab. xl, fig. 71, 72.

The third section corresponds to the genus *Ophiopholis*, M. and T., into which the species are now merged.

A. *Species of the Lower Lias.*

Ophiolepis Ramsayi, *Wright*, n. sp. Pl. XIV, fig. 3, *a*, *b*.

Disk small; rays short, robust cylindrical; surface of all the scuta covered with fine granulations; the lateral scuta armed with short, stout, thornlike spines.

Dimensions.—Length of the rays eleven twentieths of an inch.

Description.—This beautiful little Brittle-star is sometimes found on the surface of slabs of Lower Lias, associated with portions of the stem of *Pentacrinus tuberculatus*, Mill. The disk appears to have been small; the arms are short, stout, cylindrical, and clothed with a firm armour of prominent plates; examined with an inch-object-glass, their surface is seen to be covered with fine granulations; the dorsal and ventral plates are small, rhomboidal, and much enveloped by the large lateral plates, these carry on each side three or four stiff thornlike spines (Pl. XIV, fig. 3, *a*, *b*); the robust character of the ray, and the disposition of the spines, is well shown in these figures.

Affinities and Differences.—This species, in the general structure of the arms, resembles *Ophiolepis Murravii*, Forb.; but it differs from that form in having them rounder, less tapering, and more moniliform, in consequence of the thickness of the scutal plates; the short stiff spines of the lateral plates I have not seen on *O. Murravii*.

Locality and Statigraphical Position.—I have found this species on the surface of slabs of Lower Lias limestone from Purton passage, near Berkeley, Gloucestershire, associated with *Pentacrinus tuberculatus*, Miller, and young forms of *Ammonites angulatus*, Schloth., and a small smooth *Pecten*, n. sp. My friend, the Rev. P. B. Brodie, F.G.S., collected it from the same horizon at Down Hatherley in the Vale of Gloucester. To his kindness I am indebted for the loan of the specimen figured in Plate XIV, fig. 3, *a*, *b*.

B. *Species from the Middle Lias.*

OPHIOLEPIS MURRAVII, *Forbes*, sp. Pl. XIV, fig. 1, *a*, *b*, fig. 2; Pl. XVII, fig. 2, *a*, *b*, 3, 4. Pl. XIX, fig. 3.

OPHIURA MURRAVII,	*Forbes.*	Proc. Geol. Soc., vol. iv, p. 233, fig. 1. Read Nov., 1843.
— —	*Charlesworth.*	Lond. Geol. Journ., pl. xx, figs. 4, 5, 1847.
— —	*Morris.*	Catalogue of British Fossils, 2nd ed., p. 84, 1854.
— —	*Wright.*	Brit. Association Report for 1856, p. 403, 1857.
— —	*Pictet.*	Paléontologie, 2nd ed., tome iv, p. 274, 1857.
OPHIOLEPIS MURRAVII,	*Dujardin et Hupé.*	Hist. Nat. Échinod., p. 245, 1862.

Disk large in proportion to the arms; dorsal surface covered with large scales; radial plates small, scutiform, and projecting on the disk; the converging ossicula at their bases are comparatively large and broad; arms relatively short and tapering. Inferior ray-plates small and triangular. Lateral plates encroaching on those below, and uniting with them beneath in the median line of the ray. They appear to have supported large spines.

Dimensions.—Diameter of the disk seven twentieths of an inch; length of the rays eight tenths of an inch.

Description.—This beautiful little Ophiura is moderately large in proportion to the length of the arms; its upper surface is covered with a series of small imbricated scales, which are disposed in consecutive order from the margin to the centre; a double series of small scales are seen on the interbrachial space of the under surface (Pl. XVII, fig. 2); the arms are short, broad, and tapering, not quite twice and a half the diameter of the disk; the dorsal ray-plates are narrow and heart-shaped, from the manner the lateral plates clasp the rays (Pl. XIV, fig. 1, *b*); the lateral ray-plates are proportionately large, and encroach much upon the ventral series; they have an inflated appearance and appear to have supported numerous small spines, of which some obscure traces only remain; the ventral ray-plates are very small and triangular (Pl. XVII, fig. 2, *b*, fig. 3, and fig. 4); they resemble a series of heart-shaped pieces inserted between the lateral plates, and united with them along the median line. The mouth-opening forms a star with five branches, presenting well-marked buccal fissures (fig. 2, *b*); in one of the specimens it is surrounded with small pieces disposed in a series. In the enlarged figure of this species, given in Pl. XIX, fig. 3, the disposition of the dorsal plates is much better shown.

Affinities and Differences.—The structure of the rays, in this Brittle-star, resembles *Ophiolepis Ramsayii*, Wr., from the Lower Lias; it has similar large lateral and small ventral plates; the absence of the disk, however, in *O. Ramsayii* prevents a more perfect diagnosis of that species, and a more accurate comparison with *O. Murravii*, being made.

Locality and Stratigraphical Position.—This very rare little Brittle-star was discovered by my friend the late Dr. Murray, of Scarborough, to whose liberality I am indebted for the specimens figured in Pl. XIV, fig. 1, and Pl. XVII, fig. 2, both collected from the Marlstone near Staithes, on the Yorkshire coast. The one figured in Pl. XIX was obtained from the Grey Limestone near Scarborough, and kindly communicated by my friend J. Leckenby, Esq., F.G.S., to whose cabinet it belongs.

History.—First figured and described by the late Professor E. Forbes in the fourth volume of the 'Proceedings of the Geological Society,' afterwards by Mr. Charlesworth in the 'London Geological Journal.'

Genus—Acroura, *Agassiz*, 1834.

This genus, of which the organic characters are very imperfectly defined, was established by M. Agassiz in his Prodrome for *Ophiura prisca*, Münst. (Pl. II, fig. 5), a solitary species from the Muschelkalk. The form approaches much that of *Ophiura texturata*, Lamk., but differs in this, that the rays are long and very delicate; the osselets of the arms are twice as long as they are broad, having their lateral borders incurved (fig. 5 *b*); the lateral scuta support a number of small scales instead of spines, as in other genera.

Acroura Brodiei, *Wright*, n. sp. Pl. XVII, fig. 5, *a*, *b*, *c*.

Disk very small, indistinct; rays long, very delicate, slightly tapering, nearly a uniform thickness throughout, six times the length of the diameter of the disc; lateral scutæ with scale-like appendages.

Dimensions.—Diameter of the disk one eighth of an inch; length of the arms eight tenths of an inch.

Description.—It is with considerable doubt that I have referred to the genus *Acroura* this small *Ophiura*, discovered by my friend the Rev. P. B. Brodie, F.G.S., in the Middle Lias near Cheltenham. Its place there I consider only as provisional until the discovery of better specimens enables us to understand its structure. The disk is extremely small and indistinct; the rays are long, very delicate, and taper slightly, being nearly of a uniform thickness throughout; the osselets are nearly twice as long as they are broad, and the dorsal plates are deeper than wide, the few lateral plates that are preserved show small scale-like appendages (fig. 5 *c*). The length of the osselets, and the small scales on the lateral scutes, have induced me to place it in the genus *Acroura.* Under the microscope, armed with an inch-object-glass, the plates appear to be covered with fine transverse lines of ornamentation.

Affinities and Differences.—The smallness of the disk, and the proportionate length of arms, six times as long as the diameter of the body, readily distinguish this species from *Ophioderma tenuibrachiata,* the only species of the Middle Lias for which it could be mistaken; the extreme delicacy of the rays, and their nearly uniform diameter throughout, with the length of the osselets, form good characters for its diagnosis.

Locality and Statigraphical Position.—This Ophiura was collected by my friend the Rev. P. B. Brodie, from the Middle Lias of Hewletts Hill, near Cheltenham, in the zone of *Ammonites capricornus,* during the excavation of that rock for one of the reservoirs of the Water-company of that town; it was associated with the stem and side arms of *Pentacrinus robustus,* Wr. I dedicate this species to my friend the Rev. P. B. Brodie, F.G.S., who has kindly communicated for this work the only specimen found.

Genus—Ophiurella, *Agassiz.*

Disk small, membranous, and often very indistinct; rays long and slender; lateral ray-plates provided with elongated filiform spines. All the species hitherto discovered belong to the Jurassic series.

Ophiurella Griesbachii, *Wright.* Pl. XVIII, fig. 3, *a*, *b*.

Ophioderma Griesbachii, *Wright.* Ann. and Mag. Nat. Hist., 2nd series, vol. xiii, pl. xiii, fig. 2, 1854.
— — *Forbes*, in Morris's Catalogue of Brit. Fossils, 2nd edition, additional species, 1854.
— — *Wright.* Brit. Association Report for 1856, p. 403, 1857.

Disk small, membranous, irregularly pentagonal; rays long, round, slender, and gently tapering; ventral ray-plates moderately large and pentagonal, lateral large, in the form of oblique shields clasping the sides of the rays in an imbricated manner, and supporting short stout spines; buccal opening star-shaped, surrounded by a series of blunt osselets.

Dimensions.—Diameter of the disk, seven twentieths of an inch; length of the rays from peristome to apex, three quarters of an inch.

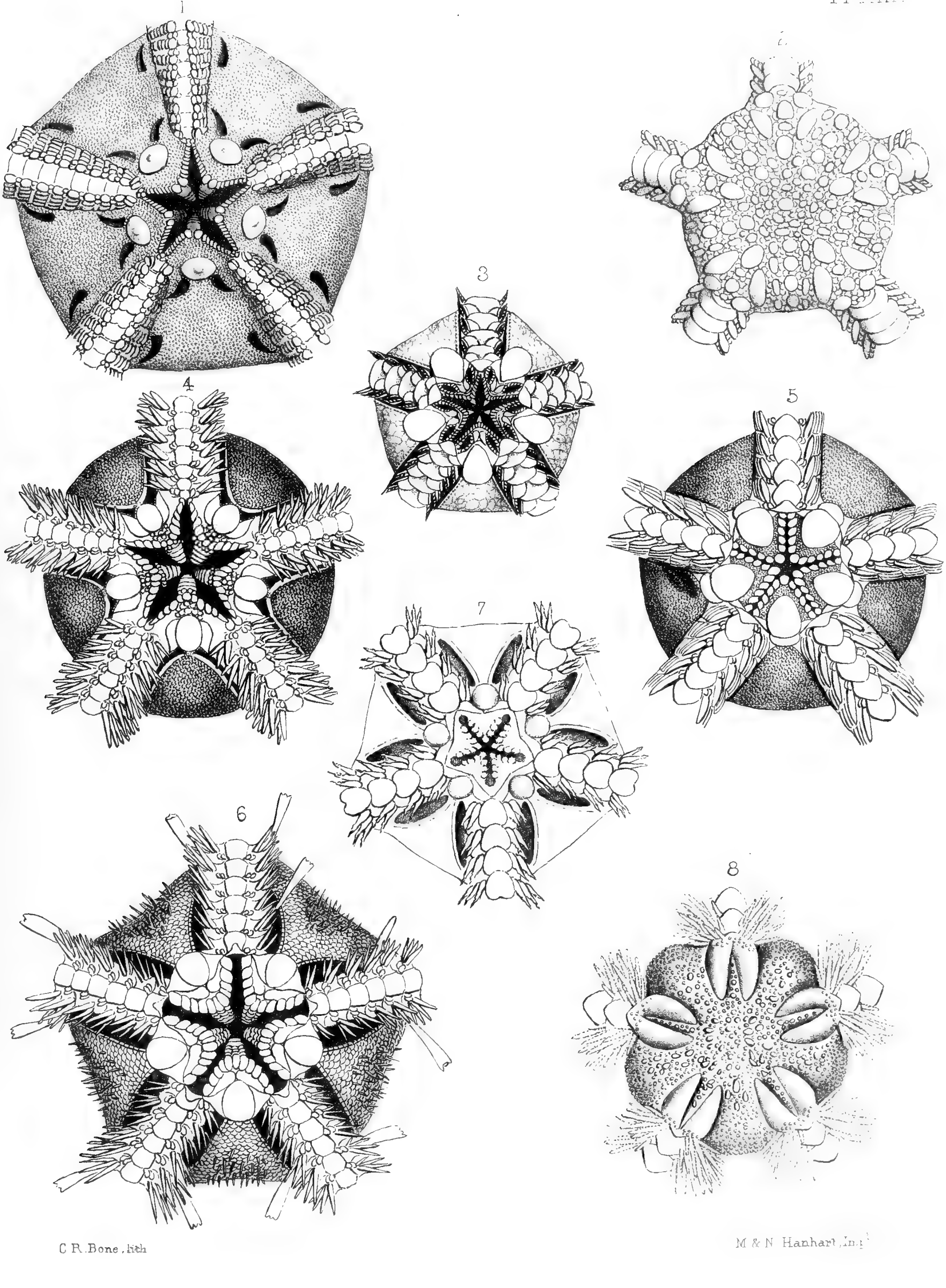
Description.—This beautiful little Brittle-star of the Oolitic sea was discovered by my friend the late Rev. A. W. Griesbach, of Wollaston, to whose kindness and liberality I am indebted for the series of specimens I possess, and by which I have been enabled to make out the structure of this fossil. The disk is small and often very indistinct, consisting of five pairs of heart-shaped plates, so closely united together that in some specimens it appears to be formed of a single circular disk. Each pair of plates has a heart-shaped form, and the small corresponding ray stands out in bold relief from the under side of the disk. All the specimens I have seen lie on their upper surface, with the ventral exposed, so that the clothing of the disk is concealed; in one specimen, however, where a portion of one of the plates is weathered, I observed with an inch-object-glass under my microscope the impression of a series of small imbricated scales resting on the matrix. The rays are long, round, slender, and gently tapering, about three times the length of the diameter of the disk; their under surface, the only one exposed, exhibits in weathered specimens a central element of an elongated form, resembling in miniature the elongated centrum of the vertebra of a fish. Pl. XVIII, fig. 3, *b* shows this structure magnified three and a half times. In the only unweathered specimen I possess, from the

PLATE XIII.

The figures in this Plate are copied from Müller and Troschel's 'System der Asteriden.'

FIG.

1. OPHIODERMA LONGICAUDA, *Linck,* sp. p. 135.
2. OPHIOLEPIS ANNULOSA, *Lamarck,* sp. p. 135.
3. ,, CILIATA, *Retz,* sp. p. 135.
4. OPHIOCOMA DENTATA, *Müll. and Trosch.* p. 135.
5. OPHIARACHNA SEPTEMSPINOSA, *Kuhl and Hasselt,* sp. p. 135.
6. OPHIOMASTIX ANNULOSA, *Lamarck,* sp. p. 135.
7. OPHIOMYXA PENTAGONA, *Linck,* sp. p. 135.
8. OPHIOTHRIX RAMMELSBERGII, *Müll. and Trosch.* p. 136.



C. R. Bone, lith.

M & N Hanhart, Imp.

PLATE XIV.

Fig.

1. Ophiolepis Murravii, *Forb.* p. 151.
   a. Natural size.
   b. Ray, magnified.

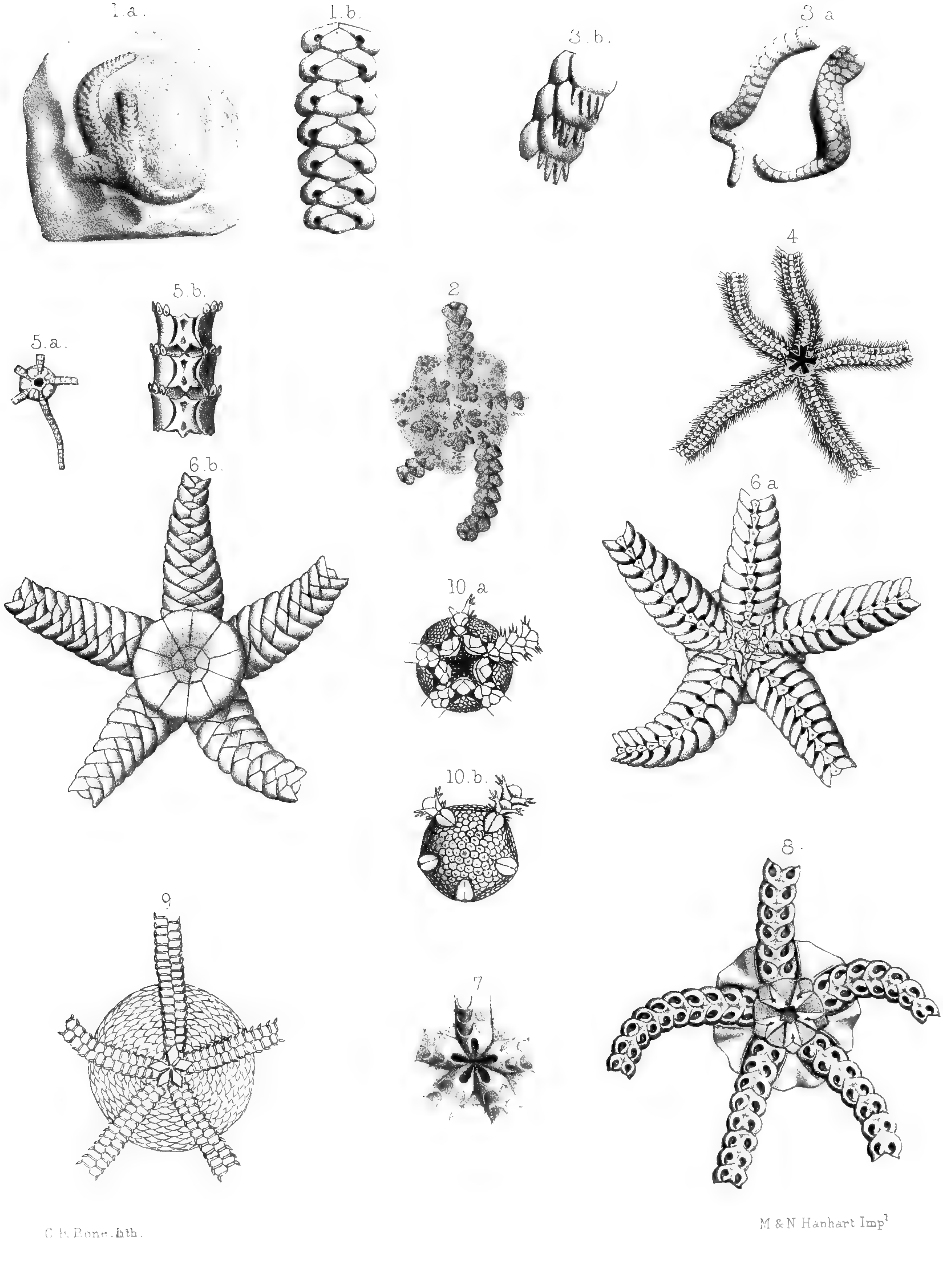
2. Ophiolepis Murravii, *Forb.* p. 151. Under surface, copied from the 'London Geological Journal,' pl. xx, fig. 4.

3. Ophiolepis Ramsayii, *Wright.* p. 150.
   a. Rays, magnified.
   b. Three rings, greatly enlarged.

4. Ophiurella speciosa, *Münster.* p. 134.
5. Acroura prisca, *Münster.* p. 133.
   a. Natural size.
   b. Portion of a ray, magnified.

6. Aspidura loricata, *Goldfuss.* p. 133.
   a. Under surface.
   b. Upper surface. Both magnified.

7. Geocoma Libanotica, *König.* p. 134. Under surface, magnified.
8. Aplocoma Agassizii, *Münster.* p. 134. Under surface, magnified.
9. Protaster Sedgwickii, *Forbes.* p. 136. Under surface, magnified.
10. Amphiura tenera, *Lütken.* p. 136.
   a. Under } surface of disk, magnified.
   b. Upper }



C. R. Bone. lith.   M & N Hanhart Imp^t

PLATE XV.

FIG.

1 *a*. OPHIODERMA GAVEYI, *Wright*. p. 147. Upper surface, natural size; this specimen belongs to Dr. Wright's collection.

b. ,, ,, Portion of a ray, dorsal surface, magnified twice.

c. ,, ,, Ditto, with lateral spines, magnified four times.

d. ,, ,, Ditto of terminal part, magnified four times.

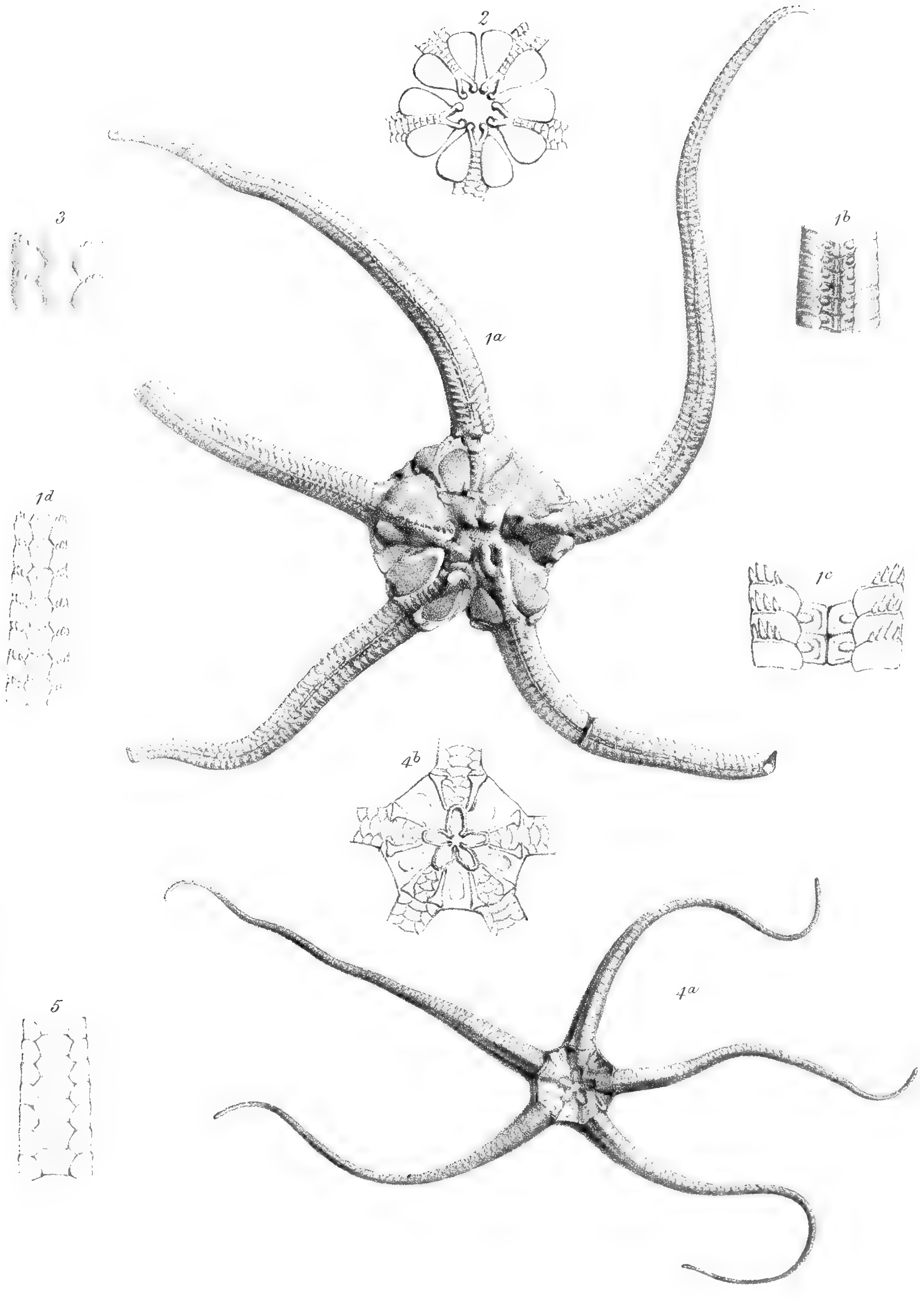
2. ,, ,, Disk and dorsal plates, natural size.

3. ,, ,, Three rings of a ray, magnified six times; this specimen belongs to Dr. Wright's collection.

4 *a*. OPHIODERMA EGERTONI, *Broderip*. p. 143. Basal surface, natural size; this specimen is in Dr. Wright's cabinet.

b. ,, ,, Under surface of the disk, magnified twice.

5. ,, ,, Portion of a ray, magnified four times.

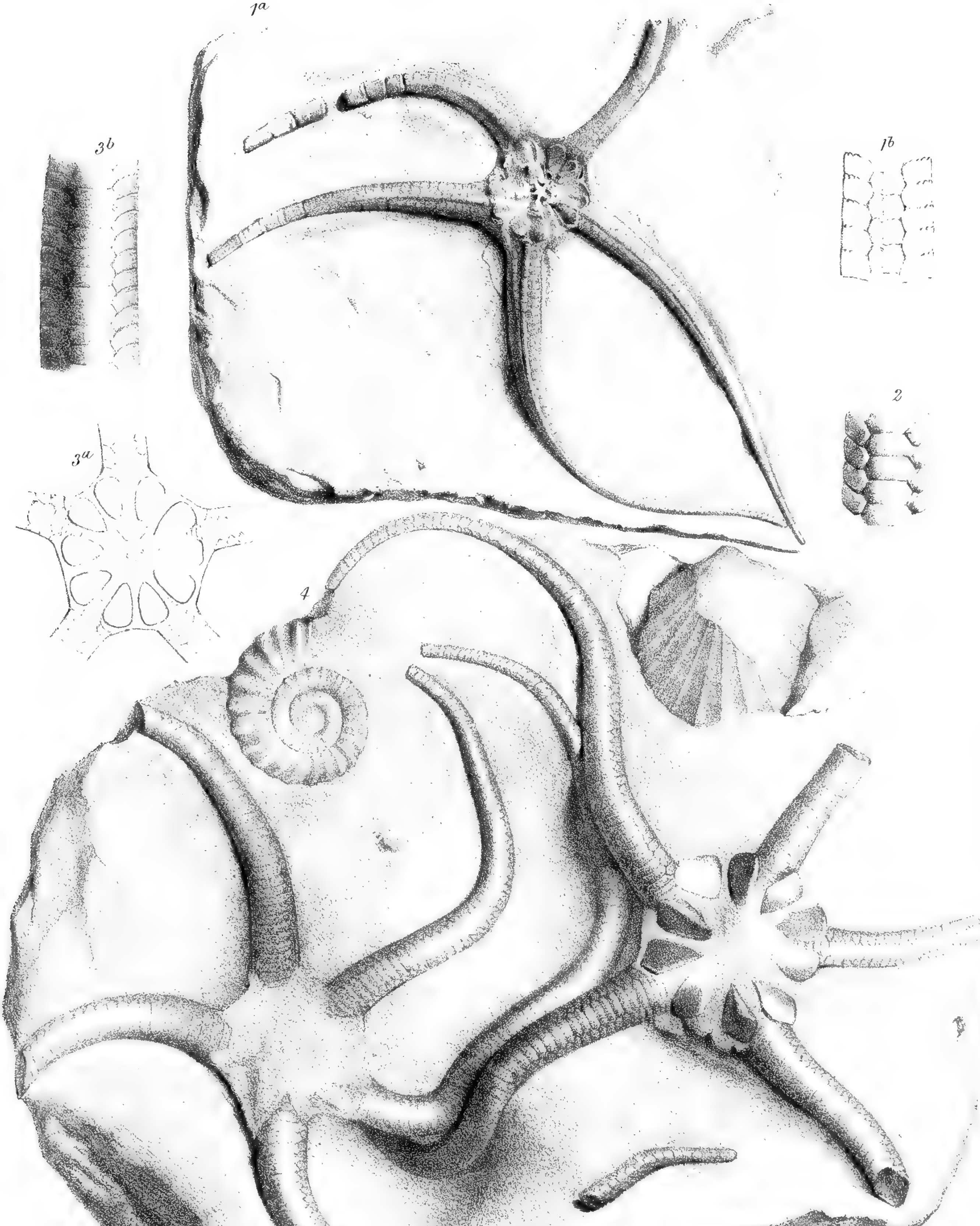


C R Bone del et lith

W West imp

PLATE XVI.

Fig.			
1 *a*.	Ophioderma carinata, *Wright*.	p. 148.	Upper surface, natural size; this specimen belongs to the collection of J. Leckenby, Esq., F.G.S.
b.	„ „		Portion of a ray, magnified four times.
2.	„ Milleri, *Phillips*.	p. 140.	Portion of a ray, magnified three times.
3 *a*.	„ „		Upper surface of the disk, natural size.
4.	„ „		A slab of Marlstone, with several specimens thereon in high relief, belonging to the Museum of the Yorkshire Philosophical Society.

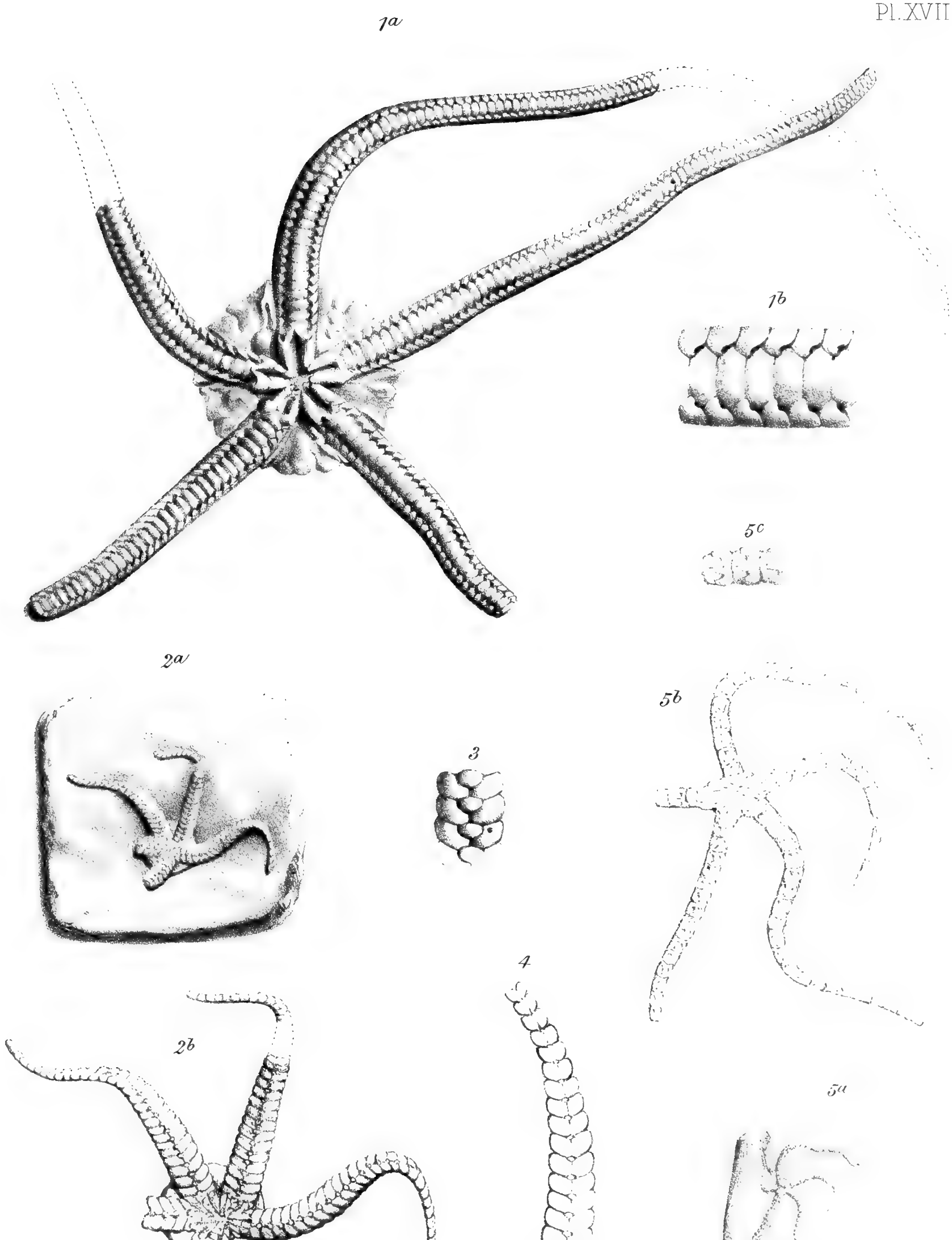


C.R. Bone del. et lith

W West imp

PLATE XVII.

Fig.		
1 *a*.	OPHIODERMA GAVEYI, *Wright*. p. 147.	Under surface, natural size; this specimen belongs to the Museum of the Worcestershire Natural History Society.
b.	,, ,,	Portion of a ray, magnified three diameters.
2 *a*.	OPHIOLEPIS MURRAVII, *Forbes*. p. 151.	Under surface, natural size, on a slab of Marlstone; this specimen belongs to Dr. Wright's collection.
b.	,, ,,	The same, magnified two diameters.
3.	,, ,,	Portion of a ray, magnified four times.
4.	,, ,,	Ditto, magnified four times.
5 *a*.	ACROURA BRODIEI, *Wright*. p. 153.	Specimen, natural size; this specimen belongs to the collection of the Rev. P. B. Brodie, F.G.S.
b.	,, ,,	The same, magnified three diameters.



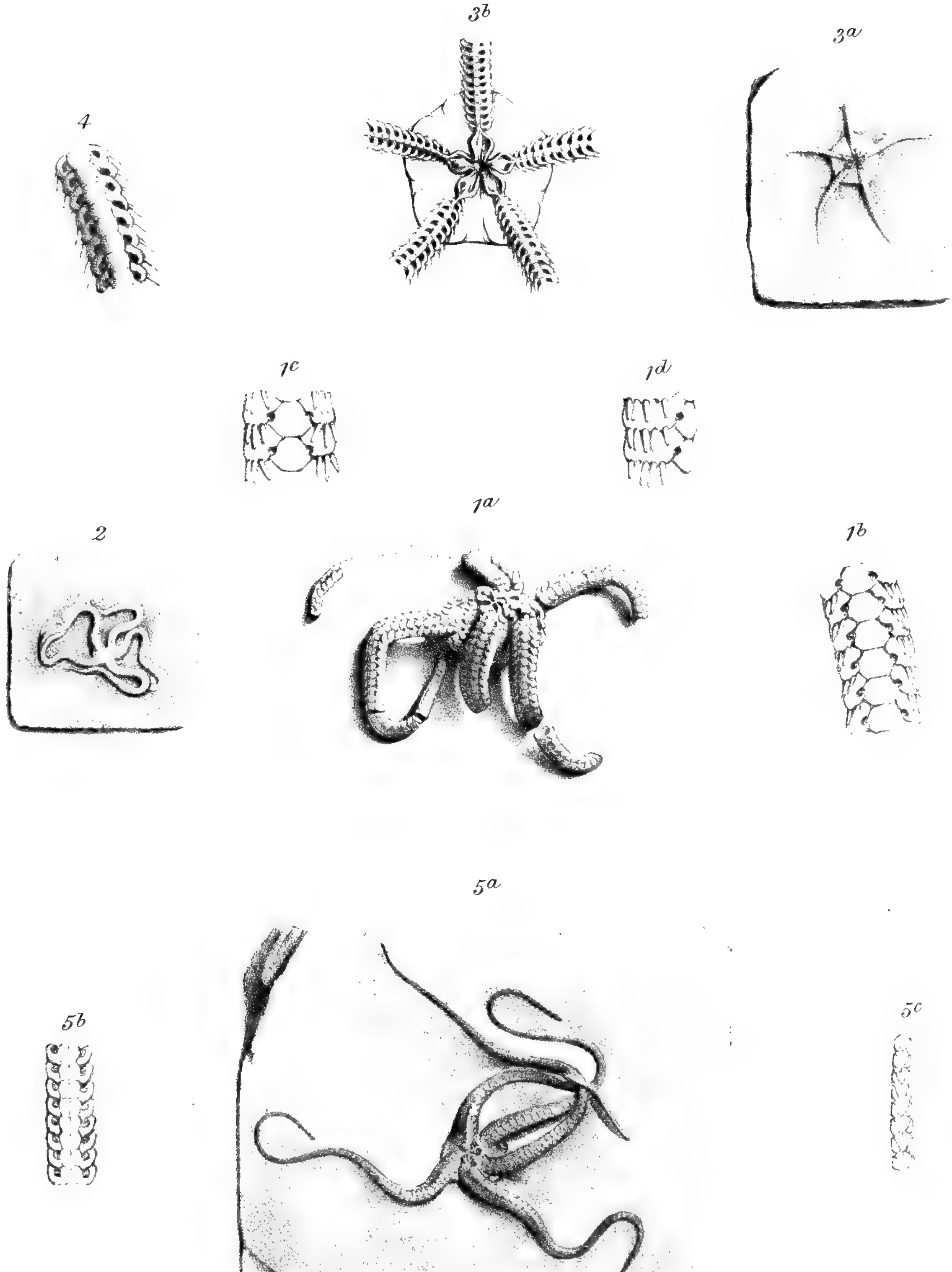
C.R. Bone del et lith.

W. West imp.

PLATE XVIII.

Fig.		
1 *a.*	Amphiura Prattii, *Forbes.* p. 156.	Under surface, natural size; this specimen belongs to the British Museum.
b.	,, ,,	Portion of a ray, magnified four times.
c.	,, ,,	Ditto of the base, magnified four times.
d.	,, ,,	Lateral portion, magnified four times.
2.	,, ,,	Small specimen coiled up on a slab, natural size. British Museum.
3 *a.*	Ophiurella Griesbachii, *Wright.* p. 154.	Natural size, under surface; this specimen belongs to Dr. Wright's collection.
b.	,, ,,	The same, magnified three and a half diameters.
4.	,, ,,	Portion of a ray, showing spines, magnified six diameters.
5 *a.*	Ophioderma tenuibrachiata, *Forbes.* p. 146.	Under surface, natural size, on a slab of Middle Lias sandstone; this specimen belongs to Dr. Wright's collection.
b.	,, ,,	Portion of a ray, magnified four times.
c.	,, ,,	Terminal portion, magnified four times.

Pl. XVIII.



C.R. Bone del et lith.

W. West imp.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1864.

LONDON:

MDCCCLXVI.

A MONOGRAPH

OF

BRITISH TRILOBITES.

BY

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

LATE OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

PART III,

CONTAINING

PAGES 129 TO 176; PLATES XV TO XXV.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1866

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ADDENDA ET CORRIGENDA.

Pl. XV, figs. 7, 8, for *Ogygia subduplicata* read *Phacops subduplicatus.*

Pl. XVII, fig. 8, for *O. pelatata* read *O. peltata.*

Pl. XX. The heading should be " UPPERMOST CAMBRIAN (TREMADOC)."

Pl. XXII, fig. 6, belongs to *A. peltastes.*

Pl. XXIII, fig. 6, description. Add: (Mr. Edgell's cabinet).

Pl. XXVIII, fig. 15, for *I. æmula* read *I. æmulus.*

Page 129, line 3 from top, and *passim*, for *anticè* read *antè*, and for *posticè* read *ponè.*

Page 130, after description of *Ogygia angustissima*, add: "This may be but a sub-species of *O. Buchii*, with a very narrow long axis. There is a more important var. common at Llandeilo, which has a wider, shorter tail, and might be called var. *convexa.* It has only 11 lateral furrows to the tail; and is characteristic apparently of the Lower, as *O. Buchii* proper is of the Upper beds of the Llandeilo Flags. (Edgell)." Line 10, dele "*Ogygia.*" It is surely a *Phacops* of the section *Chasmops*, as indicated; correct therefore the name on the plate. See above.

Page 132, bottom. Add: Meadow Town, Shropshire: Cabinets of Mr. Morton of Liverpool, and of Mr. H. Wyatt Edgell. See also page 160.

Page 133, *Ogygia scutatrix*, also page 135, *Ogygia peltata.* I must amend these descriptions (p. 133—136), by referring Pl. XVII, figs. 9, 10, which from the width of the axis I had assigned to *O. scutatrix*, to *O. peltata.* In truth, they represent the ♀ form of the latter species, with which they occur at Whitesand Bay. A noble series, lately transmitted to me by Mr. Henry Hicks, show the distinctive characters of *O. peltata* in both the broad (♀) and narrow (♂) forms.

In the broader form the axis of thorax and tail is $\frac{2}{7}$ths the whole width; and the fulcrum of the thoracic rings, which our figure 8 (copied from the yet unpublished memoir on North Wales by Prof. Ramsay and myself) scarcely shows at all, is placed $\frac{3}{4}$ths out from the axis, and terminates a short distinct facet upon the falcate tip, as shown in fig. 9. The tail has the axis reaching $\frac{3}{4}$ths the whole length; and its width in one form is $\frac{2}{7}$ths, in another barely $\frac{1}{4}$th, of the whole width of the tail. The 8 or 9 cross furrows on the axis are only strong on the sides, leaving the central part only faintly ringed. The side-furrows are like our figure, and have but faint intermediate lines or furrows. The *fascia* or inner border is coarsely striate.

Page 133, lines 9 and 12 from top, for *axin* read *axem.* Line 11 from top, for *secondariis* read *secundariis.*

Page 135, line 9 from top, for *secondariis* read *secundariis.*

Page 134, bottom. Add: "LOWER TREMADOC," Carnarvon Road, $1\frac{1}{2}$ mile west of Tremadoc (Mr. Homfray).

Pages 136 and 142, et *passim*, for *brevispinoso* read *brevi-spinoso;* for *retrocurvæ* read *retro-curvæ.*

Page 143, line 8. Also Mr. H. W. Edgell's cabinet.

Page 150, line 25. The labrum figured probably belongs to "*A: peltastes;*" as a synonym for which I should have quoted "Decade 2, Geol. Surv., pl. v, figs. 2, 4." They are reproduced in our Pl. XX, which see.

Page 153, line 29, dele "Abereiddy Bay," and insert Llampeter Felfrey." Line 5 from bottom, for '*cognota*' read '*cognita.*'

Page 154, line 19, for "LLANDEILO FLAGS?" read "*Caradoc.*" Line 7 from bottom, for '*basin*' read '*basim.*'

Page 156, line 7, for "Shropshire" read 'Horderley;' the species is local there.

Page 158, note. There has since been found reason to suppose the specimen quoted is really an American one, not British.

Page 162, line 22 from top, strike out '*cujus.*'

Page 164, line 8 from top, for '*cujus caput rotundatum*' read '*capite rotundato.*'

Page 168, line 12 from top, for '*Wrac*' read '*Wrae.*'

J. W. S.

March 12*th*, 1866.

Sub-species I.

OGYGIA ANGUSTISSIMA, n. sp. Pl. XIV, figs. 8, 9.

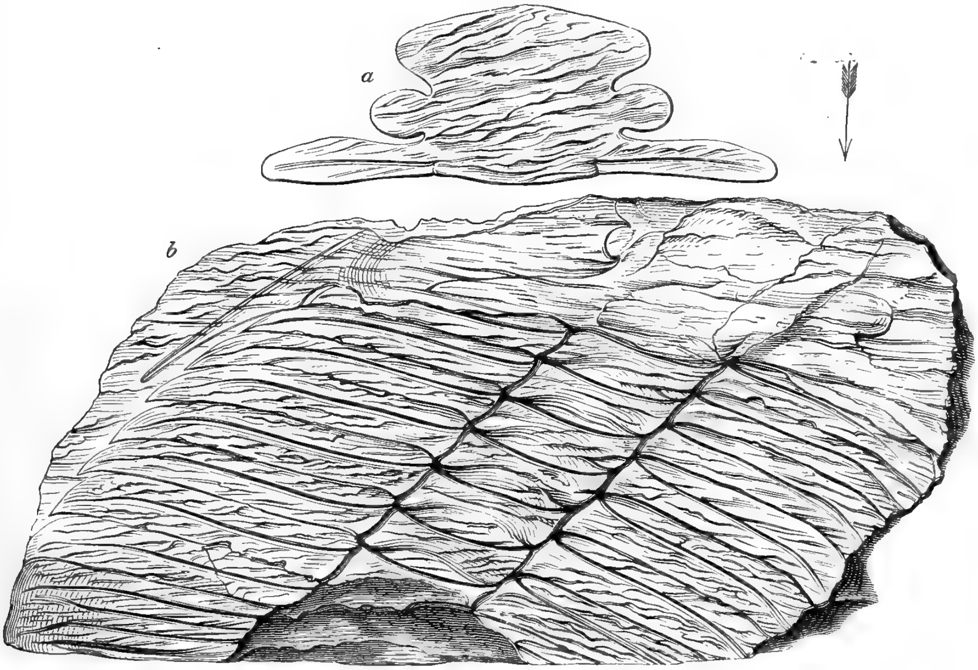
O. ovata, anticè obtusa, parva, 17 *lineas longa,* 13 *lata, capite transverso, axe angustissimo. Omnino* O. Buchii *simillima, nisi glabellâ tertiam partem latitudinis genæ vix efficiente; margine antico capitis obtuso truncato: axe thoracis caudæque pleuris ter angustiore.*

I cannot believe this to be a mere variety of *O. Buchii,* though it does approach very near in character to young male specimens of that species. *O. angustissima* has so extremely narrow an axis, and so broad, transverse, and truncate a head, that, whatever may have been the 'origin of the species,' there is sufficient difference in this to afford us a good diagnosis. The specimens are in the choice cabinet of Mr. Griffith Davies, of 17, Cloudesley Street, Islington.

Locality.—LLANDEILO FLAGS. Gilwern, near Llandrindrod, Builth.

To show how these Llandeilo trilobites are occasionally maltreated by cleavage, I give a woodcut from a specimen of *O. Buchii* in Mr. Henry Hicks' cabinet. It was found at the east end of the section of vertical slate-rocks in Abereiddy Bay, Cardigan-

FIG. 30.



Ogygia Buchii, distorted by cleavage; from the vertical black slates of Abereiddy Bay, Cardiganshire.

shire. The arrow indicates the direction of the pressure, which has shortened all the parts; and the wrinkles on the surface are in the mean direction of that force, which was undoubtedly, as Prof. Phillips, Prof. Haughton, Mr. Sharpe, and others have shown, the cause of this common phenomenon in the slaty rocks. Lateral pressure, acting on a confined plastic mass, is quite sufficient to produce such effects; and has, indeed, been proved by experiment to be equal to the result. Mr. H. C. Sorby has philosophically illustrated this change of dimensions in the rock, which is noted here the more particularly, as our future plates will show several species of trilobites affected by it.

OGYGIA? (vel PHACOPS) SUBDUPLICATA, *Salter*. Pl. XV, figs. 7, 8.

O. caudâ latâ semiovatâ, subtrigonâ, $1\frac{1}{2}$ *unciam longâ, fere planâ, costis perduplicatis. Axis conicus, per* $\frac{5}{6}$ *caudæ extensus, apice prominulo* 13-*annulato, annulis anticis abruptè angulatis. Costæ laterales* 9, *marginem angustissimum ferè attingentes, ad apices decurvatæ, omnino interlineatæ, sulcis posticis conniventibus, ultimis profundis parallelis nec abbreviatis.*

Although placed in *Ogygia*, from its general resemblance to that genus, I confess to a strong suspicion that this is a *Phacops* of the section *Chasmops*, and as such it should have been previously described. The strong posterior furrows, with their connivent intermediate sulci (or rather it is the intermediate ones which are the longest and deepest), strongly remind us of some *Ogygiæ;* while the character of the axis, with its arched and duplicate anterior rings, is much more like that of *Chasmops* (see Pl. IV, fig. 19). Moreover, it is more likely that this should be a lingering species of the latter subgenus, than that *Ogygia* should reappear in the Lower Llandovery Rocks, while it is absent from the Caradoc.

Locality.—LLANDOVERY ROCKS of Haverfordwest, Pembrokeshire. The specimens are in the small but excellent collection of Mrs. Breawell, of Cambridge Terrace, Brighton; relict of H. Day, Esq., formerly of Hadlow, Uckfield.

OGYGIA (PTYCHOPYGE[1]) CORNDENSIS, *Murchison*. Pl. XVI.

ASAPHUS CORNDENSIS, *Murchison*. Silurian System, pl. xxv, fig. 4, 1839.
— — *Salter*. Morris's Catalogue, 2nd ed., p. 100, (List at end of *Asaphus*,) omitted in p. 112; 1854.
— — *Id*. Siluria, 2nd ed., pl. iii, fig. 4, 1859.

O. obtusè ovata, 3—4-*uncialis, capite lato semicirculari, spinis parallelis. Glabella*

[1] *Ptychopyge*, Angelin, consists of those species of *Ogygia* which have the facial suture *within* the margin in front. *O. corndensis* certainly belongs to it. I do not know sufficiently the structure of other species to subdivide the genus.

urceolata, anticè clavata, lobis obscuris. Oculi modici, circumscripti. Thorax articulis rectis, fulcro remoto, sulco pleurali profundo, apicibus obtusis. Cauda axe primùm conico, dein parallelo, 7-8-*costato, lateribus* 8-*costatis, costis rotundis rectis simplicibus, ad marginem striatum concavum undulatis.*

The cabinet of Mr. Griffith Davies, of Islington, has for several years contained a fine series, from Builth, of this Trilobite, which has been so long obscure, from the very imperfect specimen figured in the 'Silurian System.' Mr. James Sowerby's figure showed, indeed, that it was distinct from the *Ogygia Buchii;* but its characters could not be fully known from the fragment figured. The exact age of the Corndon mountain, relatively to the trappean beds of Builth, may now probably be determined from this single fossil.

It is a large species; occasionally $4\frac{1}{2}$ inches by $3\frac{1}{2}$, depressed, but not flat; of an obtuse oval shape, with rather blunt extremities in the ♀ form (figs. 9, 11), or with the head somewhat pointed in the ♂ varieties (figs. 1, 7). I will describe the broader form first.

Head a broad segment of a circle, the length being to the breadth nearly as 2 to 5. Of this breadth the glabella occupies more than a third and less than a fourth; it is urceolate in shape, being broad below, contracted at the sides rather below the eye, and then again clavate above. Traces of two short furrows only on each side (the three upper ones are obsolete in the adult), the lower one oblique;—it is the neck-furrow, incomplete in the middle, but marking off a much broader segment beneath the glabella than below the cheeks, where the furrow is strong and continuous.

In front the blunt glabella invades the striated margin, which is here narrow, but very broad round the cheeks, and produced behind into an abruptly narrowed spine, which reaches the sixth thorax-segment in the adult; it is shorter in the young. The eye is rather small for the genus, placed fully half-way up the head, near the glabella, and overhung by it; a depressed space surrounds it. The facial suture cuts the posterior margin rather more than half-way out, and in front it circles round the glabella (intra-marginal). The labrum (fig. 10) is pointed, with two pairs of furrows, and a broad arched base. It is also visible in fig. 9.

The glabella-furrows are strongest in young specimens, and get partly obliterated in age. In some young ones four pairs of furrows show clearly; the two upper ones directed obliquely backwards towards the eye, the middle one obliquely forwards, the basal one (neck-furrow) direct across. Besides these there is the narrow marginal furrow frequent in the genus, and which probably marks out the articular area on the under surface of the crust. All the glabella-furrows are short and shallow, except the hindermost pair, which are deeper, and show in every specimen of all ages.

Thorax with a wide axis, less than one third the whole width, the rings straight across, and ornamented with coarse arched striæ. The pleuræ straight, scarcely bent at the remote fulcrum, very deeply grooved and strongly facetted; the apices blunt and rather tumid. The fulcrum is about half-way out in all but the front rings.

Tail semicircular, but with rather straight sides and a broad, coarsely striate margin, which is waved by the strong lateral furrows. The axis narrows abruptly from a conical base, and is then parallel-sided; reaching nearly to the end of the tail. It is 9-ringed, and has, besides, a blunt terminal portion, and no appendix beyond. The sides have eight furrows, strong and deep, and rounded at their ends, reaching to the striated border, but not the margin; the upper or marginal one much the strongest and deepest. The ribs are rounded, very convex, quite straight, radiating, and without any duplications. In the tail of young specimens, however, a faint duplication is observable in the forward ribs, and only on the forward edges of these ribs, making them angular instead of rounded. The whole surface of the tail is minutely granular; of the glabella, apparently punctate.[1]

Variations.—There seem to be the usual "*forme longue*" and "*forme large*" in this as in other species of *Ogygia.* Our principal specimens (figs. 9, 11) are of the broad form, and the smaller ones (figs. 1, 7) of the narrower one. Figs. 1 and 7, which are probably ♂ forms, have the head much more pointed, forming a gothic arch, and the margin in front of the glabella much broader than in the female form; the glabella is more pointed and clavate in front. The thorax, too, is relatively narrower, and the tail a semicircle, but with somewhat straight sides. Young specimens do not differ much in proportion or shape from older ones, except in having the tail more triangular (fig. 7), and with a narrower axis, the number of ribs in the tail remaining the same. But very young ones (figs. 5, 6) show the metamorphosis. Fig. 5, which is only two lines long, has clearly but six rings, and fig. 6 has only seven rings, besides having the cheeks contracted at the base of the spine, which is also more divergent than in the older form. This last character may be accidental in this specimen, for somewhat older ones (figs. 2, 3, 4) show the spines more parallel to the body, and the cheek not contracted at this part.

The appearance of a reduced number of body-rings is often due to accident. In fig. 4 the body has slipped under the carapace, so that on the left side there are seven rings, and on the right hand only four. But this is not the case in the two youngest specimens just quoted, which have six and seven rings respectively.

Locality.—Llandeilo Flags, Gilwern, near Llandrindod, Builth. All the specimens figured are in the collection of Mr. Griffith Davies, of Islington, except fig. 8, which is Murchison's original specimen from the Corndon Mountain W. side (Mus. Geol. Soc.)

[1] A delicate lineation occupies the whole of the axal-lobe of the thorax, and the outer half of the pleuræ is much more strongly marked with it than the inner. The concentric lineation of the tail-border is very sharply defined, in a rather narrow band, the lines abutting obliquely, as usual, against the inner edge.

OGYGIA SCUTATRIX, *Salter.* Pl. XVII, figs. 9—13 (9, 10 are wrongly marked as *O. peltata* on the plate).

OGYGIA SCUTATRIX, *Salter.* In Siluria, 2nd ed., p. 53, woodcut 9, fig. 1, 1859.
— — *Id.* Append. Ramsay, Geol. N. Wales; Mem. Geol. Survey, vol. iii, 312, pl. ix, fig. 1, and pl. viii, fig. 8, and plate ix, fig. 1, 1866.

O. septuncialis, fere rotunda! vel latissimè elliptica, depressa. Caput?—. Thorax caudâ brevior, axe lato; pleuris longis axin $1\frac{1}{2}$ *superantibus, profundè sulcatis, â fulcro (ultra dimidium posito) paullo deflexis. Cauda quam semicirculari latior, axe lato 8—9-annulato; limbo sulcis primariis 7—8, ad apices fractis; secondariis rectis profundis haud axin attingentibus.*

I well remember finding this large specimen in 1853, together with the *Asaphus affinis* hereafter to be described. They were on the face of a good slate fence in the valley behind Garth, Portmadoc; and were the harbingers and first fruits of the fauna, then unexplored, of the Tremadoc Slates.[1] The large size and round contour of *O. scutatrix* distinguish it easily from any other of the genus. The specimen is in the Museum of Pract. Geology: it may have been a little altered in form by the pressure accompanying cleavage; but in the figure some allowance is made for this. If not sufficiently so, still the form must have been a very wide and rounded one, and can scarcely ever have had the shape of the species next described, although it is evidently closely allied to it.

Length 7 inches; the breadth fully 6 inches. Of the head we have only a single specimen, in Mr. Lee's collection (fig. 10); and it is from a different locality and formation. It appears to be very short and broad, with a wide urceolate glabella, a broad striated margin, a small forward eye, and a wide labrum, with a narrow arched base.

The body is four fifths the length of the tail, and of eight widely transverse joints, with a broad axis, which is not convex, but sharply defined, and is more than two thirds as wide as the flat pleuræ. These are deeply grooved, the groove much curved at its origin and bent (as are the pleuræ) at the fulcrum-point. This occurs at about two thirds out; it is rather more remote in the front rings. The anterior or fulcral half of the pleuræ is much broader and less convex than the hinder part, which is angular, almost gibbous, beneath the fulcrum. From this point a strong oblique striation covers all the tips of the pleuræ, corresponding to the broad-striated area which runs round the tail-border. The tips of the pleuræ are truncate, the hinder end produced a little into an acute angle.

[1] I am afraid I replaced the gate-post with somewhat insufficient material. A new *Ogygia*, and that in a new and unexplored formation, was not to be resisted. The owner of the field must accept my apology; and will oblige me much by searching for more complete specimens.

The tail, nearly semicircular in outline, is more than twice as wide as long. The axis broad, quickly tapering, reaching less than four fifths the length of the tail; depressed, and with (apparently, for the extreme tip is lost) a blunt termination. It consists of eight strong rings, and a semicircular terminal portion. The broad side-lobes are grooved by eight strong primary furrows, interlined from near their origin by furrows as strong as themselves, but which commence very abruptly at a short distance from the axis, and radiate straight out, not bent (as are the primary furrows) in a line corresponding to the fulcrum of the pleuræ. A broad band of very oblique and wavy striæ ornaments the border of the tail above, and beneath it the concentric striated fascia (fig. 12) has the striations wide apart.

The labrum (fig. 13) is pointed abruptly, and seems to have two pairs of concentric furrows, but it is very imperfect in our specimen (fig. 13) from the Tremadoc Rocks.

In fig. 10, which is from the Arenig group, the labrum is more perfect. It is as broad as long, and subquadrate in outline, the front much arched; the base of attachment scarcely wider than the broad-winged sides; the notch above the short auricle somewhat acute. The concentric furrows are strong and double, the central part enclosed by them roundish and convex, and the apex (broken off) is connected with this central part by a raised space, and this elevation is sharply divided from the flat wings by longitudinal furrows.

The large size and round form of this fine species much recals that *O. Desmaresti*, Brongn. (the *O. Brongniarti* of Rouault), and well figured by the latter authority in the 'Bull. Soc. Géol. France,' vol. vi, 2nd ed., pl. i. From that species the less width of the axis, the straight, not curved, pleuræ, grooved nearly to their ends, distinguishes our rare fossil. From *O. Edwardsii* (pl. ii, fig. 1, of the same work) it is distinguished by the fewer joints of the tail, and the less number of lateral furrows, all of which are duplicated. The pleuræ, too, are curved in *O. Edwardsii*, Rou., which in many respects closely resembles *O. Desmaresti*. I do not know any species with which ours need be compared, except the following one, which at one time I thought identical ('Siluria,' l. c., p. 53).

Localities.—Lower and Upper Tremadoc Rocks. Lower Tremadoc.— Carnarvon Road, 1½ miles W. of Tremadoc (Mr. Homfray). Upper Tremadoc.—North face of Garth Hill, at the mouth of the Traeth Bach, Merionethshire, opposite Portmadoc—in company with *Angelina* and many other fossils (Mus. Pract. Geology). Also Portmadoc, quarries in the town. The labrum (fig. 12) is from thence, and is in Mr. Ash's cabinet. Arenig group.—North-east corner of Whitesand Bay, St. David's, Pembrokeshire, figs. 9, 10 (in Mr. Lee's cabinet).

OGYGIA PELTATA, *Salter*. Pl. XVII, fig. 8.

OGYGIA SCUTATRIX, *Salter*. Siluria, 2nd ed., p. 53, Foss. 9, f. 1, 1859.
— PELTATA, *Id.* Append. Ramsay, Geol. N. Wales; Mem. Geol. Survey, vol. iii, p. 313, pl. xii, fig. 8, 1866.

O. modica, vel caput, thoracem, caudam æqualis. Glabella lata, lævis, sulcis nullis. Thorax axe depresso, pleuris angustior; his usque ad apices falcatos nec decurvos planissimis; fulcro obsoleto. Cauda quam semicirculari longior, axe lato 8-*annulato; limbo sulcis primariis subrectis, secondariis abbreviatis.*

We have only portions of this fine species, but these enable us to reconstruct a fossil certainly four inches in length, of a broad-oval shape. Our fig. 8 is a copy of the figure in the 'Survey Memoir' above quoted. It is probably not of the full breadth, but nearly so; and I have no specimen which more completely shows the true shape.

The head, thorax, and tail, are nearly of the same length; the head is somewhat longer than a semicircle, with very short broad head-spines. It is widely margined; and the glabella is well distinguished from the cheeks, and is of the same width with them, parallel-sided, reaching five sixths the length of the head, and without any distinct lobes except the neck-segment, which is strongly marked out. The eyes are large?, placed half way up the head. The portion of the neck-furrow beneath the cheeks is much nearer to the posterior margin than that beneath the glabella, and abruptly so (see fig. 8). The striated margin to the cheeks is very broad towards the front.

Thorax with a wide axis, not quite so wide as the pleuræ, and somewhat narrower behind. The rings of the axis are very flat, and scalloped out at their junction with the pleuræ, so that the axal-furrows in this (as in the preceding species) present a set of re-entering angles, with concave arches between them. The pleuræ are flat, straight as far as the fulcrum, which is placed at two thirds out. The pleural groove is sharp and sigmoid in its curve, and reaches nearly to the falcate tip without any angular bend. It is parallel to the front edge, apparently more so than in *O. scutatrix*, and the hinder half of the pleuræ is rather the largest.

The tail is a semicircle, the axis occupying rather more than a fourth of the entire width, and tapering backwards for nearly three fourths of the length. It is annulated by seven furrows, which, except the two or three last, stretch right across. The tip is blunt, and rather obscure. The sides are radiated by eight strong grooves, including the upper or submarginal one, which are all slightly bent downward near their ends, and are interlined by similar but much shallower furrows, which start abruptly (as in the last species) from a point near, but not close to, the axis. A plain smooth (?) border to the upper surface, and the incurved fascia narrow and closely striated.

The specimens described are all from the north-west angle of Whitesand Bay, St. David's Head, and differ from the N. Welsh species last described as follows:—The form more elongate; the pleuræ flatter, much shorter, and more pointed; the tail with a narrower axis, and with less distinct interlineations to the sides. From *Barrandia Portlockii* (see Pl. XIX), the much greater length of the axis, and narrower glabella, will easily distinguish it.

Locality.—" Arenig group " of dark earthy slates at Whitesand Bay, St. David's Pembrokeshire, north of the reef called *Trwyn hwrddyn*, which is probably of the age of the Tremadoc Rocks.

Ogygia Selwynii, *Salter*. Pl. XVII, figs. 1—7.

Asaphus Selwynii, *Salter*. Reports Brit. Assoc. Trans. of sect., p. 57, 1852.
— — *Id.* In Morris's Catal., 2nd. ed., p. 100, 1854.
Ogygia Selwynii, *Id.* Append. Ramsay, Geol. N. Wales; Mem. Geol. Survey, vol. iii, 313, pl. ix, figs. 2—6, and pl. 11 b, fig. 5, 1866.

O. elliptica plana, triuncialis, capite brevispinoso; glabellâ oblongâ, genis angustiori. Sulci glabellares brevissimi. Oculi magni. Thorax pleuris a fulcro remoto decurvis. Cauda axe angusto, longiconico, 6, 7*-sulcato, apice prominulo; lateribus* 7*-sulcatis, sulcis brevibus, obscuris, interlineatis. Fascia latissima, striis confertis.*

A species of more than ordinary interest, since it was the first true indication of the fauna of the great group now distinguished in Britain under the name of the " Arenig or Skiddaw group." A solitary fossil, found by Prof. Sedgwick and myself in 1844, proved different from all other Lower Silurian species, and characterised a particular set of strata, which were successfully compared with the rocks west of the Stiper Stones, by means of a specimen of this same species. Such exact indices are our friends the Trilobites of age in the Palæozoic Rocks.[1] We have specimens from three localities, viz., Hengwrt Uchaf, four miles north-east of Dolgelly, and we figure the original small specimen (Fig. 31); from S. Carnarvonshire; and lastly from near Chirbury, Shropshire. The latter are by far the finest specimens, and our larger figures are taken from them. Mr. Lightbody has lent some fragments of the head, and our restored figure (Pl. XVII, fig. 1) is partly made from these, and partly from others in the Museum of Practical Geology.

Fig. 31.

Ogygia Selwynii. Original specimen from Dolgelly.

The head is broad, semi-oval, an inch and a half broad or more in Shropshire specimens, and broadly margined. The oblong glabella is distinct all round, depressed, gently clavate in front, and contracted at the sides, but otherwise parallel-sided; with a large upper lobe and three very short lateral lobes, which do not reach even one third across the glabella (fig. 2), the lower pair largest and somewhat oblique. Eyes large lunate, placed less than half-way up the head. The facial suture cuts the margin more than

[1] The " Skiddaw group " has since proved rich in *Graptolites*, and these enable us to compare it with the Quebec group of America and the black slates of Melbourne. But *Ogygia Selwynii* was the first step in the comparison for the whole series.

half way out, but not very near the short spinous angles. The glabella reaches and invades considerably the front margin, so as to leave it very narrow in front; on the sides it is rather broad. The neck-furrow is indistinct. Labrum as broad as long, obtusely pointed, with strong concentric furrows.

The thorax, of eight narrow well-defined segments, is not quite so long as either head or tail, which are equal. The axis is well defined, gently convex, not quite two thirds the width of the pleuræ. The latter are flat as far as the fulcrum, which is placed half way out, then bent down; the pleural groove very shallow, except beyond the fulcrum, where it is deeper.

The tail is rather more than a semicircle, ten lines long by sixteen broad. The axis narrow, and tapering, not reaching quite three quarters the length of the tail (in the smaller Welsh specimens it reaches fully three fourths). It is annulated by six or seven furrows above, the upper one often strongest, the rest faint. The sides of the tail are marked by seven shallow short furrows, which do not reach to the depressed border, and the upper one of these also is the strongest. The broad margin is flat or slightly concave. The incurved fascia is very broad, folding over the tip of the axis, and closely striated. Young specimens (fig. 3) show fewer ribs to the axis and sides, and the upper lateral furrow is stronger in proportion.

Localities.—Arenig group.—Hengwrt Uchaf, four miles north of Dolgelly. (Woodwardian Museum, woodcut fig. 31): Llanfaelrhys, Aberdaron, Pl. XVII, fig. 3 (Museum Pract. Geology); plentiful at White Grit Mine, near Shelve, Shropshire, figs. 1, 2, 4 to 7 (Mus. Pract. Geology; and Mr. Lightbody's cabinet); Mytton Dingle, Stiper Stones, abundant (Mr. Homfray's cabinet).

Barrandia, *M'Coy*, 1849.

A group of well-marked species, characteristic of the Llandeilo Flags. The three forms known have the habit of *Ogygia*, but differ in such obvious characters, that there can be no doubt Prof. M'Coy was correct in separating the typical species *B. Cordai* as a distinct genus. The other two species, here arranged under *Barrandia*, are not very closely connected with it; but I do not wish hastily to give a new generic name to them, though very little doubtful of its propriety. The characters of the glabella, and the position of the fulcrum in the pleuræ, are too unlike to render it probable that *Homalopteon* and *Barrandia* are merely subgenera. But I shall leave them so for the present.

This small group is a remarkable one, and tends to render the passage of the *Ogygides* into the Bronteidæ so complete, that we may well hesitate about drawing a line between the two families.[1]

[1] But the Llandeilo Flag genera have a thin crust and a wide expanded shape, and are, moreover,

Generic Character.—Ovate, greatly depressed; head with short spines. Glabella widely clavate, the axal-furrows nearly parallel below, and sometimes obsolete above. Eyes large, depressed, anterior in one subgenus, subcentral in the other. Facial suture marginal in front, nearly vertical posteriorly. Labrum pointed? Pleuræ falcate. Tail large, fan-shaped, with a shortened axis, and few lateral furrows; the caudal fascia occupies a large part of the limb beneath.

Subgenera.—1. *Homalopteon,*[1] Salter, 1865. Glabella with complete axal furrows, widely clavate above, more or less distinctly lobed transversely by four transverse furrows. Eyes anterior. Pleuræ with remote fulcrum, grooved, but scarcely facetted. Tail with a distinct short axis of several rings; the sides few-ribbed. *Range.*—Llandeilo Flags.

2. *Barrandia,* M'Coy, 1849. Glabella with incomplete axal-furrows and no distinct lobes. Eyes subcentral. Pleuræ falcate, with a fulcrum close to the axis, grooved, not facetted. Tail with a short ribless axis and smooth sides, the strong articular furrow only present. *Range.*—Llandeilo Flags.

Subgenus—HOMALOPTEON.

BARRANDIA (HOMALOPTEON) PORTLOCKII, *Salter.* Pl. XIX, figs. 6—10.

ASAPHUS DILATATUS, *Portlock.* Geol. Report of Tyrone, &c.; p. 293, pl. xxiv, fig. 2 (not of *Dalman*) 1832.
OGYGIA DILATATA, *Salter* and *Phillips.* Mem. Geol. Survey, vol. ii, pt. 1, p. 239, 1848.
— PORTLOCKII, *Salter.* Decades Geol. Survey, No. 2, pl. vii, figs. 1, 2, 6, 7 (not figs. 3—5, for which see next species), 1849.

B. (*Homal.*) *ovali-oblonga,* 3½ *uncialis, capitis margine angusto. Glabella genis latior, anticè gibbosior, lobata, lobis utrinque* 4, *distinctis. Thorax axe lato nodoso; pleuris per-sulcatis. Cauda axe lato* 5-*annulato, apice acuto; lateribus semicostatis, costis* 4-*radiatis divisis subrectis.*

The length of this, the largest of the three species known, is full four inches, judging by fig. 8, which is from the original specimen in Portlock's plate. It is nearly flat, ovate, widest in front; the head forming rather more than a semicircle, and considerably wider than the tail, but about as long as the thorax. The glabella is as wide as the cheeks below, and separated by narrow but distinct and complete axal-furrows from them. It widens and overhangs the eyes above, and is there somewhat abruptly bent down, the margin being over-

closely allied to *Ogygia* and *Stygina* in habit. The *Bronteidæ* have, on the contrary, a thick calcareous shell, and often a highly convex, almost gibbous form, while the axis is so greatly reduced as to be almost obliterated. I shall return to the Bronteidæ as soon as the Asaphidæ are completed. It is impossible to take the affinities in a linear form, because that is not the order of nature.

[1] ὁμαλος, *planum,* πτεον, Att. for πτυον, *flabellum;* from the flat, radiated character of the tail.

hung by it. For nearly two thirds its length it is marked by four lateral furrows, irregular in direction, which divide it into four lateral lobes, exclusive of the forehead- and neck-lobes. The furrows reach far inwards, leaving only a narrow median space unoccupied. The front ones are straight across, the second pair curve from without downwards, the third is a short deep impression, the fourth or lowest pair are nearly straight, but so oblique towards the narrow neck-furrow as to separate a pair of triangular lobes. None of the furrows reach the outer margin.

In the Decade, from which this description is partly drawn, I have inaccurately described the lower glabella-lobes as part of the neck-lobe. It is not so. There are four pairs of lobes to the glabella.[1]

Eyes rather large, placed very high up towards the termination of the facial suture on the margin. The eyelid semilunate, but not constricted above or below. The facial suture is nearly vertical above the eye, and below it turns very little outwards, cutting the posterior margin at about half the cheek's width. Free cheeks moderately large, with a narrow border and a small spine. Labrum with the centre gently swelled, and with concentric furrows and the usual pair of tubercles. The apex is broken off; it was probably obtusely pointed.

Thorax with a broad axis, not quite so wide as the pleuræ, and tapering backwards. The rings are nodular, with bilobed tubercles on the sides, the hinder rings with a central tubercle; but all rather faintly marked. The pleuræ are directed backward, and are somewhat sigmoid in outline; the fulcrum rather faintly marked at about half-way along them. The divisions between the pleuræ are not nearly so conspicuous as the oblique furrow that reaches nearly to the end of each, separating a broad and rather tumid posterior portion. The tips are recurved and pointed, the foremost ones, perhaps, not quite so strongly as in our large figure; the hinder ones more so, as in fig. 6 *a*.

Tail a semicircle, with the upper angles rounded off; the axis hardly more than two thirds the length, flattened, conical, the ends a little pointed. There are about five distinct ribs on the axis, each obscurely trituberculate. The axis is most convex behind; it reaches two thirds down the tail, with a rather large terminal portion connate with the triangular appendix, making the axis a pointed one (see fig. 8). Lateral furrows four or five, very oblique and short, the upper ones reaching two thirds—the lower not half across the broad striated limb. The three upper ones (see fig. 8) are strongly duplicate throughout.

Whole surface of tail covered with a concentric lineation, which runs across the limb transversely, not parallel to the margin. The striæ are continuous, but mixed with smaller interrupted ones. The incurved caudal fascia is very broad, but its margin is not distinctly seen. An equally broad fascia runs all up the pleuræ, the sharp lineation crossing them at right angles. We do not know the striæ on the head; but the labrum is strongly and coarsely striated (fig. 9).

[1] *Ogygia*, *Niobe*, the present genus, and *Cromus*, a Bohemian form, are examples of this large number of glabella-segments. But it is extremely rare in the Trilobite group.

Originally identified by its discoverer Portlock with the little known *Asaphus dilatatus* of Dalman. But Dalman's figure is far from good (that by Sars, in Oken's Isis, shows clearly that it is not even of the same genus), and Portlock's specimen was incomplete. Captain, (now Sir Henry) James afterwards obtained a noble series, which were figured in Decade 2 of the Geol. Survey. They are all from one locality: viz.—

Locality.—LLANDEILO FLAGS. Schists of Newtown Head, Waterford (Mus. Pract. Geology). Museum of Irish Industry. I do not know that this fine species exists in other collections, except that of Major Austin, Clifton.

BARRANDIA (HOMALOPTEON) RADIANS, *M'Coy.* Pl. XIX, figs. 1—4.

OGYGIA PORTLOCKII, jun., *Salter.* Decades Geol. Surv., No. 2, pl. vii, figs. 3, 5, 1849.
— RADIANS, *M'Coy.* Annals Nat. Hist., 2nd ser., vol. iv, p. 408, 1849.
— — *Id.* Synopsis Pal. foss. Woodw. Mus., p. 149, pl. i F, fig. 2, 1851.
BARRANDIA, sp. *Id.* l. c., p. 149.

B. (HOMAL.) *minor,* 1½ *unciam longa, latè ovalis. Glabella genis angustior, anticè haud gibba, illobata vel lobis obscuris. Thorax axe lævi, pleuris longè sulcatis. Cauda axe conico* 4—5-*annulato, apice rotundato: axe bis latiore limbo ferè, utrâque sulcis tribus curvis interlineatis. Sulci longi, primùm recti, dein profundiores, abruptè recurvi.*

My friend Prof. M'Coy, while animadverting, in the excellent work above quoted, (p. 149), on my mistake in placing this as the young of *B.* (*Ogygia*) *Portlockii*, apparently did not perceive that he also was referring to *Barrandia* the species he had in the same page described as an *Ogygia.* The truth is, my mistake and his own arose very naturally from the paucity of specimens. And as Burmeister had six years before predicted the occurrence of the metamorphosis among Trilobites, I was not so far out as my friend and critic supposed. With few exceptions, and those not very clearly made out, or even founded on mistake,—the increase of the number of segments with advancing age was not known till 1849, when M. de Barrande published his beautiful series of observations on the genus *Sao;* and at the same time, without knowing of his work, my own figures of this species were given. In 1851 M. Barrande examined the British specimens, and satisfied himself of the true occurrence of the metamorphosis; and that in a genus to which he had not access in Bohemia. *Barrandia* and *Ogygia* are northern types.

As I am not sure that I shall be able to show this change of form with age in any other British species, I would refer particularly to it here.

M. Barrande, to whom the real credit must belong of working out intentionally a point only accidentally observed by others, has established the fact that Trilobites—*probably all of them*—undergo a distinct and regular series of changes in the young state, comparable very nearly to that observed in the other Crustacea. The development of the eyes and facial suture takes place simultaneously with the increase of the body-segments. And the very young Trilobite (Barrande has traced some of the species from the egg) looks like a totally different genus from the adult; it is a simple disk, which gradually only becomes lobed, segmented, and provided with organs, as its life goes on and its size increases. The Zöe of the crab is now familiar to us. But its discovery hardly excited more interest among naturalists, than did Barrande's observations on the young Trilobites among palæontologists, when first announced in May, 1849, to the French Academy. My own far less complete description was published in June of the same year.

It seems that the additional segments always come in between the thorax and the tail, while the latter also receives at each fresh moult an accession of segments till it attains its full number. What becomes of the moulted crusts of Trilobites? From all analogy they should be cast off, slit open in some part of the dorsal region. And such specimens should be looked for in our shaly rocks; for it is impossible that they should be much more destructible than the newly-formed crust.

Description.—I have obtained from Mr. J. E. Lee's cabinet a much larger tail of this species than we before possessed. And we may therefore reckon the species to have been fully an inch and a half long, widely oval, with obtuse ends; the head forming a semicircle, longer than the body, and larger than the tail.

The axal-furrows are parallel below, somewhat abruptly divergent above, and reach the very narrow margin in front. The glabella is without lobes, or very obscurely lobed. The cheeks, wider than the glabella, are gently convex, narrowly margined, and bear the lunate eye so forward as nearly to touch the front margin, a character by which *B. radians* is easily distinguished from *B. Cordai*, next described. Head-angles very shortly spinous.

The axis of the body is much narrower than the straight pleuræ, which are grooved three fourths of their length, and have the scarcely visible fulcrum placed at more than half-way out from the axis. The tips are sabre-shaped.

The tail is nearly a semicircle, and all but flat. And our largest specimen shows a length of six lines by a breadth of ten lines. Of this length the conical axis occupies less than three-fourths; and but for the triangular appendage (appendix) beyond its bluntish tip, does not reach more than half-way down. It has four ribs straight across, divided by shallow furrows.

The sides have three strong furrows, which at first run directly out, and then suddenly bend down, expand, and nearly touch the margin. They are interlined by three others, which are shallow, and cease at the straight portion. The rest of the tail is bare of ribs, and apparently smooth; but the incurved caudal fascia beneath is very broad and straight-edged anteriorly. It just reaches the tip of the axis (see fig. 4).

The metamorphosis above referred to (figs. 1, 2) is very simple. Fig. 1, a very young specimen, has only four rings, and this is the true number in this specimen, and is not due to accident. The ribs of the tail are more conspicuous in proportion than in the somewhat older specimen, fig. 2, which has truly seven rings; while in fig. 3 the eighth thorax-segment is becoming visible (see fig. 3 *a*).

Locality.—LLANDEILO FLAGS. Two or three places near Builth, Radnorshire, viz.: Wellfield; (figs. 1, 3), and Pencerrig, (Mus. P. Geology fig. 2); also Gwernyfyd (Mr. J. E. Lee's cabinet, fig. 4).

Subgenus—BARRANDIA, *M'Coy*, 1849.

BARRANDIA (BARRANDIA) CORDAI, *M'Coy*, Pl. XIX, fig. 5.

BARRANDIA CORDAI, *M'Coy*.		Annals Nat. Hist., 2nd ser., vol. iv, p. 409, 1849.
—	— *Id.*	Synopsis Pal. Foss. Woodw. Mus., p. 149, pl. i F, fig. 1, 1851.
OGYGIA PORTLOCKII, *Salter*.		In Morris' Catalogue, 2nd ed., p. 112. 1854.

B. *uncialis, ovata, vel caput, thoracem, caudam æqualis. Oculi post medium capitis positi. Pleuræ retrocurvæ, brevisulcatæ. Cauda axe integro, lateribus unisulcatis.*

One specimen only of this most distinct and characteristic species is known, and it is a perfect one in the Woodwardian Museum. But I believe it is a common fossil, and it should be sought for at Builth. I had no excuse for uniting this very distinct form with the *B. Portlocki.*

Length 11 lines (our figure is enlarged to once and a half the natural size), of which the head, thorax, and tail are nearly equal parts. The semi-oval head is rather more than twice as wide as long, lunate, with a concave hinder border and obsolete neck-furrow. The axal-furrows are parallel below, slightly converging at less than half-way up the head, and then obsolete. The front margin concave, the border of the cheeks extremely narrow; the large slightly curved eyes placed much nearer the axis than the border, and very near the hinder edge.

The facial suture curves slightly out above the eye; and beneath it cuts the posterior margin below the eye, and very remote from the short spinous angles.

Thorax with its slightly convex axis very little less in width than the pleuræ, and tapering backwards; the rings a good deal arched forward, and strongly grooved across. The pleuræ are oblique backwards, and falcate at their tips; with a short, strong, oblique groove not half their length, and the fulcral point very prominent (as in some of the *Olenidæ*, for instance, *Remopleurides*).

The tail is half as wide again as long, and the front much arched to follow the form of the retreating pleural segments. The axis short-conical, extending less than two thirds down the tail, pointed, not prominent at the tip, and without furrows. It is well distinguished from the gently sloping sides, and the border is very gently concave. One upper marginal furrow is all that is visible, and that is very strong and deep. The upper surface is not well preserved; but the caudal fascia on the under side is so broad as to occupy the whole surface of the sides beneath, and the ornamental lines are rather close. The same width of fascia is continued beneath the pleuræ; and the lines on it run directly across them, as seen in our figure. The same sharp lines run round the under margin of the head.

Locality.—LLANDEILO FLAGS. Penkerrig, near Builth, Radnorshire; (Woodwardian Museum).

The passage from the Ogygides to the *Bronteidæ* is rendered still more easy by a MSS. genus, *Bronteopsis,* distinguished so far back as 1857, by my friend Prof. Wyville Thomson, who was at that time carefully studying the Caradoc fossils of the Girvan district. The genus is a very remarkable one, having all the characters of the *Bronteidæ,* and will be described under that family. But the crust appears to have been thin, not calcareous; and the habit of the tail is so much that of *Barrandia,* that it might well be mistaken for an extreme member of the group we are describing.

Again—*Stygina* leads from the *Ogygides* to the *Illænides,* besides having some affinities with *Bronteus.* But we must first describe the typical Asaphi; and therefore return on our road to them by means of the genus Niobe (see diagram on p. 124).

NIOBE, *Angelin,* 1852.

A genus instituted by Prof. Angelin to include a few flattened species of Asaphus, which have the body flat, the axis broad, and the labrum pointed like that of Ogygia. *Asaphus frontalis,* Dalman, is the typical species. The genus is strictly intermediate between Ogygia and Asaphus. Range, Upper Cambrian to Lower Silurian.

Broad-oval, depressed; with a distinct broad axis, and a scarcely clavate glabella which is slightly 4-lobed. Head-angles *obtuse.* Eyes approximate. The pleuræ facetted and grooved, not produced into points. Tail broadly margined, of a moderate number of segments. Labrum with a narrow base and parallel sides; the tip obtusely pointed or slightly emarginate, not forked. Hypostome (in *N. emarginula* at least) without a vertical suture.

N. læviceps, placed by Angelin with this genus, should, I think, rather be referred to *Nileus* among the subgenera of Asaphus. It has a perfectly smooth unribbed tail.

NIOBE HOMFRAYI, *Salter.* Pl. XX, figs. 3—12.

NIOBE HOMFRAYI, *Salter.* App. Ramsay Geol. N. Wales; Mem. Geol. Survey, vol. iii, p. 314, pl. vi, figs. 5—8, 1866.

N. ovalis lata, 3—4 *uncialis, depressa, axe subplano distincto, caudâ semicirculari semiradiatâ. Glabella genis æqualis, urceolata. Oculi præ medio capitis positi. Labrum acutum. Cauda sulcis lateralibus* 4—5 *abbreviatis, interlineatis.*

A most characteristic fossil, which rewarded a good day's hammering (in Mr. Homfray's company) at the head of the marsh, Penmorfa; and was afterwards obtained in great plenty by Messrs. Homfray and Ash of Portmadoc.

General shape a very broad oval, depressed, fully two thirds as wide as long; the length between four and five inches. The axis is flattened, yet distinct throughout, wide and tapering from the broad urceolate glabella to the blunt tail-axis. The head is smooth and very little lobed, and the sides of the tail imperfectly radiated.

The head is rather more than one third of the whole length, semicircular, with blunt outer angles; the glabella occupying one third the width of the head, and reaching to the sharp marginal furrow. It is urceolate, blunt and widest in front, then a little contracted, and thence widening again to the base, marked by a very distinct neck-furrow. The glabella-furrows are faint, four short ones on each side, somewhat radiating from the eye inwards, the lower one longest. The eye is very near the glabella, as in all the genus, and placed more than half-way up the head, semilunar, and rather large. The facial suture reaches the edge immediately over the eye, curves boldly out beneath it, so as to leave but a third part of the posterior margin of the cheek outside it; it is marginal in front.

The body-axis is broad, equal to the pleuræ in front, but narrower than those behind, and ornamented with arched striæ. The pleuræ are strongly facetted for rolling up, convex, blunt and rounded at their ends; the fulcrum close in toward the axis in the front rings, and gradually further out till it reaches the inner fourth of the pleura in the hinder ones. The pleural furrow deep, but rather short and diamond-shaped.

The tail, a true semicircle, is somewhat flattened; and has a short broad axis reaching three fourths the whole length, and about half as broad as the side portions, or a little more. It is marked by seven or eight distinct ribs nearly to the tip, which is prominent and bluntly pointed. The sides are scored by five short furrows, which (faintly interlined) only reach to the inner edge of the broad flattened margin, and there stop abruptly. The margin is concentrically striated, of equal breadth all round. Young specimens (fig. 6) differ but little in proportion, but there are some specimens (one particularly in Mr. Ash's cabinet) which are much narrower than usual, and may, as that gentleman suggests, be the male forms (see also figs. 6, 7).

The labrum is long, broader at the base, but still on the whole parallel-sided. The sides are not contracted, nor the front expanded, as in the *N. emarginula* figured by Angelin; and the apex is an obtuse angle, at about 100°, and the tip rather acute. There is a concentric furrow near the margin, and a strong pair of indentations near the tip.

Localities.—Upper Cambrian. Lower Tremadoc Slates of Penmorfa Church and Llanerch, Tremadoc; also Castle Deudraeth, near Maentwrog, N. Wales (Mus. Pract. Geology). The figured specimens are from the cabinet of our excellent friend Mr. David Homfray.

ASAPHUS, *Brongniart*, 1822.

Of so large a genus much might be said, and with advantage too, if our space permitted us to discuss largely its affinities. The diagram, however, on page 124, will give at a glance the relation which the chief subgenera of *Asaphus* bear to one another, and to the neighbouring groups, *Ogygides* and *Illænides;* and we can more easily refer to these affinities when the subgenera themselves have been defined. The genus is as remarkable among the smooth Trilobites of our right-hand division (see Preface, p. 2), as *Phacops* is of the left-hand group.[1] There is the same perfection of organisation and compactness of character, the same wide limits of variation within the genus, and as great importance numerically. While however *Phacops* and its subdivisions are more characteristic of the Upper Silurian rocks, *Asaphus* is strictly Lower Silurian,—scarcely ranging below, and never above that horizon. The *Phacopidæ* in the higher groups are remarkably convex; the *Asaphi* expanded. The *Phacopidæ* have, as a rule, the segments both of head and tail well marked out; the *Asaphi* have them obliterated in the same portions. The *Phacopidæ* are ornamented with a tubercular or granular coat; the genus we are describing has a smooth or only lineated one, a distinction seen and ably noted by Dr. Burmeister, who, however, attached too much value to the character, since both kinds of ornament coexist in several genera. The lenses of the great eyes in *Phacops* are very large—the equally prominent eyes of *Asaphus* have them very small,—and so of several other contrasting characters; and while the chief character of all—the relative possession of eight and eleven body-rings—keeps the two groups widely apart, they are no less sundered by the course of the facial suture beneath the eye, which in all the *Asaphidæ* is to the margin behind, and in all *Phacopidæ* to the outer margin.

For size, only the large *Paradoxides* among the *Olenoid* group (see Preface) can match the *Asaphi*, which include, if not quite the longest, certainly the bulkiest forms of Trilobites, and indeed, so many of these, as to make size an important character of the genus. Few of the species are less than three inches, many of them nine or ten in length, and a few range beyond a foot in extreme measure.

The subgenera include several extreme forms, but the essential characters of this large genus seem to be as follows:—

Form oval, without spines or tubercles on the surface, with the head and tail nearly

[1] It might, perhaps, be convenient to designate the Trilobites of the left-hand branch—which have a well-developed thorax, and a relatively small pygidium of few segments, *Micropygini*, and those on the right-hand *Macropygini*. But I do not think the terms are needed.

equal in size, and the thorax of eight rings. The surface smooth, or only covered with a close lineation intermixed with puncta, which does not interfere with the general smoothness of the exterior. The head is semicircular or half-oval, or pointed, with a glabella widest in front, and generally very faintly marked out, and with quite obsolete lobes.[1] Smooth prominent eyes; a hypostome without rostral shield (only a vertical suture being occasionally present), and a forked labrum.

The thorax-rings convex; the pleuræ rounded, grooved, and facetted for rolling. The tail large, of many segments; but these are not generally visible, except on the axis, and in some cases not even there.

The several subgenera are dependent chiefly on the degree of convexity, distinctness of the tail-furrows, course of the facial suture in front, and the degree in which the obscure glabella occupies a larger or smaller space of the head. I will proceed to give these characters as briefly as I can, the route being from the *Ogygides* last described towards the *Illænides*, which we shall take up afterwards. Some of these subgenera have been indicated by Goldfuss, Dekay, Dalman, Emmerich, Milne-Edwards, Burmeister, and others. None of them are satisfactory, the habit having been too much overlooked, while trifling differences in the glabella, &c., have been preferred to the more important characters of the facial suture. Corda's arrangement is perhaps the least worthy consideration; and Emmerich's and Goldfuss's seem to me the best. Professor Burmeister had not sufficient material for all the divisions, but his acumen detected the importance of the facial suture, and his arrangement is clear. Professor M'Coy's divisions are far too few. We are greatly indebted to Barrande for his laborious collection of the entire history of these groups, and are sorry not to be able to adopt his own subdivisions. Following Emmerich and Goldfuss, but subdividing their group of "Ogygiæ" especially, we have the following eight subgenera:

1. *Ptychopyge*, Angelin. Expanded, ovate, gently convex, or flattened, with narrow axis; short urceolate glabella, reaching more than half-way up the head, and lobeless; approximate elevated eyes; subangular tips to pleuræ; and tail with moderately long axis, and many faint ribs on axis and tail. Facial suture forming a long ogive in front. Hypostome entire. Labrum shortly notched. North Europe.

Types, *A. angustifrons*, Dalm.
A. latus, Angelin.

2. *Basilicus*, Salter, 1849. Flattened and expanded forms, with rather broad axis; clavate glabella reaching far up the head, with only obscure lobes, the basal pair most conspicuous; approximate depressed eyes, angular or even pointed tips to the pleuræ;

[1] Except within the crust, where they may be seen faintly marked out, or even strongly in some cases.

tail with many ribs on axis and limb; facial suture marginal in front; hypostome[1] entire. Labrum deeply lobed. *Range.*—North and South Europe.

Types, *A. tyrannus*, Murch.
A. Powisii, Murch.
? *A. ingens*, Barrande.

3. *Megalaspis*, Angelin, 1852. Flattened and expanded, with narrow axis; short urceolate glabella, reaching but a little way up the head, and lobeless; approximate depressed eyes, subangular tips to pleuræ; and tail with narrow long axis, and many ribs on axis and limb. Facial suture intramarginal, in a long ogive on the upper surface. Hypostome—? Labrum notched? North Europe.

Angelin figures a labrum of *M. planilimbata* as entire, but there is some imperfection in the look of the figures, as if the forked lobes were broken off.

Types, *A. gigas*, Angelin, not of Dekay.
A. heros, Dalm.
A. extenuatus, Dalm.
A. nobilis, Barr.

[I have inserted here *A. nobilis*, Barrande, chiefly to call attention to it. It is possibly a distinct subgenus. Its short glabella is lobed posteriorly; the hypostome appears to have a vertical suture; the pleuræ are recurved and pointed; the tail-furrows not duplicate; and the crust very thin. It seems intermediate between *Basilicus* and *Megalaspis*.]

4. *Isotelus*, Dekay, 1824. Convex, moderately expanded, with broad axis; obsolete glabella; remote, moderately convex eyes; rounded pleuræ, and no ribs on the tail. Facial suture intramarginal, ogived. Hypostome vertically divided. Labrum deeply furcate. North America, North-west Europe.

Types, *I. gigas*, Dekay.
I. platycephalus, Stokes.

5. *Cryptonymus*, Eichwald, 1825. *Hemicrypturus*, Corda, *Asaphus*, Angelin. Short, convex, with narrow axis, a clavate glabella reaching the front of the head, and with three pairs of lobes; elevated eyes (sometimes stalked in the ♂); rounded pleuræ; tail short, of few joints, very obscurely ribbed, except on the axis. Facial suture intramarginal in a short ogive. Labrum deeply lobed. North Europe.

Types, *A. expansus*, Linn.
A. raniceps, Dalm.

6. *Symphysurus*, Goldfuss, 1843.[2] Short convex, with narrow axis; the gibbous, lobeless glabella overhanging the front margin; large remote depressed eyes; rounded pleuræ;

[1] In former pages I have used Dalman's old term *hypostome* for the incurved under front margin of the head, which supports the labrum; and I adhere to this, although the term *epistome* is often adopted. Barrande calls it '*la doublure frontale*.'

[2] Better defined and restricted by Angelin, 1852.

and short tail, with axis of few joints; and sides without ribs. Facial suture marginal in front. Hypostome entire. Labrum—? North Europe.

Type, *S. palpebrosus*, Dalm.

7. *Brachyaspis*, Salter, 1866. Short, broad, expanded, with moderately broad axis; the head with obsolete glabella; eyes depressed but convex, remote; pleuræ rounded; tail short, with no ribs. Facial suture marginal in front. Hypostome entire. Labrum—? North Europe.

Types, *A. rectifrons*, Portlock.
A. lævigatus, Angelin.

[8. *Nileus*, Dalman, 1826. Very convex, scarcely trilobed, with very wide axis, and hemispherical lobeless glabella; eyes very large, remote, depressed, reniform; pleuræ rounded; tail short broad, with no trace of axis or ribs. Facial suture marginal. Hypostome entire. Labrum scarcely notched. North Europe.

Type, *N. Armadillo*, Dalm.]

I believe other subgenera might easily be formed, but these are perhaps sufficient for convenient reference. For instance, *Asaphus nobilis*, Barr., and the several Mid-European species connected with it, are very doubtfully forms of *Megalaspis;* and might with advantage be kept separate. *Asaph. ingens* of the same author does not quite fit with *Basilicus;* and so of several others.

I have noticed briefly the geographical range of each of these subgenera under their definitions. The species of all the groups except *Isotelus* are European; and even this reaches our north-western shores, but is not found on the Continent. *Nileus, Symphysurus,* and *Cryptonymus* are almost exclusively Scandinavian types; *Brachyaspis* is North-European only. *Basilicus* and *Megalaspis* range over North and South Europe, and *Ptychopyge* appears to have a wider range, extending to North America, and even to India.

I do not know to what group the smooth-tailed *Asaphi* of the Andes, described by D'Orbigny, belong. The genus is evidently world-wide.

Returning over the ground just trodden, it may well be questioned if *Nileus* should be included in the list of subgenera. It not only has the broad and lobeless glabella, the wide axis to the thorax, and the smooth unfurrowed tail of *Illænus*, but it has a nearly entire labrum. It evidently leads the way to that genus.

But then it is so near *Symphysurus,* which cannot be separated, except by its inflated glabella, from *Cryptonymus,* that it is difficult to see how to draw the line. It is not so far removed from *Cryptonymus* as this is from *Isotelus,* which last may perhaps be regarded as the central type of *Asaphus.*

Brachyaspis follows next; and from this point the subgenera diverge towards *Ogygia. Megalaspis* consists of expanded forms, which yet have, on the whole, more resemblance to the typical *Asaphi* than *Basilicus*, a subgenus having the facial suture marginal in front like *Ogygia*, but yet having the deeply lobed labrum of the typical forms.

Lastly *Ptychopyge*, of which we have no certain representative in Britain,[1] has the aspect of the *Ogygiæ;* and even its intramarginal suture finds its parallel in the *O.* (*Ogygiocaris*) *dilatata*, Dalm. Yet having the labrum strongly notched, it may for the present be safely included in *Asaphus*.

Subgenus 2.—BASILICUS, 1849.

1. ASAPHUS (BASILICUS) TYRANNUS, *Murchison*, Plates XXI and XXII, figs. 5—12.

ASAPHUS TYRANNUS, *Murchison*. Silurian System, pl. xxiv, fig. 4, pl. xxv, fig. 1, 1837.
— — *Milne-Edwards*. Crustacés, vol. iii, 310, 1840.
— — *Emmerich*. Leonhard und Bronn's Jahrb., 1845.
— — *Salter*. Decade ii, Geol. Surv., pl. v, 1849 (1848).
— — *Id.* Morris's Catalogue, ed. 2, p. 100, 1854.
— — *Id.* Siluria, ed. 2, pl. 1, fig. 5, pl. ii, fig. 1, 1859. (Not of Burmeister, Org. Trilob., t. 5, fig. 4, which is *A. heros*).
OGYGIA TYRANNUS, *Emmerich*. Dissert. (1839).
ASAPHUS TYRANNUS, *Id.* Leonh. und Bronn's Jahrb., p. 42, 1845.
ISOTELUS TYRANNUS, *M'Coy*. Synops. Woodw. Pal. Foss. Fasc. i, p. 171, 1851.
ASAPHUS TYRANNUS, *Salter*. App. Ramsay, Geol. N. Wales; Mem. Geol. Surv., vol. iii, p. 312, pl. xiii, fig. 1—6 (1866 ined.)

A. magnus, interdum pedalis, ovatus ferè, per-sculptus; capite obtuso quam caudâ elongatâ breviore. Oculi depressi approximati, sese spatio glabellæ longitudinis remoti. Glabella brevis pyriformis, lobis lateralibus supra oculum distinctis. Anguli capitis breves. Cauda parabolica, apice truncato, axe multi-annulato, lateribus multicostatis, costis 12—13 *abbreviatis.*

Sir Roderick Murchison hit upon a happy name for this fossil, the largest then known among British Trilobites, and singularly plentiful in the region which he made his own by hard work along the South Welsh frontier. It is not only our finest British species, but is peculiarly British, and even restricted to the Welsh Principality and the border-counties. Often as it has been quoted out of Britain, it has never, except in one single locality (in North Wales), been really found outside the restricted area of Shropshire and South Wales, where, as above said, it may be counted in swarms. Earl Cawdor's magnificent specimen found in Dynevor Park, Llandeilo, is here again figured from the British Museum collection, with others, of smaller size, from the Museum of Practical Geology. It is the best of types, together with the *Ogygia Buchii*, for the Llandeilo rocks proper,

[1] It was an error to insert this subgeneric name under *Ogygia corndensis*, p. 130. That is a true *Ogygia*. It is just possible *A. radiatus*, p. 154, may belong to it.

and its place is taken in strata of the same age in Sweden by the equally large *A. heros*, Dalman, a species which Burmeister and others have confounded with it.

Besides, it belongs to a group of *Asaphi*, which, by their thinner crust, narrower axis, more expanded form, and strongly furrowed pygidium, conduct easily to *Ogygia*. This subgenus was first noticed in the 'Memoirs of the Geological Survey,' Decade 2, in 1849, and has been generally adopted.

Description.—Length of large specimens eleven and a half inches; breadth more than six inches. General form true ovate, more obtuse in front, moderately convex; the head semicircular, the tail much longer, more convex, and parabolic. Head sculptured, very gently convex, with only a very slight concavity marking off the margin. The cheeks are broad, and their hinder angles produced into short spines, which only reach the third thoracic segment. The glabella is convex in front, broad-clavate, well defined forwards, only slightly so on the sides, and as long as the breadth between the eyes. The forehead-lobe large, round, and rather protuberant, especially in old specimens. Beneath this lobe, and at about the level of the eye, is the uppermost of three short, obscure, oblique lobes, the basal one of which is largest. There is at the base of the glabella a tubercle, and beneath it a shallow transverse impression marking the place of the neck-furrow. Eyes rather large, depressed, much arched, placed behind the middle of the head, and close to the glabella in this species.

The base of the eye-lobe is constricted, the lentiferous surface probably narrow, and the numerous lenses beneath the smooth cornea are not very closely set (fig. 7). Facial suture curving widely out on the posterior margin to half the width of the cheek, and in front of the eye turned outwards in a sigmoid curve to cut the front margin beyond the parallel of the eye, and continue exactly along the front edge of the shield.

The hypostome is yet unknown; the labrum large, with a semicircular base, which is moderately broad only; a squarish slightly tumid centre, surrounded by a strong furrow, in which are set obliquely a pair of minute transverse ovate tubercles. The apex is deeply divided into two ovate-lanceolate forks, between which the shelly plate turns strongly inwards; the length of the lobes is greater than one third of that of the whole labrum.

Thorax of eight moderately arched rings; the axis is not strongly marked out, and is as broad as the pleuræ; these latter are grooved for more than half their length, the strong groove bounded behind and before by strong ridges, which form a prominent node at their point of junction beyond the groove; from thence the pleuræ rather flat. They are curved down, but scarcely backward, at the obscure fulcrum, which in the hinder rings is placed one third away from the axis, but nearer to it than in the forward rings. The anterior edge of each pleura is sharpened and coarsely striate, and its termination square.

Tail parabolic, a little truncate at the end; its width at the front one fourth greater than the length (though apparently not more than equal to it); not quite regularly convex, the axis being flattened in front, narrow, scarcely one fourth the width of the tail, and prominent behind, reaching seven eighths of the whole length; it ends somewhat abruptly in a swelled tip. There are eighteen or twenty rings marked out on it, not quite reaching the tip. The sides are convex, almost tumid at first, and ribbed by twelve distinct raised ridges for about two thirds their width. These end rather abruptly, and the concave limb is quite smooth and even, except for the imbricated lines of ornament which cover the whole surface in one form or another. The lateral ribs are as broad as the furrows between them, somewhat square in section, with tumid abrupt ends. They are as numerous in young specimens (see fig. 12), and these are nearly as convex as the older ones.

The caudal fascia is broad, considerably indented by the axis, and concave, so as to leave a space between it and the outer crust. The lines of growth are coarse, and rather distant, obliquely set against the margin of the fascia (see fig. 10), not parallel to it.

Of all the *Asaphidæ* this is the most highly ornamented species. Our largest figured specimen was, indeed, named, as a variety, *ornatus* by Sir R. I. Murchison ('Sil. Syst.,' pl. xxv, fig. 1), but it is the normal condition of the old specimens, sometimes a foot long.

The sculptured lines, which are veritable plicæ or folds of the crust, are wavy and interrupted, following a general curve all round the margin, but sinuous and inosculating with each other. They follow the broad head-margin, and are concentric, fainter, and closer round the forehead-lobe of the glabella; but they are far stronger and shorter, and form deep pits on the thorax-segments and tail, strongest on the axis of each, and occur only on the prominent parts of the side-lobes, the hollows being nearly free from them. They arch over the axis from side to side, almost obliterating the annuli of the tail-axis by their strength; while on the side-lobes they radiate from behind forwards, and decussate the ridges strongly. They become transverse lines on the outer margins of the thoracic rings, except in very old specimens (fig. 8), where they form pits and puncta to the very ends of the pleuræ. On the smooth concave limb of the tail they sweep forwards in sinuous lines, strongly imbricated forwards, and cut the margin obliquely.

On half-grown specimens they are much fainter, and, indeed, can only be rarely seen in young specimens.

The caudal fascia (fig. 10) has them distant, and branching, as it were, from an imaginary line along its middle portion. But on the corresponding part beneath the thorax-rings they are quite longitudinal instead of transverse. (See Decade 2, Geol. Survey, pl. v, fig. 8.)

There are few species to compare this fine fossil with, unless it be our next two species. It is most nearly like the *Asaphus Powisii*, which occurs in Caradoc, not in Llandeilo rocks. That species, however, shows no sculpture, and is, moreover, more convex; and it has very indistinct ribs on the tail, the axis of which is wide above, and then suddenly contracted for the rest of its length. The species figured by Prof. Burmeister as *A. tyrannus* has, indeed (in his figure), a strong resemblance; but that figure is a mixture of two species, for the Professor has transferred the sculpture of the British fossil to a worn Swedish specimen of *A. heros,* Dalman, which had lost the characteristic mucro of the tail. *Isotelus marginalis,* Hall, formerly supposed by me to be the same, is quite distinct.

In comparing with other species, the following must be particularly noted as a very close ally; indeed, it has hitherto always been confounded with it. Both occur at the same locality near Llandeilo.

Localities.—LLANDEILO FLAGS. Abundant in South Wales; Llandeilo and many localities in Carmarthenshire. In Pembrokeshire; Musclewick Bay, Llampeter-Felfrey, Narberth, Mydrim, and Lann Mill. In Shropshire, Meadowtown, Shelve, &c. In North Wales; Craig-y-glyn, near Llanhaiadr, in the Berwyns. But not in Scotland, Ireland, nor in any Continental locality.

2. ASAPHUS (BASILICUS) PELTASTES, spec. nov. Pl. XXII, figs. 1—4.

A. modicus, vix 4-*uncias longus, convexus, ovalis, obscurè lineatus, capite caudæ æquali. Oculi elevati, sese spatio capitis totius longitudinis remoti. Glabella elongato-pyriformis, lobis basalibus subtrigonis isolatis. Anguli longè producti. Cauda axe* 14—15-*annulato, lateribus* 9—10-*costatis.*

Certainly when I figured these specimens I did not expect to be able to determine two completely distinct forms, for the general aspect is exceedingly alike in both. Yet if form and proportion, difference in position of the eyes, in the form of the glabella and its lobes, shape and number of ribs in the tail, &c., be sufficient characters, we must reckon for the future two distinct Llandeilo fossils hitherto confounded under one name.

A. peltastes is probably as common as the better known *A. tyrannus.* It is easily distinguished by the more oval, (not ovate) shape, and the equality in length of the head and tail. But also notably by the small cheeks, remote and large eyes, long and broad head-spines, and the fewer ribs to the tail. The following description may serve:

Length, judging from large fragments, not more than six inches, the breadth two and a half. Strictly oval, convex; the half-elliptic head equal in length to the tail; the body shorter than either, not exceeding the glabella in length. The glabella elongate, narrower than the cheeks; a pair of very distinct oval basal lobes (really composed of the two lower pairs), isolated from the rest of the glabella, and set wide apart. A long oval forehead-lobe, which reaches quite to the concave front margin, and is more than half the entire length of the head, from which it is not abruptly distinguished in front as in the last species.

The cheeks are very convex, steeply bent down towards the truly flat margin, and produced behind into broad blunt spines, which are long enough to reach to the sixth thorax-ring. This character at once distinguishes *A. peltastes.* The eyes are large and prominent, much wider apart than in the last species, the width from eye to eye being greater than the whole length of the head. The eye is broad, and almost as high as broad, and much curved, sunk in a depression of the cheek, and placed hardly its own breadth from the marginal furrow (see fig. 2). Facial suture beneath the eye reaching very little outwards, and cutting the margin beneath the outer edge of the eye. In front it cuts the margin more abruptly than in *A. tyrannus.*

The thorax is generally convex, but the axis is not very strongly separated from the sides, but more so than in the allied species; and is somewhat narrower than the pleuræ, which curve down steeply from the fulcrum, placed at about one third out, and they bend more sharply backward than in *A. tyrannus:* their ends are more oblique and less square, and the pleural groove is longer, much narrower, and somewhat deeper than in that species.

The tail is half-oval, rounded, not at all truncate at the end, and with a flat rim all round, not concave as in the last. The axis narrow, more convex, shorter, and more regularly tapering, and with fewer (fourteen or fifteen) rings. The sides are convex, forming a channel against the flat margin, and with nine or ten ribs only (rarely eleven), and these are longer, more curved, and more prominent than in *A. tyrannus.* The caudal fascia has more closely set lines.

The sculpture, too, is different. The same in character, it is much less prominent and conspicuous. This may be due to the less size of the specimens, but there is a difference in the only part where I can find it conspicuous, viz., the border of the tail, where it is much closer, more thread-like, and directed more longitudinally than in the typical species. *A. peltastes* cannot be a simple variety of *A. tyrannus;* still less can the differences be regarded as mere sexual variations. It is a good and distinct species.

Locality.—LLANDEILO FLAGS. Llandeilo, South Wales; abundant. Cabinets of Mus. Prac. Geol. (figured specimens 1 to 3); of Mr. J. Lee, Caerleon (do. fig. 4); Mr. R. Lightbody; Rev. G. Smith, of Tenby; and Mr. Edgell, who finds it abundant in the flagstones, while *A. tyrannus*[1] affects the limestone. Also in volcanic grit, Builth, Radnorshire, and from Abereiddy Bay, Pembrokeshire (Mr. H. Wyatt Edgell).

ASAPHUS? (B.) HYBRIDUS, n. sp. Pl. XXIII, figs. 8, 9.

A. (*B*) *modicus,* 4—5 *uncias longus? complanatus, axe angustissimo. Cauda, solùm cognota, rotundata semiovalis* (*long. ad lat. ut* 8 : 11) *axe contracto quàm limbo ter angustiore, vix* $\frac{2}{3}$ *longitudinis caudæ superante, apice abrupto obtuso. Sulci axales anticè profundi,*

[1] The *A. tyrannus* figured by Hoffman in his summary of the Russ. Tribolites ('Verhandl. Russ. Kais. Min. Gesellsch.,' 1858, pl. vi, fig. 3) is a *Ptychopyge.* The *Ogygia Buchii,* fig. 4, is a *Megalaspis,* like *A. heros,* Dalm.!

limbum ad hoc elevatum ab axe depresso benè separantes. Limbus paullo convexus, costatus, margine lato plano seu concavo. Costæ axales angustæ, 7—8 *; laterales* 7 *abbreviatæ, curvæ, ad basin duplicatæ.*

I do not feel quite sure that this caudal portion (we possess two specimens only) represents the tail of a *Basilicus.* It may be a fossil allied to the *Ogygia Selwynii* (Pl. XVII). But on close examination the axis is so much depressed in front, and is so short, that, as our fossil cannot possibly be that ancient species, it may as well be figured with *Basilicus.*

Tail half-elliptic, blunt at the end, the length being to the breadth as 8 to 11. Axis very narrow, not above one third the width of the limb, depressed at its upper portion, where, the axal-furrows being strong here, it is sunk between the convex upper portions of the limb. Behind, the furrows vanish, and the axis is prominent above the more depressed limb: its termination is blunt, and it reaches only two thirds down the tail, or but little more.

The axis is a little wider in front, then parallel for the rest of its length. The sides, on the contrary, are convex in front and for half their width, and then flat or slightly concave. The seven lateral curved ribs extend only over the convex portion, the ribs being broad and flattened and the furrows narrow. At the base the upper ribs are duplicate, and this is the chief reason for thinking the species may be an *Ogygia.*

Locality.—Llandeilo Flags? Henllan Amgoed, Carmarthenshire.

Asaphus (Basilicus) Powisii, *Murchison.* Pl. XXIII, figs. 2—7.

Asaphus Powisii, *Murchison.* Sil. Syst., t. xxiii, fig. 9 (not *a*, *b*), body and tail only, 1837.
— — *Burmeister.* Org. Trilob., Ray ed., p. 96, and note: *Isotelus Powisii*, p. 122 (not of Portlock), 1846.
Isotelus Powisii, *M'Coy.* Pal. Foss. Woodw. Mus., p. 170, 1851.
Asaphus Powisii, *Salter.* Mem. Geol. Surv., Decade 2, t. iii, p. 5, 1849.
— — *Id.* Morris's Catal., 2nd ed., p. 100, 1854.
— — *Id.* Siluria, 2nd ed., t. ii, fig. 2, 1859.
— — *Id.* App. Ramsay, Geol. N. Wales; Mem. Geol. Surv., vol. iii, p. 312, 1866, pl. xv.

As. (*B.*) *magnus, sæpe* 6-*uncialis, lævis, ovalis, convexus, oculis remotioribus; caudâ axe conico, lateribus vix costatis. Glabella ad frontem rotundata, posticè elobata. Caput immarginatum, spinis brevibus. Cauda thorace longior, axe ad basin lato, dein contracto, nisi ad apicem vix elevato, costis* 8—9 *obscuris. Limbus lentè declivus sulcis abbreviatis* 9, *primo solùm profundo, reliquis obscuris, margine concavo.*

The original name bestowed by Sir R. I. Murchison is still by common consent retained for this fine fossil, although the author confounded the head of *Phacops macroura* with the species, as Burmeister first observed in his Ray edition in 1846, and as has been already noticed in our Part I, p. 37. The species is very distinct, and has nothing to do with the form described by Portlock under the name *Isotelus Powisii* in 1843; nor is it easy to see why Prof. M'Coy retained it under that subgenus, since the facial suture is exactly that of *Basilicus.* It is one of the commonest of Caradoc fossils. From *A. tyrannus* the rounded shape, faint furrows on the pygidium, and quite different head, without any furrows to the glabella, easily distinguish it.

Rarely six inches long, but still a large species, of truly elliptic, very regularly convex form; the semilunar head much shorter than the thorax, and this shorter than the tail. The glabella is only convex and rounded in front; behind, it neither shows convexity, separation from the cheeks, nor lobes of any kind. The eyes are rather large and lunate, but not elevated, and, measured from their outside, are wider apart than the length of the head; they are not at all sunk in the free cheeks, and their curved lentiferous surface contains about 7000 lenses, according to observations of mine in 1849 (Mus. P. Geology, and Collection of the late Daniel Sharpe). The cheeks are very little convex, without any marginal furrows, and produced into very short head-spines.

Thorax distinctly three-lobed, the axis broad, wider than the pleuræ, but not strongly separated from them; a punctum in the cast marks the point of junction. The pleural groove is bordered, as in *A. tyrannus*, by strong ridges, meeting beyond it in a sort of node; and it extends as a broad, well-defined furrow for more than half the length of the pleuræ. These have the fulcrum near the axis, not above one third out, and at nearly an equal distance in all the rings. From the fulcral point the pleuræ bend down, but not backward, and are somewhat recurved at the tip.

The tail is the truly characteristic portion, and has a whimsical resemblance to that of the *Homalonotus bisulcatus* (Pl. X, fig. 3), with which it is so often found in company. It is semioval, rounded at the end, and regularly convex, the axis not greatly raised above the general convexity; broad at its base, where it occupies rather more than one third the whole width of the tail, but soon narrowing behind, and becoming more parallel-sided. It reaches quite to the inner edge of the concave margin, fully five sixths down the tail, and is there rounded and a little prominent, especially in young specimens (figs. 3 and 4). These indeed have the axis generally more strongly marked out than in the adult. The axis is marked by about eight or nine obscure ribs, and the sides by an equal number of rather short and obscure furrows; but the upper or border furrow, always the deepest in the *Asaphidæ*, is here distinctly and strongly so, and hence, together with the wide pyramidal axis, the resemblance to the *Homalonotus* aforesaid. The limb is concave all round, and the caudal fascia, rarely seen, is only slightly indented by the tail-axis.

In all the above characters,—the absence of glabella-lobes, the smooth and almost unfurrowed tail, with its broader and more pyramidal axis, &c., the species is distinguished from *A. tyrannus*. The labrum (fig. 6) is also different; longer, more indented on the sides, less raised in the centre, with very oblique lateral tubercles and shorter forks to the apex.

Localities. — Llandeilo Flags. Treiorwerth, near Llanerchymedd, Anglesea. S. E. side of Arenig Mountain. Llangadoc, S. Wales. Caradoc or Bala Rocks, everywhere in North Wales: Snowdon; Bettws-y-coed; Bala; Dinas Mowddwy; Meifod; Berwyn Mountains, &c.: fig. 5 is a fine specimen from near Waterloo Bridge in the Vale of Conway; and fig. 7 shows a specimen, distorted by cleavage, from Moel Benddu, Dinas Mowddwy, (both in Mus. P. Geol.). Figs. 3, 4, and 6 are from Horderly and the neighbourhood. It is extremely common in the Caradoc of Shropshire.

Foreign Localities.—None. It is, like *A. tyrannus*, a truly British species.

Asaphus (Basilicus) Marstoni, n. sp. Pl. XXIII, fig. 1.

A. parvus, vix uncialis, complanatus, ovato-oblongus, oculis magnis capite caudâque thorace brevioribus. Caput vix marginatum (angulis brevispinosis ?), oculis magnis remotis. Glabella anticè prominens, marginem ferè attingens, haud lobata? Cauda ut in A. Powisii, *nisi brevior, subtrigona, axe angustiori costis distinctis, lateribus latimarginatis, costisque utrinque 7 brevibus.*

This neat little species is evidently distinct from any other British form, nor do I think it has been figured in European works. It might have passed as a young *A. Powisii,* but for the great size of the eyes and the distinctness of the glabella; for the less relative size of the tail and the strength of its furrows would hardly be enough to distinguish it, as these are the usual characters of young specimens. I think the larger fragment belongs to it, but I shall describe the smaller one only.

Half an inch long; and three tenths broad at the base of the head—the widest part; oblong-ovate, blunt in front and rather pointed behind; the convex head as long as the thorax, and each of them much longer than the tail. Glabella large, oblong, reaching nearly to the front edge and almost overhanging it; about one third the width of the head. Cheeks strongly margined, bearing the large lunate eyes close to the glabella, and much nearer the hinder margin of the head than in *A. Powisii;* the facial suture beneath them not extending half-way out. Angles blunt? (or with short spines).

Thorax with a rather narrow axis, which tapers backwards, the rings somewhat nodose. Fulcrum of the nearly direct pleuræ placed beyond one third out, and strongly grooved. The tail is half ovate, somewhat triangular in outline, with a narrow conical axis reaching to the strongly concave margin, and sharply separated from the somewhat depressed sides. The axis has six or seven distinct rings (nodose, like the hinder thorax-rings) on the sides and middle, and the limb has about six abbreviated furrows, besides the upper strong furrow which reaches, much beyond the others, nearly to the margin. The concave margin has some concentric striæ, which may be, and probably are, pressed through the cast from the caudal fascia beneath.

Locality.—Caradoc. Lower shale, under the sandstones of Horderly, Shropshire. (discovered by Mr. A. Marston, and now in Mr. H. Wyatt Edgell's cabinet).

Asaphus (Basilicus?) radiatus, *Salter*. Pl. XVIII, figs. 1—5.

Ogygia radiata, *Salter*. Appendix to Ray edition of Burmeister, Org. Tril., p. 125, 1846 (and quoted by M'Coy).
Isotelus (Basilicus) laticostatus, *M'Coy*, in part. Synopsis Woodwardian Fossils, pl. i E, fig. 18 (not fig. 18 *a*, or of Green), 1853.
Asaphus radiatus, *Salter*. App. Ramsay, Geol. N. Wales; Mem. Geol. Surv., vol. iii, p. 311, pl. xxiii, fig. 7, 1866.

A. subplanus, 7—8 *uncias longus ?, obtusè ovatus, axe angusto, capite latissimo, glabellâ distinctâ. Thorax brevis dimidium caudæ efficiens. Cauda semicircularis lata, axe angusto abbreviato* 8-*annulato, vix per* $\frac{2}{3}$ *caudæ producto, apice prominulo; limbo utrinque costis* 7—8 *abbreviatis tumidis radiato. Sulci æquales, recti, subsinuosi. Margo anticus valdè sinuosus. Superficies striis obliquis striata, perornata; fascia interna latissima, lineis remotis rugosa.*

This elegant and common species has not yet attracted much attention; the first specimen, found at Bala by myself in a pleasant summer's work with Prof. Sedgwick in 1844, was without much doubt referred to *Ogygia* in the MS. catalogue of British forms supplied to the Ray edition of Burmeister[1] by myself. A hasty field-note had previously assigned our fig. 2 to the *O. Buchii*, a species which does not occur in North Wales.

Prof. M'Coy supposed he could identify this, and another different species, with the cast published by Green. It is quite certain they are not the same, and, indeed, that fossil is a *Phacops* (see note, page 158). And though I do not admit his strong criticism as to the generic name I first gave it, for *Ogygia* has often simple furrows, it is more likely an *Asaphus*, of the group *Basilicus*, or of that to which *A. nobilis* of Bohemia belongs.

M'Coy describes the entire form as "obtusely oval; the cephalic shield rounded, about three times as wide as long, the thorax shorter than the head—only a little more than half the length of the tail—of eight slender segments; its axis rather less than two thirds the width of the pleuræ, which are nearly straight, slightly bent downwards and backwards; the tail nearly semicircular, length more than half the width, and one third" (it is nearly twice) "longer than the thorax." The rest of his description applies to the *A. laticostatus* (fig. 6), and not to our species.

I may add that the glabella is widest in front, and the head with a distinct margin; the neck-segment narrow, but strong. The pleuræ well grooved throughout. The tail has a curiously sinuated front margin, the outer portion at the angle almost forming a

[1] A most inaccurate edition it is, especially in the introductory portion, the German terms being misunderstood by the translator. Burmeister's descriptions are intelligible enough in the original.

lobe. The axis runs about two thirds down the tail, is narrow, not half the width of the side-lobes, of about eight distinct ribs and a terminal portion, all strongly covered by arched striæ, the tip quite prominent (*a* in fig. 1). The sides are radiated by eight equal strong furrows, which run direct to about two thirds to the flat margin, but are sinuated in their course. The five hinder ones scarcely reach half way. The whole tail (as shown in the splendid specimen, fig. 1, in the collection of Mr. Blunt, of Shrewsbury, who has had it for twenty years) is covered with a strong oblique striation. And the incurved fascia beneath is the widest and most coarsely ribbed that I know in any British species. It resembles that of the Bohemian fossils quoted above. *Asaphus nobilis*, Barr., however, has a larger cephalic shield and longer in proportion, and the tail has a longer and slenderer axis, more strongly ornamented. The side-furrows, which in ours are crowded at their origin, and so appear radiated, are in the Bohemian fossil more parallel.

There is an *Asaphus* (referred to *Ptychopyge*) described by M. Lawrow in the 'Verhandl. der Russ. Kais. Min. Gesellschaft,' 1858; pl. xiii, fig 2, which has radiating ribs (but fewer) and a similar sculpture.

Localities.—Caradoc only: Rhiwlas, near Bala (figs. 2, 3, Woodw. Mus.), Berwyn Mountains (Mr. Blunt's collection, fig. 1). Co. Louth, Ireland (figs. 4, 5, Mus. Pract. Geology).

Asaphus (B.) laticostatus. Pl. XVIII, fig. 6.

Isotelus (Basilicus) laticostatus, *M'Coy.* Synopsis Woodw. Museum, pl. i E, fig. 18 *a*, 1851 (not of Green's Monogr. p. 45, which is a Phacops).

Asaphus laticostatus, *Salter.* Morris's Catal., 2nd ed., 1854, p. 100 (Builth locality only).

Asaph. (*B.*) *planus,* 5 *uncias longus? Cauda lentè convexa, semiovata, obtusa, margine angusto striato, haud concavo. Axis angustus longiconicus* $\frac{5}{6}$ *caudæ longus, sulcis axalibus exaratis bene notatus, quartamque partem latitudinis efficiens, annulis rectis* 10 *planatis, per medium interruptis; apice haud abrupto. Limbus lente convexus, costis* 10 *planis marginem ferè attingentibus, sulcisque profundis, ad apices recurvatis. Fascia angustissima.*

We only know the tail of this remarkable species, which Prof. M'Coy has unaccountably referred to the *Asaphus laticostatus* of Green. The American cast (No. 13 of the Monograph) shows that species to be a large *Dalmania,* which we have lately found in Britain.[1] Prof. Green himself rightly compared his species with the *Phacops* (*Dalm.*)

[1] In Mr. H. W. Edgell's cabinet. The specimen seems to be from Upper Llandovery rocks. Green's specimen has no locality, but he quotes it from the Helderberg (Ludlow) series.

Hausmanni, a Bohemian Upper Silurian fossil. There can be no reason, however, for instituting a new name, as that of *laticostatus* is not occupied for the present genus. *Asaphus radiatus,* with which Prof. M'Coy united it, has been described above, and is a totally different species, as our figures will show.

Tail obtusely half-oval, not semicircular, gently convex; length two and a quarter inches, width three and a quarter inches. The long-conical flat axis, with straight sides, occupies ten lines in breadth at top, and rather quickly and regularly tapers backwards for five sixths the length of the tail; it is not clearly marked out at the tip or at all prominent there. It is annulated by ten flat rings, which run direct across, and are interrupted in the middle (as in several species of *Phacops*), so as to leave a line of connecting points down the centre of the axis. The furrows which separate the axis from the limb are deep, though narrow, the limb itself gently convex to the very margin, and scored deeply by eleven furrows, which are at first direct or only slightly oblique, and radiate outwards, then at the apices enlarge and turn backwards rather abruptly. They reach nearly to the margin, and invade the striated border, which is in this species much narrower than usual in the genus. I suppose the caudal fascia has impressed itself upon the upper surface, as is frequently the case. But this character will serve well whereby to contrast the present with the next species. M'Coy's figure is not satisfactory, and we have corrected it very carefully from the original. His figure has the axis too narrow at top, and the furrows across it entire, not interrupted in the middle, nor does it shew well the character of the lateral furrows, especially the upper one.

This species differs at once from *A. radiatus* (fig. 1) in the narrower, longer form of tail and greater number of furrows. The furrows, too, are curved, not straight, and the striate border narrow, not broad, as in that species. It may be a *Ptychopyge*, but I think not.

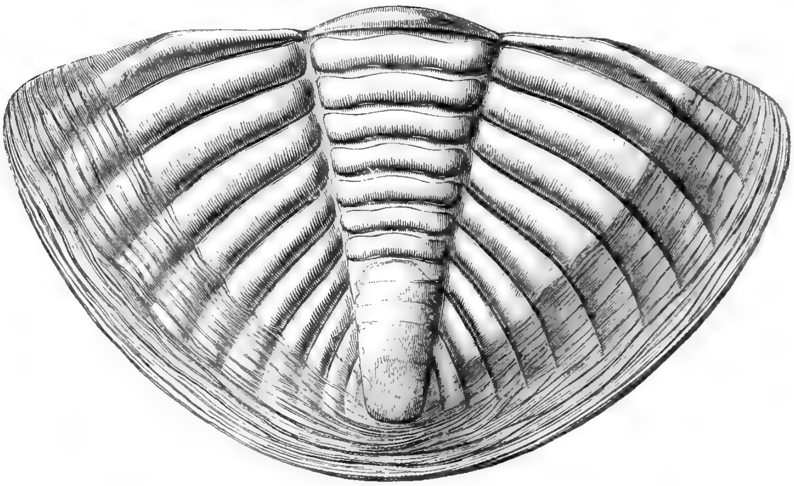
Locality. — LLANDEILO FLAG. Maen Goran, Builth, Radnorshire (Woodwardian Museum).

[I must be pardoned for introducing here a figure or two of a species before described, and figured in Pl. XVI. The specimens are pressed in different directions, that from Builth (Woodcut, Fig. 32) being shortened by pressure, and that from the collection of Mr. Pardoe (Fig. 33) being narrowed by the same process—cleavage-action.]

The extreme similarity of caudal shields of this fine fossil (*Ogygia corndensis,* Murch.) to the fossil last described (*Asaph. laticostatus*) has rendered it necessary to show how the two may be distinguished, when found in company, as they are very likely to be often found, since they occur in neighbouring localities of the same rock.

The caudal shield much resembles that figured as *A. laticostatus*, but it differs from it in the greater width of the tail, and especially of the axis, which has continuous non-interrupted furrows across it; and also in the undulated, convex and not flat, ribs of the limb. The caudal fascia, too, is twice as broad. *O. corndensis* is, moreover, a larger species, and must have measured full five and a half inches in length when perfect.

FIG. 32.

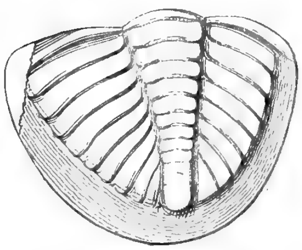


Ogygia corndensis, Murchison.

Very perfect caudal portion, from the Lower Llandeilo Flags, Builth, Radnorshire (Mus. P. Geology).

Tail two and a half inches long and four and a half inches wide, semicircular, gently convex all over, with the conical axis broader than in *A. laticostatus*, not one fourth of the whole width of the tail, and tapering gradually backwards to a very obscure apex, which reaches to five sixths of the whole length. It has about eight or ten rings, a little more curved than in the last species, not quite direct across, but not interrupted in the middle by any line of connected points. The axal furrows are shallow, and not very well defined in this fossil, while in the last they are deep and strong.

FIG. 33.



O. corndensis, Murch.

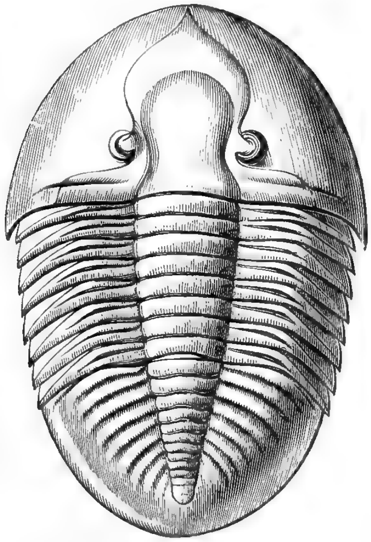
Small specimen from felspathic rock, probably a boulder. The late Mr. Pardoe's collection.

The sides show a broad gently convex surface, marked by eight gently undulating convex ribs, the furrows between which are shallow, and curved backward nearly to reach the margin, which is a little concave only just at the end of the tail, not on the sides. The furrows seem to radiate just as in the last species, but are more regularly curved and not bent back so suddenly as in that species. The caudal fascia is half as broad as the limb and coarsely striated throughout. The other figures in Pl. XVI will sufficiently shew the characters of the species.

Locality.—LLANDEILO FLAGS of Penrhiw, four and a half miles north-east of Builth. Collected by Miss Thomas, of Penkerrig, and presented to the Mus. P. Geol. several years back. The species is abundant at Gilwern, near Llandrindod; and also at Min Cop, Meadowtown, in the Corndon district, whence the species was named.

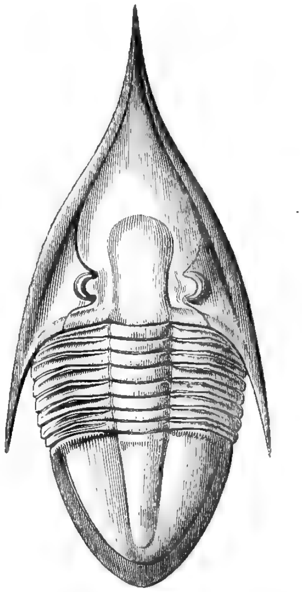
As reference has been made under the last two or three species to subgenera not yet *distinctly* recognised in Britain, I subjoin a figure of the subgenus *Ptychopyge*, Angelin, and also one of *Megalaspis*, to shew the extravagant form sometimes assumed by the latter group.

FIG. 34.



Asaphus (*Ptychopyge*) *latus*, Angelin.
'Pal. Suec.,' t. xxxi, Fogelsång, Scania.
Lower Silurian.

FIG. 35.



As. (*Megalaspis*) *extenuatus*, Angelin.
'Pal. Suec.,' t. xi, fig. 1, Ostrogothia. L. Silurian.

ISOTELUS, *De Kay.*, 1824.

ASAPHUS (ISOTELUS) GIGAS, *De Kay*. Pl. XXIV, figs. 1—5; Pl. XXV, fig. 1 (*var.*).

ASAPHUS PLATYCEPHALUS, *Stokes.* Trans. Geol. Soc., 1st series, vol. viii, p. 208, pl. xxvii, 1822.

ISOTELUS GIGAS and I. PLANUS, *De Kay.* Annals of Lyceum New York, vol. i, p. 176, pls. xii and xiii, fig. 1, 1824.

ASAPHUS GIGAS, *Dalman.* Palæadæ, p. 71, 1826.

ISOTELUS GIGAS, *Green.* Monograph Tril., 67. I. PLANUS; I. STEGOPS, *Ib.*, pp. 68—71. I. CYCLOPS; I. MEGALOPS, *Ibid.*, 1832.

BRONGNIARTIA ISOTELA, *Eaton.* Geol. Text-book, pl. ii, fig. 19, 1832.

ASAPHUS PLATYCEPHALUS, *Bronn.* Lethæa, vol. i, p. 115, pl. ix, fig. 8, 1835.
— GIGAS, *Emmrich.* Dissert. 32, 1839.
ISOTELUS GIGAS, *Milne-Edwards.* Crust., vol. iii, p. 298, 1840.
ASAPHUS PLATYCEPHALUS, *Buckland.* Bridgw. Treat., vol. 2, p. 76, 1840.
— — *Burmeister.* Org. Tril., p. 127, pl. ii, fig. 12, 1843; and Ray edition, p. 110, 1846.
ISOTELUS GIGAS; I. PLANUS, *Portlock.* Geol. Report, p. 295, pl. viii, fig. 7; pl. vii, figs. 2, 3 (except pl. viii, figs. 2, 3,). I. OVATUS; I. SCLEROPS. *Id.*, Pl. viii, fig. 5; pl. x, fig. 2. I. POWISII (not of 'Sil. Syst.') *Id.*, p. 297, pl. vi, fig. 1, 1843.
— MEGISTOS, *Locke.* Americ. Journ. Science, vol. xiii, p. 366, 1842; Trans. Assoc. Amer. Nat. and Geol., vol. i, pl. vi, 1843.
— GIGAS, *Hall.* Pal. New York, vol. i, p. 231, pl. lx, fig. 7; pl. lxi, figs. 3, 4; pl. lxii, figs. 1, 2; pl. lxiii, 1847.
— — *Billings.* Geol. Canada, p. 184, fig. 182. *A. platycephalus*, ib., fig. 183? 1863.
ASAPHUS (ISOTELUS) GIGAS, *Salter.* Mem. Geol. Surv., Decade xi, sec. 3, p. 1, pl. iii, 1864.

A. (Isot.) ovato-oblongus, lævis, lateribus rectis; capite pygidioque ejusdem magnitudinis, subtrigonis et hyperbolicis. Capitis sulci axales minimè profundi. Oculi modici et pone medium caput. Sutura facialis intrà marginem, cui parallela est; labrum ad basim angustum, in cornua longa parallela productum. Thorax axe pleurisque ejusdem latitudinis, fulcro ad tertias posito. Caudæ axis indistinctus conicus longusque; in latere quoque sulcus superior tantùm videtur, cæteri desunt; oculi modici pone medium caput.

One sometimes persuades oneself of a thing by continually asserting it, and as this species has been continually quoted of late years as the *I. gigas*, it has come to be generally accepted as such. There are some differences from American specimens, however, which may possibly cause its separation when we have more abundant material. I have used General Portlock's original specimens, and, believing the species identical with the common American form, follow most writers in adopting De Kay's name. It must have been published at nearly the same time as Mr. Stokes' name *platycephalus*, though the paper of the latter, in the Geol. Trans., was read early in 1823. Moreover the fossil described by Stokes has a broader form and smaller eyes than the narrower one commonly known as *I. gigas*. But if these differences be regarded as due to sex, the *I. gigas* being the ♂, and *I. platycephalus* the ♀ form, there would be no difficulty in accepting all as of one species.

In the Decade XI of the Geol. Survey, I have fully described this fossil, and I do not know that I can do better than quote that description. I look upon all Professor Green's casts as one species. Professor Hall does the same; and Portlock's difficulties arose out of an attempt to identify his variably preserved specimens with the named casts of Professor Green. There is no occasion here to distinguish *I. gigas* from *I. Powisii;* they belong to different subgenera.

I would only repeat here that there is no warrant, in any fragments I have seen or heard of, for supposing the great *I. megistos* of American authors to be so large as the cast sold for lecture-purposes would indicate. Twenty-one inches is not too long for the largest *Paradoxides*, but is far too much for any species of *Asaphus*.

"General shape oval-oblong, with the sides rather straight; the head and tail nearly equal, and both subtriangular; the head pointed, the tail more obtuse at the tip; the surface is convex, a line taken from the snout to the apex of the tail being a regularly convex one, uninterrupted by neck-furrow, depression or convexity of the smooth and even body-rings, or by furrows on the axis of the tail. The axal furrows are very obscure in the head; they are neatly marked, but shallow, along the body, and only very faint along the tail; all the surface is smooth, and the sides are strongly deflected, but not steep. The head has the shape of a broad and pointed Gothic arch, the breadth at base being to the length as three to two; the margin is very narrow and flat, not at all recurved; the facial suture, forming a broad ogive arch in front, runs for some distance close within and parallel to the front margin; and beneath the eyes,—which are large, placed near the glabella, and rather behind the middle of the head—the suture curves gently out and cuts the hinder margin midway; the head-angles are blunt-pointed, not rounded. On the under side of the cheek, near the angle, is a convex space containing an oval depression, which receives the apices of the front pleuræ in rolling up (fig. 6; see also fig. 5 for the cast of this depression on the matrix). The labrum (fig. 7) has a narrow base, then a strong constriction, and thence the sides are parallel; its apex is deeply furcate, the parallel forks occupying nearly half the entire length of the organ. Body-rings smooth, rounded at the apices, deflexed at the fulcrum, which is placed rather beyond one third, and with a broad strong groove. Tail subtrigonal, with straight sides and rounded blunt tip; the faint axis rapidly tapering, broad-conical, and reaching three quarters the length; sides quite smooth. In young specimens (says Professor Hall) the tail is more pointed, and exhibits eight faint articulations; in older specimens these increase in number, but the crust presents many traces of them when viewed from within, and they are often distinct (Hall, Pal. New York, *loc. cit.*, p. 231). Dr. Burmeister also calls attention to this character, which is, indeed, no more, as we shall see by and bye, than occurs in most of the smooth-shelled genera, the lobes being only obscured, not destroyed, by the even contour of the crust. *Illænus* shows this well, not only on the axis, but even in the inflated glabella. I have not seen internal lobes to the glabella in this species, but Dr. Burmeister figures them as strongly expressed."

Varieties.—If I am right in connecting the two forms above given—viz., *A. platycephalus*, Stokes, and *I. gigas*, there are two very distinct varieties of this species—the one, *A. platycephalus*, with "broad form and with small eyes; the other, of elongate form, and with variably large eyes, to which nearly all the above synonyms belong." I have quoted the best figures of these from the 'Geology of Canada,' (1863), by Sir W. Logan and E. Billings. But I have no difficulty in referring these differences to sex, the common form, *I. gigas*, being the ♂.

Localities.—Caradoc Rocks. Desertcreat, &c., Tyrone, Mus. P. Geology. The species ranges all through the North American Continent, in Lower Silurian rocks.

Asaphus (Isotelus) affinis, *M'Coy*. Pl. XXIV, figs. 13—14.

Isotelus affinis, *M'Coy*. Synops. Foss. Woodw. Mus., pl. i f, fig. 3, 1851.
Asaphus — *Salter*. App., Ramsay Geol. N. Wales, Mem. Geol. Surv., vol. iii, p. 310, pl. viii, fig. 15 (pl. xii, fig. 4 ?), 1866.

A. (Isot.) longè ovatus, capite rotundato, spiculis brevibus. Oculi submedii parvi. Sutura facialis ad frontem marginalis. Axis caudæ lævissimæ longus, et apice vix prominulo tenus prominens.

There are possibly two species in the Upper Tremadoc Rocks, and I retain for one of them the name given by Prof. M'Coy to an imperfect specimen, without head and without apex to the tail, but which, on comparison, seems to agree (the figure does not) with our Tremadoc species. In case the *A. Homfrayi*, fully described by me in the volume of the 'Memoirs' above quoted, should prove to be identical with this, Prof. M'Coy's name must give way, as it is quite impossible to determine his specimen. Still, the great difference in the facial suture in front, rendering this species a sort of link with *Basilicus*, ought to distinguish it from the next, to which it has the closest resemblance. Were the two alive, we should probably find them totally different in colour. But palæontologists have no such advantages in pursuing their studies, and must make the most they can of form.

Oblong-oval, two and a half inches long, of which the head measures more than a third, and is rounded in front; the glabella is very obscurely marked out, and has no furrows: it is most convex forwards. The facial suture curves boldly out above the eye, and cuts the margin considerably outside of it. Below the eye, which is of moderate size, more than half-way up the cheek, and close to the glabella,—the suture again curves largely out. No distinct neck-furrow is to be seen; and this is usual in *Isotelus*.

Thorax shorter than the head, but as long as the caudal shield. The axis broader than the sides, and not strongly separated from them. Pleuræ flat as far as the fulcrum (which is at one-half in the middle rings), then curved rather than bent down. The facet broad and very well marked. Pleural groove obscure, except just beneath the fulcrum.

Caudal shield larger than a semicircle, but proportionately rather short, without any segmental furrows on the sides, except the uppermost. Axis narrow, tapering, well defined, and reaching three fourths the length of the shield; its end not prominent. Incurved fascia broad, striate.

The under side of the head has the broad epistome well divided by a strong vertical furrow, so characteristic of this subgenus; the labrum is subquadrate, broader above and narrower towards the truncate tip. It appears not to be at all bilobed (unless it be imperfect in our specimen; but if it be not, *A. affinis* does not belong to *Isotelus*, but must form the type of an entirely new subgenus). It resembles some of the Swedish species of *Cryptonymus*, but the course of the facial suture and the indistinct glabella will distinguish it from these; while from the species of *Isotelus* the well-marked-out axis of the caudal shield will easily separate this primordial species.

Locality.—Upper Tremadoc Slate. Pen-y-clogwyn, S. of Portmadoc, in flinty slate, much compressed by cleavage; at Garth, Penrhyn; and near Llanerch, by the roadside towards Treflys. Prof. Sedgwick's specimen came from the slopes above Tremadoc; and I have gathered this species at Tyddyn-dicwm, on the Tremadoc mountain-side.

[This and the following are the earliest true species of *Asaphus* known; if, as above said, the labrum do not betray an affinity with *Ogygia*.]

Asaphus (Isotelus) Homfrayi, *Salter*. Pl. XXIV, figs. 6—12.

Asaphus Homfrayi, *Salter*. App., Ramsay Geol. N. Wales, Mem. Geol. Surv., vol. iii, p. 311, pl. viii, figs. 11—14, 1866.

A. (*Isot.*) *longè ovatus, lentè convexus, capite ante subangulato, spiculis brevibus. Sutura facialis intramarginalis. Oculi submedii, parvi. Axis caudæ longus, ad apicem prominulus.*

This is a more common species than the last, and is, indeed, not infrequent in the Tremadoc district. It is conspicuous too, being three inches long and one and a half broad. Compressed as our fine specimen from Mr. Homfray's cabinet is, it measures three and one third inches by three quarters of an inch. The Museum of Practical Geology has a fine series, presented by the same gentleman, to whom geological science is indebted for much hard work in the Tremadoc district.

The head is more than a third of the whole length, and longer than the thorax, which, in its turn, is longer than the caudal shield. The head is semi-oval, rather pointed in front, and has very short posterior spines; it is broadly depressed round the margin. The glabellar portion is scarcely marked out; the eyes are placed nearly half way up the head; they are small (two lines long), the facial sutures curving out boldly beneath them, and cutting the posterior margin more than half-way out from the axis. Above the eye they form a narrow ogive, and nearly follow the front margin. On the under-side of the head the vertical furrow on the epistome shows distinctly through the cast. The labrum is imperfect, but exhibits a strong marginal groove and two small lateral furrows.

The body-rings have the axis as broad as the sides, and moderately convex. The pleuræ are flat as far as the fulcrum, truncate at their ends, and have but a slight groove, which reaches only two thirds of the length. The fulcrum is at one third in front, and less than half-way out in the middle rings.

The caudal axis extends three fourths down the smooth tail, very indistinctly marked above, but in some specimens crossed by several faint rings, and is always prominent at the tip (see figs. 10, 11).

This has the characteristic facial suture of *Isotelus;* but if its labrum be like that of *A. affinis*, a point which is not yet known, it may belong to quite a distinct subgenus.

A. Homfrayi differs from its associate *A. affinis*, not merely in the facial suture, but in the much less pronounced axis of the tail; and from *A. Powisii*, with which it might be confounded by casual observers, the want of any tail-furrows, except obscure ones, on the axis, and the very slight convexity of the glabella, will easily separate it. Besides, it grew to only half the size of that Caradoc species.

Localities.—UPPER TREMADOC SLATE. Under Garth, near Tremadoc. Railway behind Penmorfa village. Tu-hwnt-yr-bwlch, near Portmadoc (cabinet of Messrs. Ash and Homfray, and Mus. Pract. Geol.).

§ BRACHYASPIS, *Salter*, 1866.

ASAPHUS (ISOTELUS) RECTIFRONS, *Portlock*.[1] Pl. XXV, figs. 6—10.

ISOTELUS RECTIFRONS, *Portlock*. Geol. Rep., p. 298, pl. ix, fig. 1, *a*, *b*, and pl. viii, figs. 2, 3, 7 (head), 1843.
— ARCUATUS, *Id.* Ib., pl. ix, figs. 2, 3 (tail).
— RECTIFRONS, *Salter*. Mem. Geol. Surv., Decades No. xi, sec. 3, p. 4, 1864.
[Compare *A. lævigatus*, Angelin, Pal. Suecica, t. 29, fig. 1, 1852.]

A. (*Brach.*) *latè ovatus, lævis, obtusus, cui caput caudaque transversæ, convexæ sunt. Caput breve, vix semicirculatum, angulis obtusis deflexis. Oculi arcuati, procul pone medium caput positi. Sutura facialis postica dimidium genæ efficit, anterior axi parallela est. Thoracis axis latus, vix á pleuris arcuatis distinctus, fulcro propinquo. Cauda brevis* (*long* : *lat* : : 7 : 12), *axe lato,* 11 *annulis minimè profundis distinctus, haud prominente, sed in apicem prominulum desinente : latera, nisi sulco superno lato exarata, æqualia, limbumque angustum planiorem gerentia. Fascia modica, striis distantibus.*

I venture to consider this the type of a distinct subgenus, intermediate between *Isotelus* and *Cryptonymus;* the extremely short form of the head and tail, and the marginal suture in front, distinguishing it easily. *A. lævigatus*, Angelin, figured in the next page, belongs to the same group.

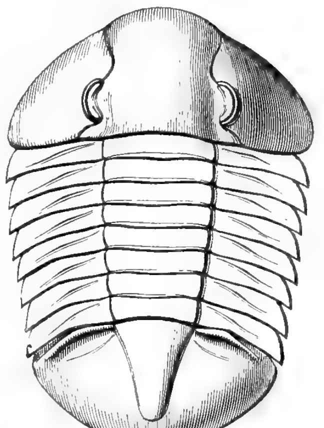
[1] General Portlock himself said that the species should form a new group, intermediate between *Asaphus* proper and *Isotelus.*

Head rather shorter than semicircular, gently convex; the angles rounded, but rather produced and incurved. The space between the eyes equal to the length of the head, the large, curved, semicircular corneæ being placed at one third from the base, about their own length distant from it; the eye-lobe horizontal, flattened above, and surrounded by the very convex lentiferous surface. The glabella quite obsolete, only marked by a deep punctation below the eye. The facial suture nearly straight above the eye, curving gently out, and cutting the front margin, along which it runs. Below the eye it runs outwards much beyond the eye about halfway along the cheek, and parallel to the posterior margin. On the underside of the head a narrow, convex, incurved margin shows the deep narrow pit above the angle for the reception of the pleuræ in rolling, and in front has a wide flat hypostome, divided by no vertical suture as in *Isotelus*, and showing a rather narrow base of attachment for the labrum, which is not yet known.

Of the body-rings we have only five, and these have a very broad axis, much wider than the pleuræ, and only divided from them by a shallow sulcus. They are much curved forward at their rounded ends. The fulcrum lies near the axis, about one fourth out.

The tail (*I. arcuatus*, Portlock) is wider than a semicircle. The upper angles are much bent down for the facet. The axis, marked out at its origin by two deep impressions, is at this part rather wider than the side-lobes. But from this point backwards it is not indicated, except by a slight prominence at the apex, which occurs at three-fourths the length of the tail. A broad shallow furrow beneath the fulcrum is all the marking that shows on the smooth convex sides. Caudal fascia concave, so narrow that its edge is not indented by the point of the axis; it is strongly lineated, the lines abutting sharply against the inner margin. *I. intermedius*, of Portlock, was formerly quoted by me wrongly as a synonym. But General Portlock erred in comparing this species with *A. tyrannus*, which it does not in the least resemble.

FIG. 36.



Asaphus Brachyaspis) *lævigatus*, Angelin, Lower Silurian, Sweden. From the 'Palæontologia Suecica,' pl. xxix, fig. 1. (The thorax is imaginary.)

But, if compared with the recently published *Asaphus lævigatus* of Angelin, the resemblance is so close that, were it not for considerable differences in the proportions of the head, and especially in the course of the facial suture beneath the eye, I should have combined that species with ours. They are, however, clearly distinct. We must include *A. lævigatus* in the same subgenus, and I give a figure of that species, which may serve to illustrate the subgenus *Brachyaspis*.

Other Species of the Subgenus.

To render our account complete, I must quote from the Decade XI, Geol. Survey, hoping in an Appendix to fill up these desiderata.

ASAPHUS (ISOTELUS), *n. sp.* *Salter.* Quart. Geol. Journ., Vol. VII, Pl. VIII, fig. 2.

A caudal portion of an undetermined species, figured by myself for Sir R. I. Murchison's paper on the Silurian rocks of the South of Scotland. Probably distinct from *I. gigas.*

Locality.—LLANDEILO FLAGS (?). Bogang or Bugan, Knockdolian, Ayrshire.

ASAPHUS (ISOTELUS ?), *sp.* *Salter.* Quart. Geol. Journ., Vol. IV, p. 205.

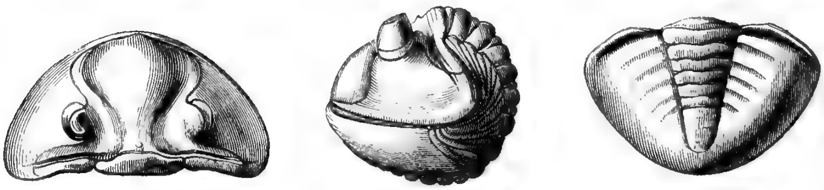
Quoted in Professor Nicol's paper on the Peebleshire Silurians. The specimen is now lost, but was stated to be allied to *A. gigas.*

Locality.—CARADOC. Wrac limestone, Peeblesshire.

CRYPTONYMUS, *Eichwald,* 1825.

The typical species of this section is the well-known *Asaphus expansus* of the Swedish and Russian works, of which a figure is given below. But though our British species does not show the lobes of the glabella, it has the hourglass-shape of that portion; the facial suture in a low ogive close to the contracted front margin; and the tail-axis with many obscure joints marked out within the crust. Lest, however, I may be mistaken in referring it to that subgenus, the figure will show what the type should be. I regard the British fossil as a link between *Cryptonymus* and *Isotelus.*

FIG. 37.



Asaphus (*Cryptonymus*) *expansus*, Russian variety. Lower Silurian, N. Russia. Mus. Brit.

Fig. 38.

Asaphus (Crypt.) Kowalewskii, Lower Silurian. Pulkowka, Russia. (From Lawrow.)

Asaphus (Cryptonymus) scutalis, *Salter*. Pl. XXV, figs. 2 and 3.

Isotelus læviceps, *Portl.* Geol. Report, p. 299, t. ix, fig. 4 (not of *Dalman*, Paleadæ., t. iv, fig. 1), 1843.

Asaphus (Isot.) læviceps? *Salter*, in Morris's Catal., 2nd edition, p. 100, including wrongly *I. intermedius*, Portl.; see *I. gigas*, 1854.

— (Crypton.) læviceps? *Ib.*, in Decade xi, Geol. Survey, under the description of *A. gigas*, sec. 3, p. 4, 1864.

— scutalis, *Salter*, in the Catalogue of Fossils in the Mus. P. Geology, p. 5, 1864.

A. (*Crypt.?*) *modicus, triuncis, latè ovatus, convexus, caudâ obtusâ, capite subangulato. Caput caudâ longius* (*long.* $1\frac{1}{2}$ *unc., lat.* 2 *uncias*), *angulis obtusis. Glabella non lobata, lævissima, in medio capite constricta, et sulcis axalibus pone oculos profundis convergentibus, antè minimè profundis et divergentibus. Oculi ex medio capite prominentes, propiores. Suturæ faciales posticæ valdè arcuatæ, pæne angulum attingentes. Thorax axe lato convexo, pleuris brevibus. Cauda semicirculata ferè; axe conico prominente sub cortice annulato, per* $\frac{2}{3}$ *caudæ extenso. Latera caudæ lævia, sulco superno solum distincto.*

The *Asaphus læviceps* of Dalman's Palæadæ, T. IV, fig. 1, though in some general characters like this species, is quite another thing really, and is a species of the subgenus *Symphysurus* rather than of *Cryptonymus* or *Isotelus*, as Professor Burmeister pointed out. It is near to *A. palpebrosus*, Dalm., and Portlock himself pointed out some of the differences from his species.

I. intermedius of the last-named author, which he says he only separated provisionally from *I. læviceps*, is a crushed specimen of the *A. gigas*. Portlock seems not to have been clear about this form, for he has labelled the specimen here figured (fig. 3) as *Isotelus intermedius*, whereas the axis of the tail is well marked out, and the ribs visible.

I have figured the true *I. intermedius* of Portlock with ours at the top of the plate, that the difference in the eyes, thorax, &c., may be apparent. Our species is a marked one, and I am glad to have the opportunity of clearing it up. It has long been in the Mus. P. Geology as *A. scutalis* (MS.).

Our fossil seems to have been about three inches long. The general form is very broad-oval, blunt behind, but angulated in front of the semioval head, which is much longer than the tail, and a little longer than the thorax-rings. In our best specimen it is thirteen lines long by two inches wide, and of this width the hour-glass-shaped glabella occupies more than one third below, contracting to much less than a third midway, opposite the eyes, and again expanding to nearly half above, to form the forehead-lobe. No lateral lobes or furrows interrupt the very even contour of the glabella, which is divided from the equally convex cheeks by a rather sharp but not deep furrow, ending on the neck-margin in a distinct punctum, not strongly enough shown in the plate. In the extremely narrow and almost obsolete neck-segment there is so close an approach to *Isotelus*, that I think we may fairly look on the species as linking together the two subgenera.

The eyes are placed halfway up the head, and are much raised, not very large, approximate (measured from their outer edges they are as far apart as the length of the head). The cheeks are regularly convex, the angles rather acute than rounded, and above the angles is seen the pit for the reception of the pleuræ, so conspicuous in *Asaphus gigas*, Pl. XXIV, fig. 6. Portlock notices this as a tubercle, but a tubercle on a cast signifies a pit on the true surface.

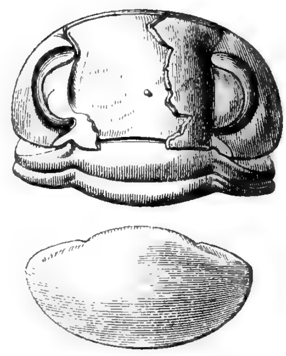
The facial suture curves largely out below the eye to more than half the width of the cheek; above it keeps within the line of the eye to reach the margin, and then continues parallel and close to it all along the front, scarcely angular even at the point itself.

The body, of eight rings, and the tail, can only be described from a single specimen (fig. 3), and this presents some differences from the central figure (fig. 1), which belongs to *I. gigas*, though, like fig. 3, it has been labelled as *I. intermedius*, Portl., a species which must be entirely obliterated.

The axis of the thorax is as broad as the pleuræ, but more convex than in *I. gigas;* the fulcrum is rather close to the axis; the pleural groove short, faint, and not so strong as in that species. The tail of our specimen (fig. 3) is semicircular, with smooth, gently convex sides, and a narrow raised axis, extending slightly more than two thirds down the tail, and marked interiorly by ten or eleven rings, or rather by a double row of puncta (representing the glands described at p. 52), one on each side of the axis. The sides are furnished with one long and broad depression or upper furrow, but with none else, the sides being free from ribs, as in all *Cryptonymi* or *Isoteli.* The fulcrum is strongly marked, and the facet broad, long, and turned much backwards. Caudal fascia broad, strongly striated.

Locality.—Caradoc, Tyrone (Mus. P. Geology).

FIG. 39.



Nileus armadillo, Dalman.
Lower Silurian. Russia (Brit. Mus.).

The sub-genus *Nileus* has not yet, so far as I know, occurred in Britain, although it is so common in Northern Europe that it may reasonably be expected to be found in our own Lower Silurian rocks. I subjoin a figure of the common *N. armadillo*, Dalman, to show the near approach made to *Illænus* by this peculiar group of *Asaphidæ*. The internal lobes of the glabella are well seen in the cast; the specimen is a fine one, in the British Museum collection.

STYGINA, *Salter*.

Among the many new and interesting forms of Trilobites described by Major-General Portlock in his work on Londonderry and Tyrone, a small species of *Asaphus* is recorded from the Lower Silurian of Tyrone, which he named *A. latifrons*, distinguishing it from some other species by the breadth of front included within the curve of the facial suture. The species is remarkable for the position of the eyes, which are placed so far backwards and inwards as to be close to the base of the small and narrow glabella. This peculiarity of habit is associated with some other characters which will remove the species from *Asaphus*. The flattened-oval form, long axis to the tail, and the head-spines, much resemble those of *Asaphus*, from which the nine ungrooved pleuræ effectually distinguish it. In the partial obliteration of the glabella, number of body-rings, and course of the facial suture, it is closely allied to *Illænus*, from which its habit differs so much; and there is enough of the under side preserved to show there was no rostral shield, which last is an essential character of *Illænus*. The technical generic character may be thus given:

Body ovate, flattened; head and caudal shield nearly equal; body of nine rings, and with narrow axis; eyes small, placed far backwards and inwards, near the base of the glabella, which is quite distinct above, and much contracted below. Facial suture marginal along a wide space in front, and below the eyes curved outwards and ending on the posterior margin; no rostral shield; labrum convex, entire; pleuræ without furrows; tail with a long and partially furrowed axis.

Stygina latifrons, *Portlock.* Pl. XVIII, figs. 7—10.

Asaphus latifrons, *Portlock.* Geol. Rep. Londonderry and Tyrone, pl. vii, figs. 5, 6.
— marginatus, *Portlock.* Ib., fig. 7, 1843.
Stygina latifrons, *Salter.* Rep. Brit. Assoc. Trans. Sect., p. 59, (read 1852), 1853.
— — *Id.* Siluria, 1st ed., 1854; and 2nd ed., p. 184, Foss. 26, fig. 2, 1859.
— — *Id.* Mem. Geol. Surv., Decade xi, sec. 2, p. 1, pl. ii, 1864.

S. sescuncialis, ovata, axe angusto; spicula capitis brevissima. Caput semiovatum, obtusum, glabellâ ad basim angustâ, oculis retrorsis, ad basim capitis pænè retractis. Cauda semiovata, obtusa, axe subannulato.

The general form is depressed and elliptical; the length about one inch and a half, the breadth one inch. The contour of the head, which is exactly as long as the caudal shield, and more than one third the whole length, is nearly a true semi-oval, evenly convex except on the median line behind (which is abruptly raised), and slopes on all sides to a concave border. The glabella, scarcely defined at all in front, though faintly indicated (more strongly so in young specimens), is of a pyriform shape. Posteriorly it is much contracted, and again suddenly expanded upon the neck-border. Its greatest width behind is not above one fifth that of the head. The eyes are small, convex, much curved, placed at less than their own length from the hinder margin, opposite the contracted part of the glabella, and rather further apart than the width of the thoracic axis. The facial suture runs nearly out nearly at right angles beneath the eye, and in front of it describes a large arc diverging from the eyes at an angle of 70°, and cutting the anterior border far outwards, in a line overhanging the fulcral points. The facial suture is strictly marginal in front, and the hypostome (fig. 4) appears to be quite continuous, without a rostral shield as in *Illænus*, or a vertical suture as in some *Asaphi*.

Two good specimens in Dr. Wyville Thomson's cabinet show the labrum, but its margin is broken off. It is wide at its attachment, considerably convex in the middle, more so than in *Asaphus*, and is marked with concentric lines on the sides. There is not enough to show that there was no marginal groove, or whether the tip was rounded and entire, as in *Illænus*, which is most probable.

Thorax of nine rings, not so long as the head, and with its axis only two thirds as wide as the pleuræ, convex. Pleuræ flat as far as the fulcrum, which is about the width of the axis remote from it. Thence the pleuræ are bent down and a little back, and facetted for rolling up. There is no groove whatever to the pleuræ, which in this respect resemble those of *Illænus*.

Tail semi-oval, blunt, not convex; the conical axis about half the width of the sides, and reaching fully two thirds the length of the tail. The axis has about eight faint furrows. The sides are gently convex at first, and then broadly concave, with a somewhat sharply defined margin; it is without any furrows, even the usual upper one is obsolete, or nearly so. The apex is very blunt, more so than the front of the head. The incurved striated portion is broad, and not indented by the point of the axis.

Locality.—Caradoc of Desertcreight, Tyrone. It will probably be found in the South of Scotland.

Stygina Murchisoniæ, *Murchison.* Pl. XVIII, fig. 11.

Ogygia Murchisoniæ, *Murchison.*	Silur. Syst., pl. xxv, fig. 3, 1837.
Stygina Murchisoniæ, *Salter.*	Rep. Brit. Assoc. Trans. Sect., p. 59 (read 1852), 1853.
— — *Id.*	Morris's Catal., 2nd ed., Foss. 10, fig. 4, p. 55, p. 115, 1854.
— — *Id.*	Siluria, 2nd ed., p. 55, Foss. 10, fig. 4; pl. iv, fig. 1, 1859.
— — *Id.*	Mem. Geol. Surv., Decade xi, sec. 2, p. 3, 1864.

S. convexa, valdè trilobata, capite longè semiovato cum spiculis productis. Cauda longè semiovata, axe prominulo lævi, non annulato.

In the black schists, which alternate with conglomerate and grit-bands at Mount Pleasant, Carmarthenshire, and which are most probably of Caradoc, not of Llandeilo age, a single specimen of this rather remarkable fossil occurred to Sir Roderick Murchison's hammer, and none other has since been found. The locality is worth searching. *Nacula* and *Orthoceras* are found with it.

The head is greatly longer in proportion than that of the species last described, forming a long semi-oval, produced behind into lengthy spines, and divided strongly into glabella and cheeks at the base. Above, our only specimen is indistinct, and it does not show the position of the eyes.

Of the thorax-rings but three or four joints are preserved, but these show the trilobation to be very strongly marked, and the axis is quite convex, while the pleuræ are considerably bent down from the fulcral point, and backwards too. They seem to be longer and narrower than those of *S. latifrons.*

The tail, reversed on the specimen (which was probably curled up when imbedded in the silt) is also of a long-oval contour, and its narrow axis is prominent to the very end; it shows no signs of transverse ribbing. The sides are faintly convex, then concave along the margin, which reveals, when the upper crust is removed, a moderately broad fascia, closely striated.

The species differs at a glance from *S. latifrons* in the much longer shape and more protracted head-spines. The tail, too, has a longer axis, without a trace of annular furrows, and the trilobation is throughout much more distinct.

Locality.—Caradoc? Black shales of Mount Pleasant, Carmarthen.

Presented to the Geol. Soc. Museum by Sir R. I. Murchison. It is named after Lady Murchison, and is as rare a species as any in Britain.

Stygina —, sp. Woodcut 40.

I do not like to risk naming an apparently new *Stygina*, with much shorter tail than in the two preceding species. It is from the Caradoc slates of Pembrokeshire. The axis reaches only half way down the tail, and the general shape is very broad.

Fig. 40.

Stygina, sp.

Locality.—Caradoc. Sholes Hook, Haverfordwest. Mr. H. Wyatt Edgell's cabinet.

Stygina? Musheni, n. sp. Pl. XXIX, fig. 1.

S. major, triuncialis, latè ovalis, subplanus, thorace caudâ obtusâ breviore. Axis corporis depressus, annulis arcuatis. Pleuræ lentè convexæ. Cauda semiovalis, obtusa (*lat.* 20 *lin.*, *long.* 14 *lin.*), *axe longo primùm conico, dein parallelo ; apice haud prominulo, annulis obscuris. Limbus lente convexus, margine angusto concavo.*

A larger species than either of the two preceding, and unfortunately not perfect enough to determine the genus. I have figured it with the *Illæni* only because there was most room on the plate. But it can hardly belong to any known British genera except *Asaphus* or *Stygina*, and I refer it to the latter for choice.

The whole fossil must have been above three inches long, for without the head it measures fully two inches. The thorax, with a gently convex surface, is shorter than the tail, and has a much wider axis, of eight arched rings, and with the axal furrows well marked out. The pleuræ are so much lost and obscured by rubbing, that we can only see they were unfurrowed and much arched, not bent down greatly. This is like *Stygina* or *Illænus*, not at all like *Asaphus*.

The tail is more perfect, and shows a wide semioval plate, blunt behind, gently convex, except the narrow concave border. The axis is not convex, and is very narrow, broadest and conical at the base, then parallel-sided, and extending to the edge of the concave border, but there indistinct, and, as it were, connate with the border. This is partly the case with *S. latifrons*. A few obscure annuli show at the upper part. The sides of the tail are smooth, and show no trace of furrows, not even the top one.

Locality.—In a gray calcareous flagstone boulder (from the Caradoc probably) in the drift of the Severn, near Buildwas. Cabinet of the late James Mushen, of Birmingham, whose persevering labours collected so fine a series of Silurian fossils.

Psilocephalus, *new genus,* 1866.

This has been long a MS. name, but only not yet made public owing to the great delay in the publication of vol. iii of the 'Memoirs of the Geol. Survey of North Wales.' The genus is an inconspicuous one, and at first sight it looks as if it might be placed with either *Asaphus* or *Illænus*. But the shape of the head, all but lobeless, as well as the forward position of the small eye, easily distinguish it from *Nileus,* the group of *Asaphi* which it most nearly resembles, while the eight grooved body-rings effectually exclude it from *Illænus*. In the absence of the hypostome and labrum — essential characters in the *Asaphidæ,* it is impossible to characterise it fully. But I feel assured it is a distinct genus.

Oval, convex, especially the head, which may be described as inflated, with a faintly marked out parallel-sided glabella, undefined in front; no marginal furrow; eyes very forward and small; head-angles obtuse; body of eight rings, with grooved and facetted pleuræ; it has an ungrooved tail, with a rather long distinct axis; the metamorphosis is only partly known.

Psilocephalus may be considered as forming the passage from *Illænus* to *Asaphus,* by means of the abnormal subgenus *Nileus* of Dalman.

Psilocephalus innotatus, *Salter.* Pl. XX, figs. 13—19.

Psilocephalus innotatus, *Salter.* App., Ramsay, Geol. N. Wales; Mem. Geol. Surv., vol. iii, p. 315, pl. vi, figs. 9—12, 1866.

P. latè-ovatus, lævis, sescuncialis; cujus caput semiovatum caudâ semicirculatâ majus; sunt 8 *pleuræ, fulcro tenus* (*ad tertias posito*), *planæ dein decurvæ. Cauda lævissima, axe prominulo.*

This neat and rather conspicuous form is the most abundant fossil in the Lower Tremadoc beds, and usually found in company with the much rarer *Niobe Homfrayi,* described at p. 143. We owe our best specimens to David Homfray, Esq., of Portmadoc.

The general shape is a rather broad blunt oval. It is scarcely an inch and a half, seldom more than an inch, long, by about three quarters of an inch broad. The form is very convex, especially in the head, which is but slightly lobed; the tail more strongly so, and the thorax strongly tri-lobed throughout.

The head may be called hemispherical; it is considerably longer than the tail, semi-oval, blunt, very convex and smooth, not margined at all in front. The glabella is confused with the cheeks, and scarcely marked out except near the base, as in *Illænus;* it is about as broad as the cheeks. Neck-furrow quite absent. Fixed cheeks narrow, and the free cheeks a small segment of a circle; the facial suture taking its rise near the obtuse outer angles, running obliquely forwards to the front margin, which it cuts rather within than immediately over the eye. The eye is very forward, fully two thirds up the head, and small. The body is strongly trilobed, a little shorter than the head; the axis narrower than the sides, tapering backwards slowly, and very convex. The pleuræ have square ends, are blunt, a good deal curved down from the fulcrum, which is at one fourth in front and thence extending further and further out till it reaches one third in the hinder rings, an unusual arrangement. The pleuræ are flat or but slightly concave as far as the fulcrum, thence sharply facetted and decurved, and striated lengthwise. The pleural groove shows strongly, but only towards its lozenge-shaped outward termination.

The semicircular, somewhat convex tail has the axis rather long, blunt, sub-cylindrical, reaching three quarters down the tail; it is smooth and has a blunt prominent tip. The sides are convex, smooth, with no flat or hollow margin along the striate border, and no furrows or ribs whatever.

Metamorphosis; one young specimen (fig. 17) shows only five rings.

Locality.—Lower Tremadoc beds of Penmorfa, Tremadoc, and the neighbourhood of Borth and Moel-y-gest; *e.g.*, Borthwood, Tyn-y-llan, Tyddyn-llwyd farm, &c. Mr. D. Homfray's fine specimens are figured, but the species is now in many other cabinets.

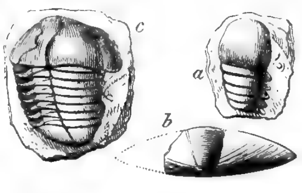
Psilocephalus inflatus, *Salter*. Woodcut 41.

Psilocephalus inflatus, *Salter*. App., Ramsay, Geol. N. Wales; Mem. Geol. Surv., vol. iii, p. 316, woodcut fig. 8, 1866.

P. prorsus trilobatus, capite inflato, et glabellâ conspicuè rotundâ. Axis corporis prominulus, caudæ brevissimæ distinctissimus, et valdè a lateri sejunctus.

This small species has always appeared to me to differ from the preceding. The head is very convex, the glabella rounded, and separated by its convexity and by distinct furrows from the head. Eye?

Fig. 41.



Psilocephalus inflatus, **Salter.**
Lower Tremadoc, N. Wales.
Mr. D. Homfray's cabinet.

Body with a moderately broad convex axis, also well distinguished from the somewhat convex pleuræ, the hinder of which are curved. I can only find seven body-rings. The tail, if it belongs to the same species (and I believe it does) is very short, and has the axis not only convex but short-conical, and marked out clearly all round.

Locality.—Lower Tremadoc, lowest beds, north-west of Penmorfa, on the Caernarvon Road (*a*, *b*). Upper beds, Trwyn cae Iago, Portmadoc Harbour (*c*). Borthwood.

PLATE XV.

LLANDEILO FLAGS.

Figs. 1—6.	*Ogygia Buchii,* Brongniart.	
1.	,, ,,	Male form ♂, Builth (Mr. Davies' cabinet), of the true convexity (most of the specimens are flattened).
2.	,, ,,	Specimen showing the labrum *in situ.* (Same cabinet.)
3.	,, ,,	Labrum. (Mus. Pract. Geology.)
4.	,, ,,	Portion of the striated upper border of the tail.
5.	,, ,,	Female form ♀; a variety with the dorsal tubercles conspicuous. (Mus. Pract. Geology.)
6.	,, ,,	Female form; a fine external cast. Presented to the Mus. Pract. Geology by R. Banks, Esq., of Kington.
Figs. 7, 8.	*Ogygia ? ?* (or *Phacops*) *subduplicata,* Salter. Llandovery Rocks of Haverfordwest. (Cabinet of Mrs. Breawell, Brighton.)	

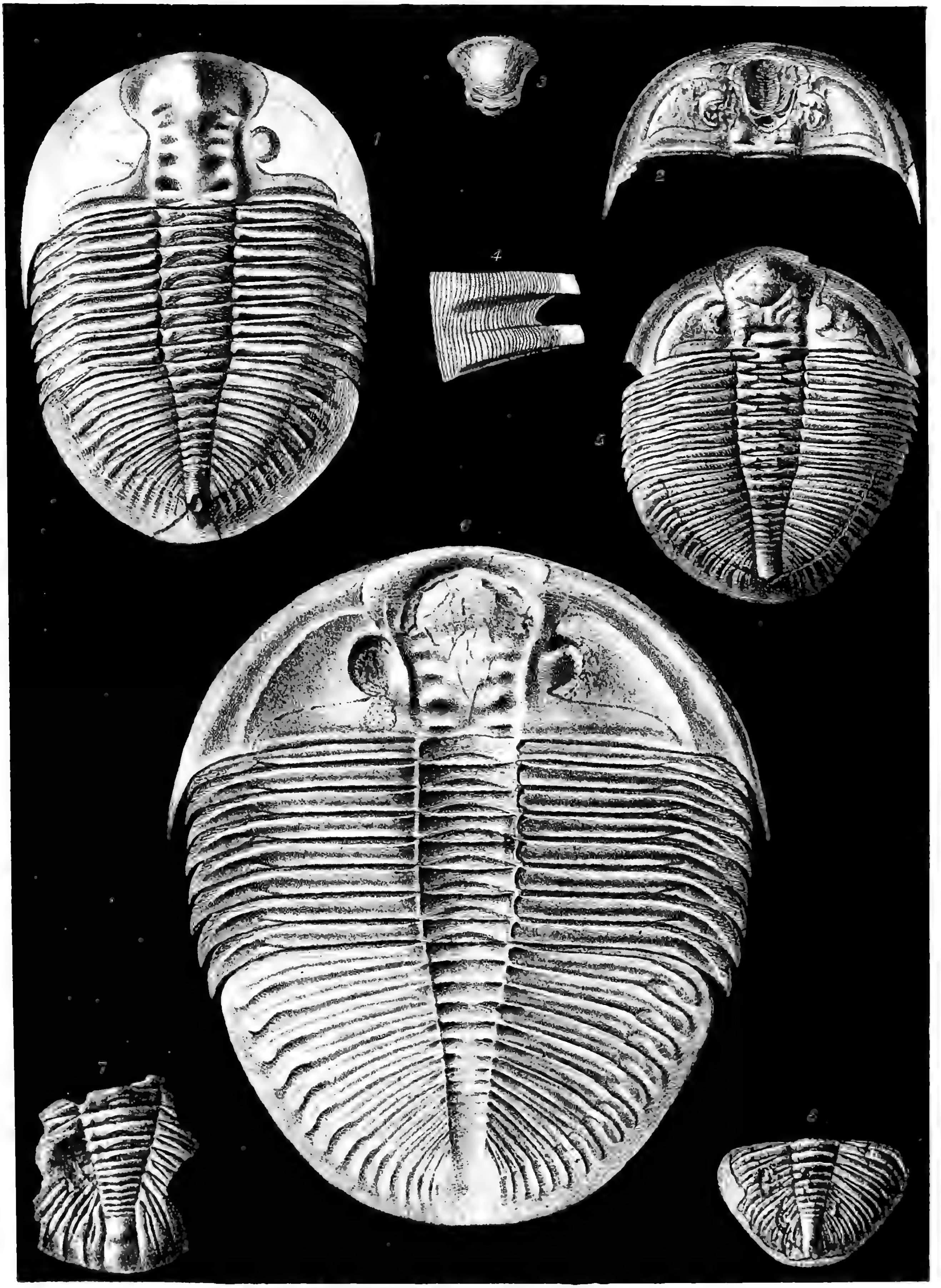

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PLATE XVI.

LLANDEILO FLAGS OF BUILTH, RADNORSHIRE.

Figs. 1—14.	*Ogygia*	*Corndensis,*	Murchison. Chiefly from the cabinet of Mr. Griffith Davies, of Cloudesley Street, Islington. The smaller specimens (figs. 2—6) are from the Shales of Trecoed, North of Builth, and are in the Museum Pract. Geology.
1.	,,	,,	Male ♂ form? with pointed head. Gilwern, near Llandrindrod.
2.	,,	,,	Young specimens, but with the full number of rings. Trecoed.
3, 4.	,,	,,	Distorted young specimens. Trecoed, Builth. The number of rings not quite certain.
5.	,,	,,	Very young state, with only six body-rings.
6.	,,	,,	Somewhat older, with seven rings.
7.	,,	,,	Half-grown specimen, the head has slipped over three of the body rings, and only five are visible.
8.	,,	,,	The originally figured specimen, from the Corndon Mountain, Shelve. (See 'Siluria,' pl. iii, fig. 4.)
9.	,,	,,	Very large specimen, showing impression of labrum, and the caudal fascia below. Gilwern.
10.	,,	,,	Young specimen, with labrum *in situ.* Gilwern.
11.	,,	,,	Full-grown female ♀ form, rounded at both ends.
12, 13, 14.	,,	,,	Half-grown specimens. Gilwern.

LOWER SILURIAN

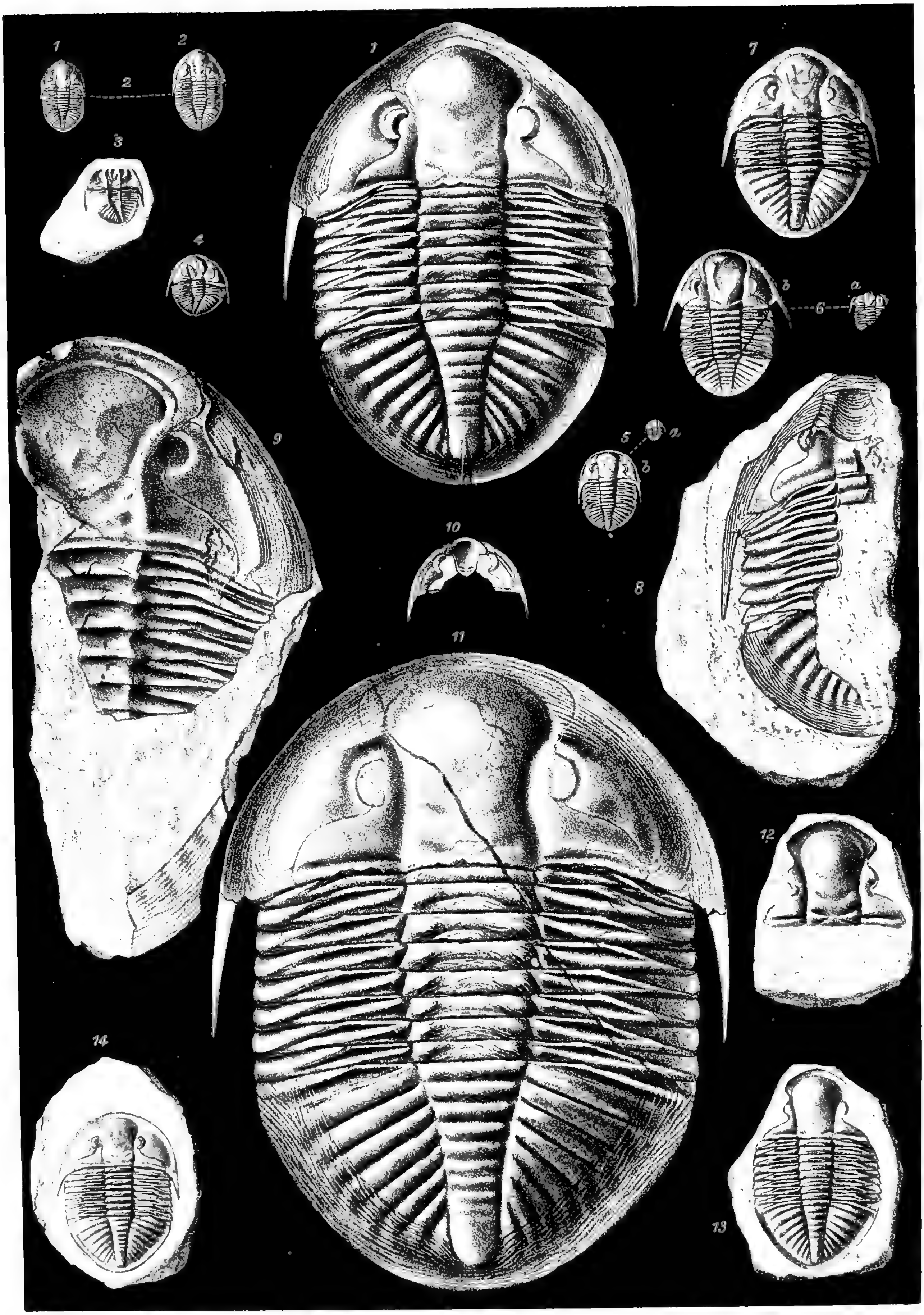

PLATE XVII.

LOWEST SILURIAN (ARENIG GROUP).

Figs. 1—7.	*Ogygia Selwynii*, SALTER.	
1.	,, ,,	Restored figure (not quite correct in proportions, the glabella should be broader), chiefly from specimens in the Museum of Practical Geology.
2.	,, ,,	Glabella. (Mr. Lightbody's cabinet.) White Grit Mine, Shelve.
3.	,, ,,	Compressed. From Llanfaelrhys, Aberdaron, South Carnarvonshire. (Mus. Pract. Geology.)
4.	,, ,,	Large caudal shield, White Grit Mine. (Mus. Pract. Geology.)
5, 6.	,, ,,	Thorax-joint and caudal shield. Same locality and cabinet.
7.	,, ,,	Labrum. Same locality. (Mr. Lightbody's cabinet.)
Figs. 8—10.	*Ogygia peltata*,	SALTER. From Whitesand Bay, St. David's, Pembrokeshire.
8.	,, ,,	A figure partly restored, and made too narrow in the axis, and the eye wrongly placed. Please to correct this by fig. 10.
9, 10.	,, ,,	Parts of one fine specimen, pressed by cleavage-action into a shorter form than ordinary. (Cabinet of J. E. Lee, Esq., Caerleon.) Fig. 9 should show faint traces of the intermediate furrows of the tail-ribs; and fig. 10 shows the labrum broken at the tip, so as to look like an *Asaphus*. It is, however, incomplete, and must have been pointed, as in *Ogygia*.

TREMADOC ROCKS (UPPERMOST CAMBRIAN).

Figs. 11—13.	*Ogygia scutatrix*, SALTER.	Fig. 11, the specimen originally found at Garth, in Upper Tremadoc. Fig. 13, labrum, imperfect, from Portmadoc. (Mus. Pract. Geology.) Fig. 12, tail from West of Penmorfa, Lower Tremadoc. (Mr. Ash's cabinet.)

ARENIG ROCKS.

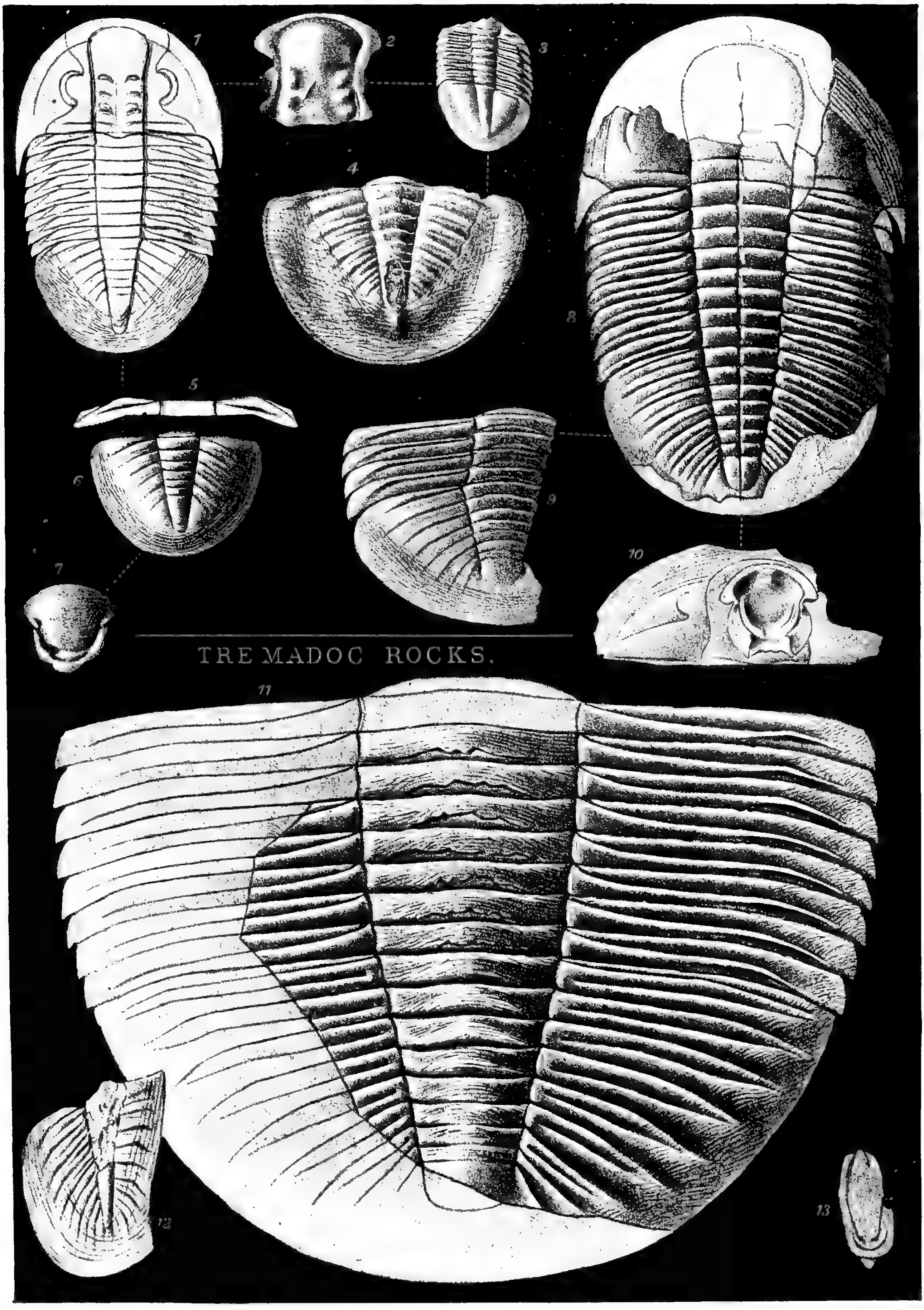

PLATE XVIII.

CARADOC AND LLANDEILO ROCKS.

Figs. 1—5. *Asaphus radiatus*, SALTER.

1. „ „ Largest specimen known. Berwyn Mountains. (Collection of Mr. Blunt, of Shrewsbury.)

2. „ „ Small but perfect specimen, figured by M'Coy as *A. laticostatus*. Bala, North Wales. (Woodw. Mus.)

3. „ „ Tail, compressed. Same locality. (Mus. Pract. Geology.)

4, 5. „ „ Caudal shields, shortened by pressure. Caradoc Slates of Louth, Ireland.

Fig. 6. *Asaphus laticostatus*, M'COY. The only specimen known. Llandeilo flags, Maen Goran, Builth. (Woodwardian collection.)

Figs. 7—10. *Stygina latifrons*, PORTLOCK. (Chiefly specimens figured in Decade II of Geol. Survey.) Tyrone.

7. „ „ Compressed laterally; best specimen known. (Mus. Pract. Geology.)

8. „ „ A little shortened by pressure. (Mr. J. E. Lee's cabinet.)

9. „ „ Epistome and labrum. (Prof. W. Thomson's cabinet.)

10. „ „ Dissected head, from various specimens. It shows there is no rostral shield.

Fig. 11. *Stygina Murchisonæ*, MURCHISON. Head and tail from the only locality known. Mount Pleasant, Carmarthen.

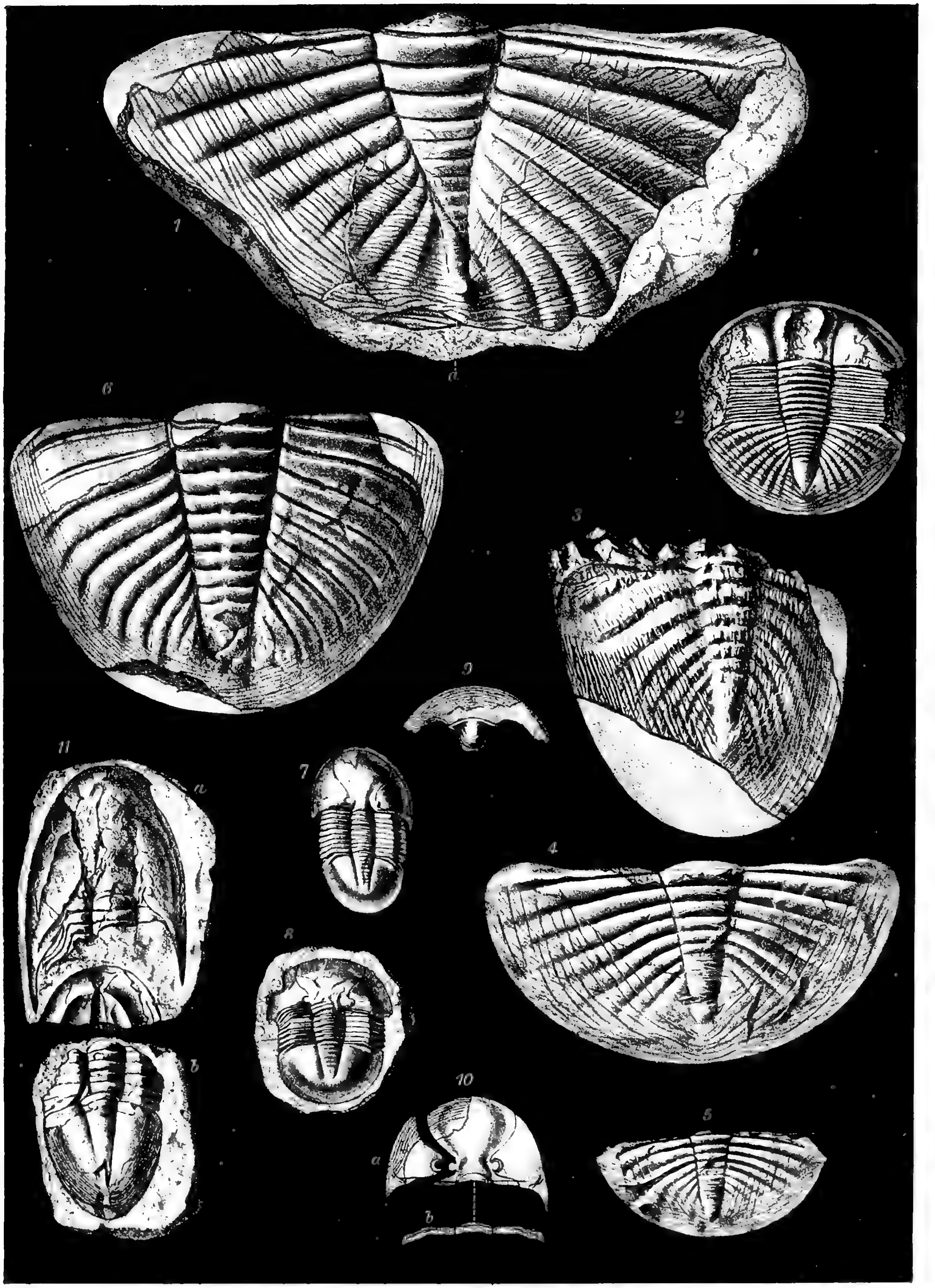
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PLATE XIX.

LLANDEILO FLAGS.

Figs. 1—4. *Barrandia* (*Homalopteon*) *radians,* M'Coy. In various stages of growth.

1. ,, ,, ,, Young, with only four thorax-rings developed. *a,* natural size; *b,* magnified. Wellfield, Builth.

2. ,, ,, ,, Somewhat older, with seven thorax-rings. Pencerrig, Builth.

3. ,, ,, ,, Not quite half grown, the eighth thorax-ring partly developed. (All the above in the Mus. Pract. Geology.)

4. ,, ,, ,, Full-grown tail. Gwernyfyd, Builth. (Mr. J. E. Lee's cabinet.)

Fig. 5. *Barrandia* (*proper*) *Cordai,* M'Coy. The only specimen known. Pencerrig, Builth. Once and a half natural size. The true length is represented by the line beside it. 5 *a.* A thorax-ring, enlarged. (Woodwardian Museum.)

Figs. 6—10. *Barrandia* (*Homalopteon*) *Portlockii,* Salter.

6. ,, ,, ,, Large specimen, partly restored. 6 *a.* One of the thorax-rings; diagram.

7. ,, ,, ,, Young specimen.

8. ,, ,, ,, Full-grown caudal portion.

9. ,, ,, ,, Labrum, with one side and the tip broken off.

10. ,, ,, ,, Head, showing glabella-furrows very perfectly. The free cheeks are wanting in all our specimens.

Figs. 3, 4, 6—10 are natural size; figs. 1, 2 magnified; fig. 5 enlarged one half.
Figs. 6—10 are from the Mus. Pract. Geology.

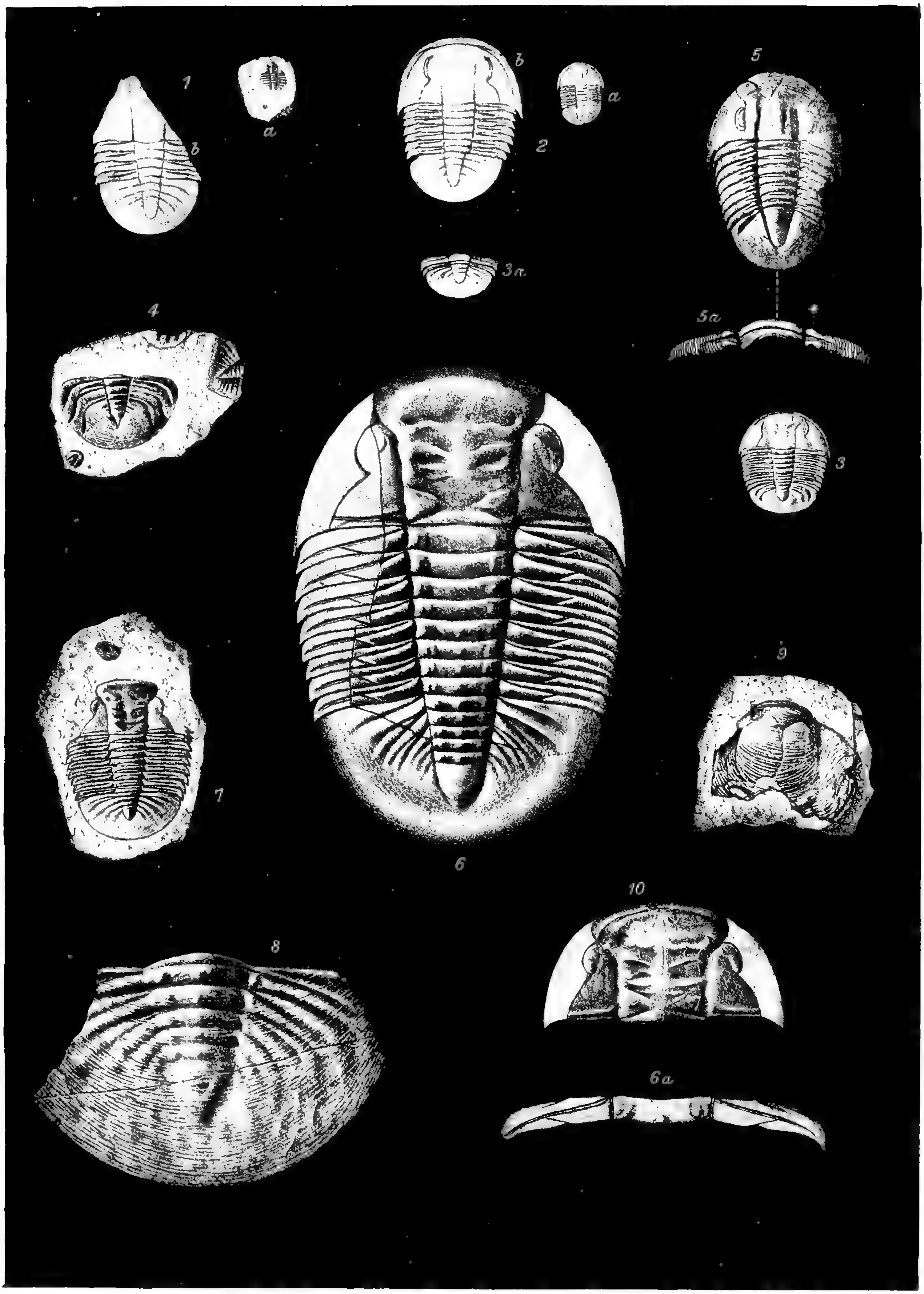
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PLATE XX.

LOWER TREMADOC SLATES AND ARENIG GROUP.

ARENIG ROCKS.

Figs. 1, 2. *Illænopsis Thomsoni*, SALTER. From the mine-works at Ritton Castle, Shelve, Shropshire. (Mus. Pract. Geology.)

LOWER TREMADOC SLATES.

Figs. 3—12. *Niobe Homfrayi*, SALTER. Penmorfa Church, near Tremadoc. (In the cabinet of Mr. David Homfray.)

3. ,, ,, Nearly full-grown, the free cheeks only wanting.

4. ,, ,, Head, showing more or less completely the glabella-furrows.

5. ,, ,, Tail, showing the caudal fascia well. (My own cabinet.)

6. ,, ,, Complete head; the free cheeks obtuse, not pointed. (Probably ♂.)

7. ,, ,, Young specimen (♂ form), the general shape and the axis being narrower than usual.

8—11. ,, ,, Outline diagrams from actual specimens, showing the true position of the glabella-furrows.

12. ,, ,, Broad (♀) form, compressed and shortened by cleavage.

Figs. 13—19. *Psilocephalus innotatus*, SALTER. Specimens of all ages and various degrees of compression in the rock. Fig. 16 is the fry; but the metamorphosis has not yet been properly observed.

UPPER CAMBRIAN LOWER SILURIAN

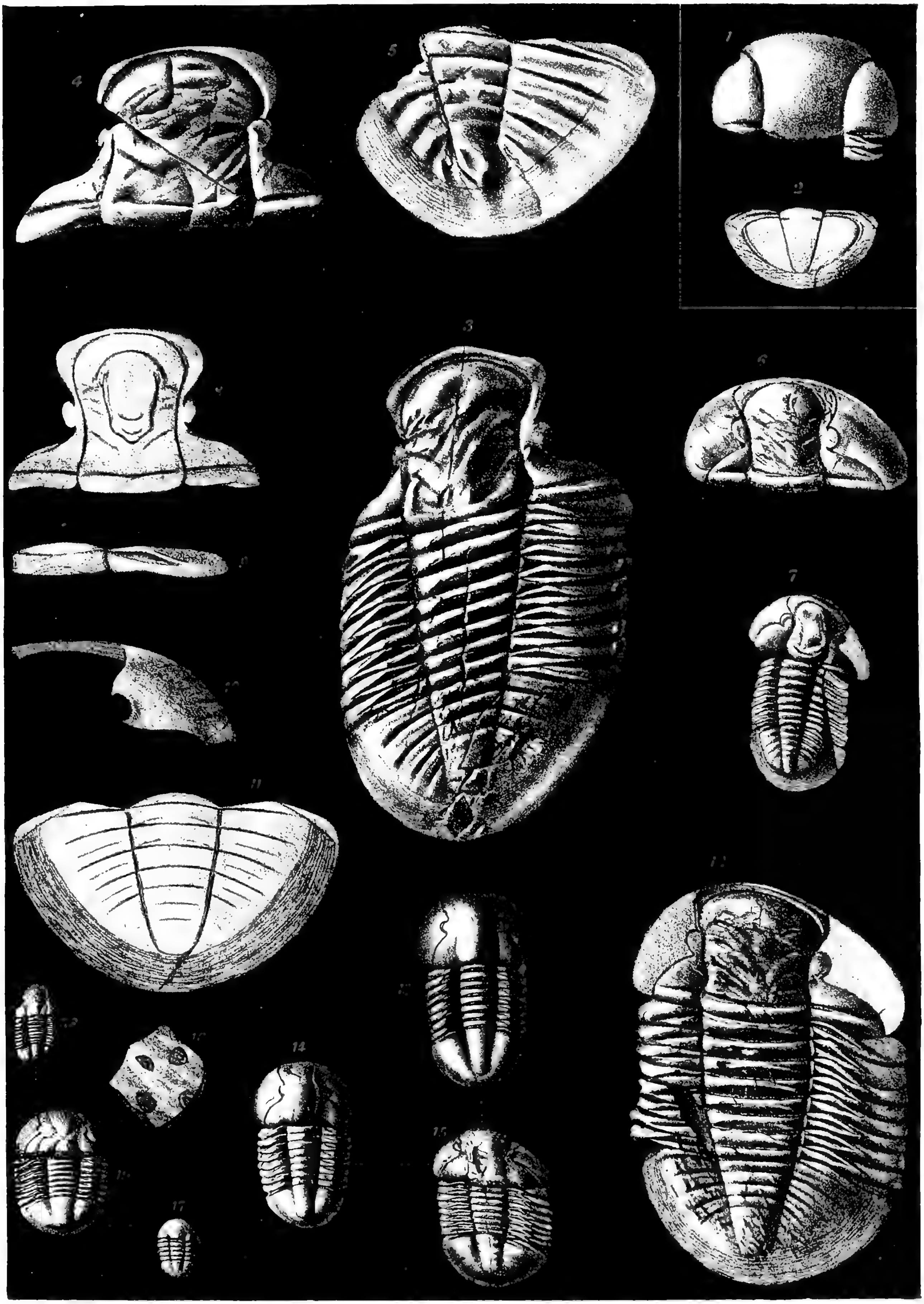


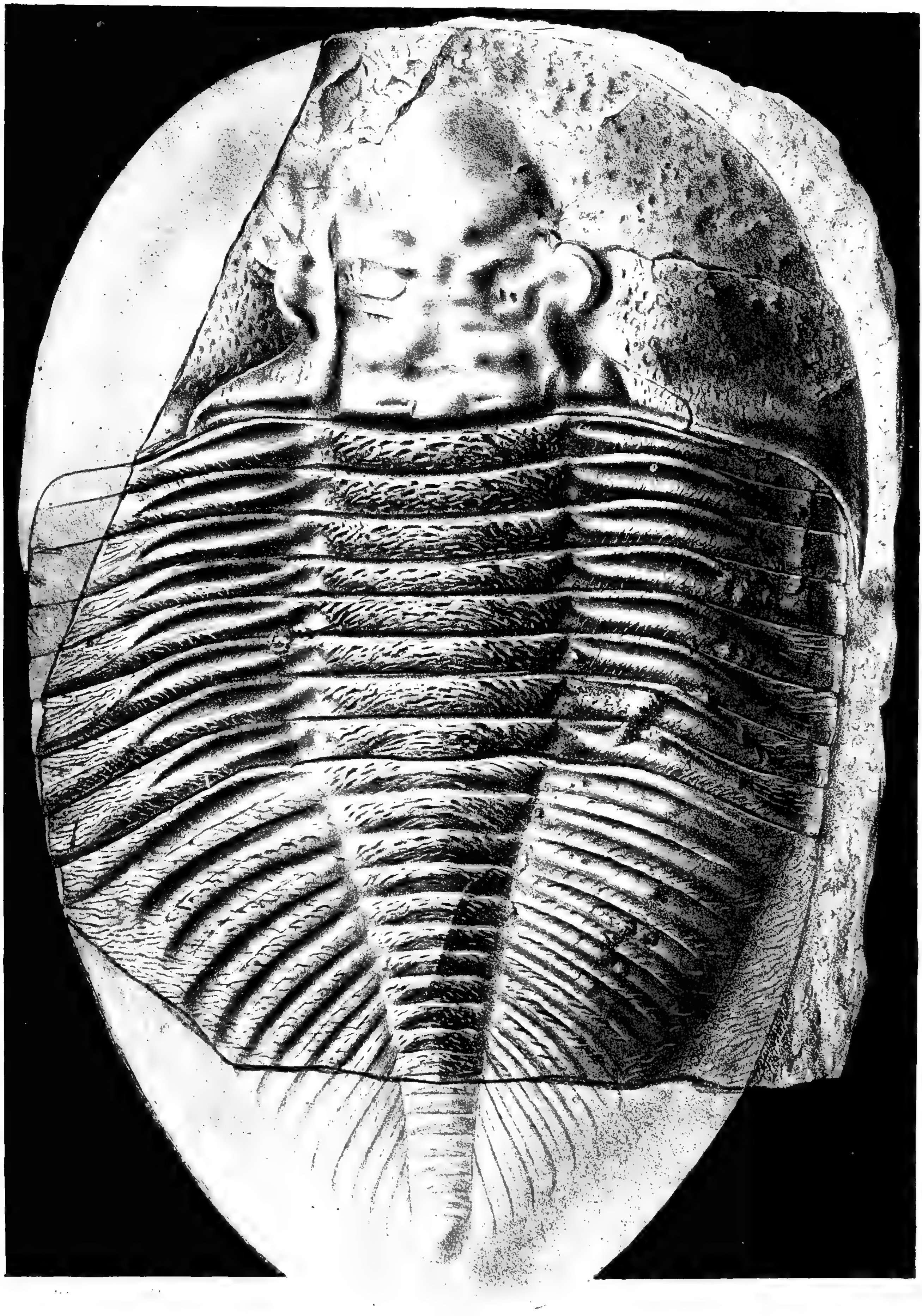
PLATE XXI.

LLANDEILO FLAGS.

The large and fine specimen of *Asaphus tyrannus* figured in the 'Silurian System,' pl. xxiv, as a variety, *ornatus*.

[We have, as usual in these plates, restored missing portions in a light tint. No inconvenience can arise from this practice so long as care is taken to distinguish accurately between the real and the missing parts. In the present instance one rib too many is added to the tail, which never shows more than twelve side-ribs.]

This is not the largest specimen known. *A. tyrannus* grows very nearly a foot in length.



Asaphus [illegible] *Murchison*

PLATE XXII.

LLANDEILO FLAGS.

Figs. 1—4. *Asaphus peltastes*, SALTER.

1. „ „ Fine young specimen, showing the lateral lobes of glabella and long head-spines. (Mus. Pract. Geology.) Llandeilo.

2. „ „ Free cheek and eye. The smooth cornea is removed, and shows the minute lenses, 4000 or more in a single eye. (Mus. Pract. Geology.)

3. „ „ Head of young specimen. Llampeter Felfrey. (Mus. Pract. Geology.) It is a little shortened by pressure.

4. „ „ Tail of nearly full-grown specimen. Llandeilo.

Figs. 5—12. *Asaphus tyrannus*, MURCHISON. Old and young. Llandeilo.

5. „ „ Head of very perfect specimen. (In the cabinet of Mrs. Breawell, of Brighton.)

6. „ „ Labrum from Llampeter Felfrey. (Mus. Pract. Geology.)

7. „ „ Magnified eye-lenses.

8. „ „ End of large thorax-ring. (Mus. Pract. Geology.)

9. „ „ Fine caudal shield. (Brit. Mus.) The nodes on the sides of the axis are the internal glands mentioned in p. 52.

10, 11, 12. „ „ Young caudal shields. The ribs are shorter and more numerous than in corresponding specimens of *A. peltastes*. (Mus. Pract. Geology.)

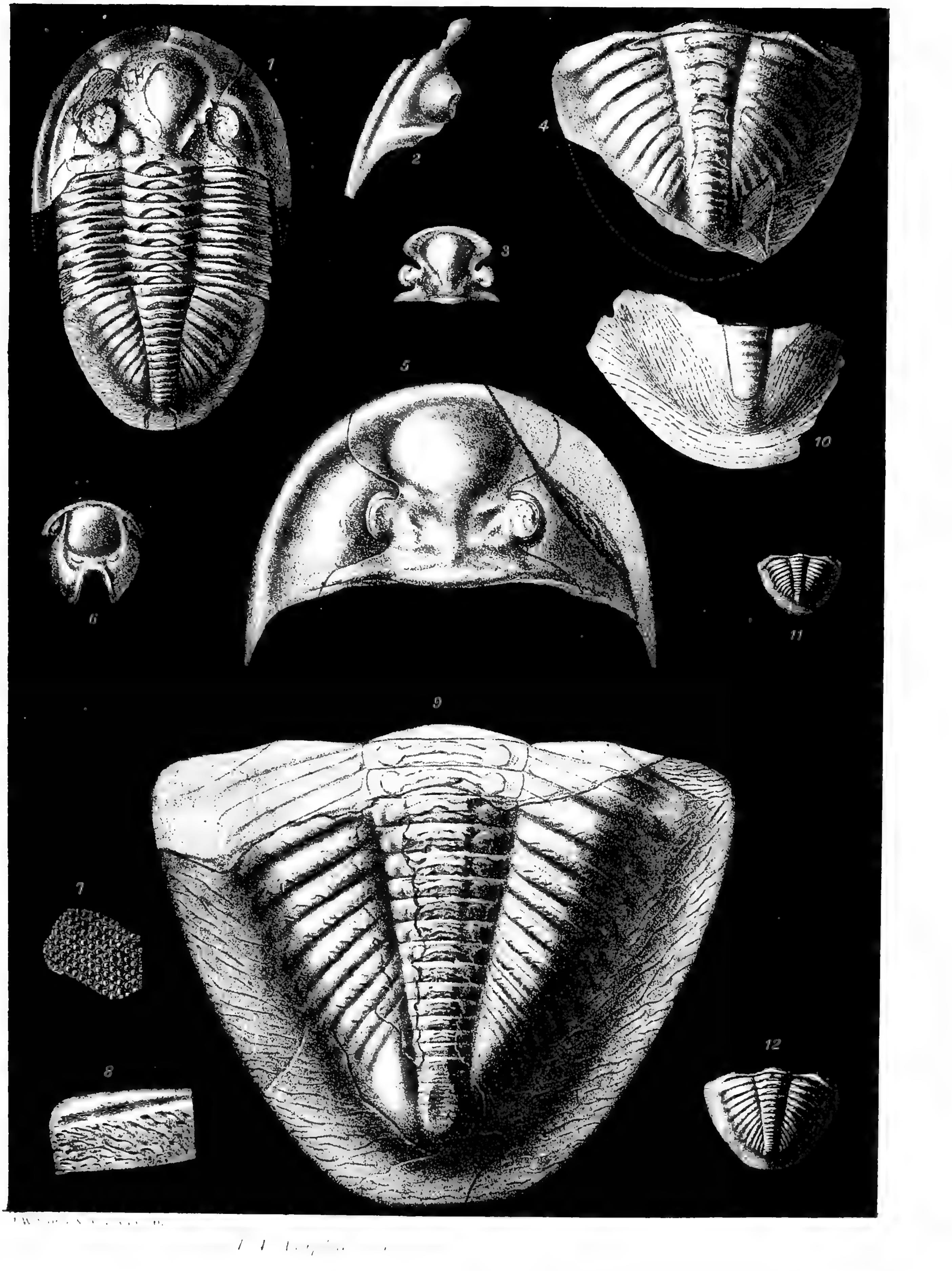

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PLATE XXIII.

LOWER SILURIAN (CARADOC).

Fig. 1. *Asaphus* (*Basilicus*) *Marstoni*, SALTER. Natural size; 1 *a*, magnified. *b* Is a free cheek of a larger specimen. Shales of Horderly. (Mr. H. W. Edgell's cabinet.)

Figs. 2—7. *Asaphus* (*Basilicus*) *Powisii*, MURCHISON. Chiefly from the Mus. of Pract. Geology. Figs. 3, 4, 6, are from Mr. H. Wyatt Edgell's cabinet.

2. ,, ,, ,, Restored figure, from many specimens. The head is not so perfectly known, and is only given here in outline. *a* Is a free cheek from Mr. Edgell's cabinet.

3. ,, ,, ,, Tail of young specimen. (Mr. Griffith's cabinet.)

4. ,, ,, ,, Somewhat older. Horderly.

5. ,, ,, ,, Large specimen from Waterloo Bridge, Conway. (Mus. Pract. Geology.)

6. ,, ,, ,, Labrum, not quite perfect at its base.

7. ,, ,, ,, Specimen from Dinas Mowddwy, North Wales. (Mus. Pract. Geology.)

Figs. 8, 9. *Asaphus* (*Basilicus ?*) *hybridus*, SALTER. From the Caradoc Shales (called in the text "Llandeilo flags"?) Henllan Amgoed, near Narberth, Carmarthenshire.

LOWER SILURIAN

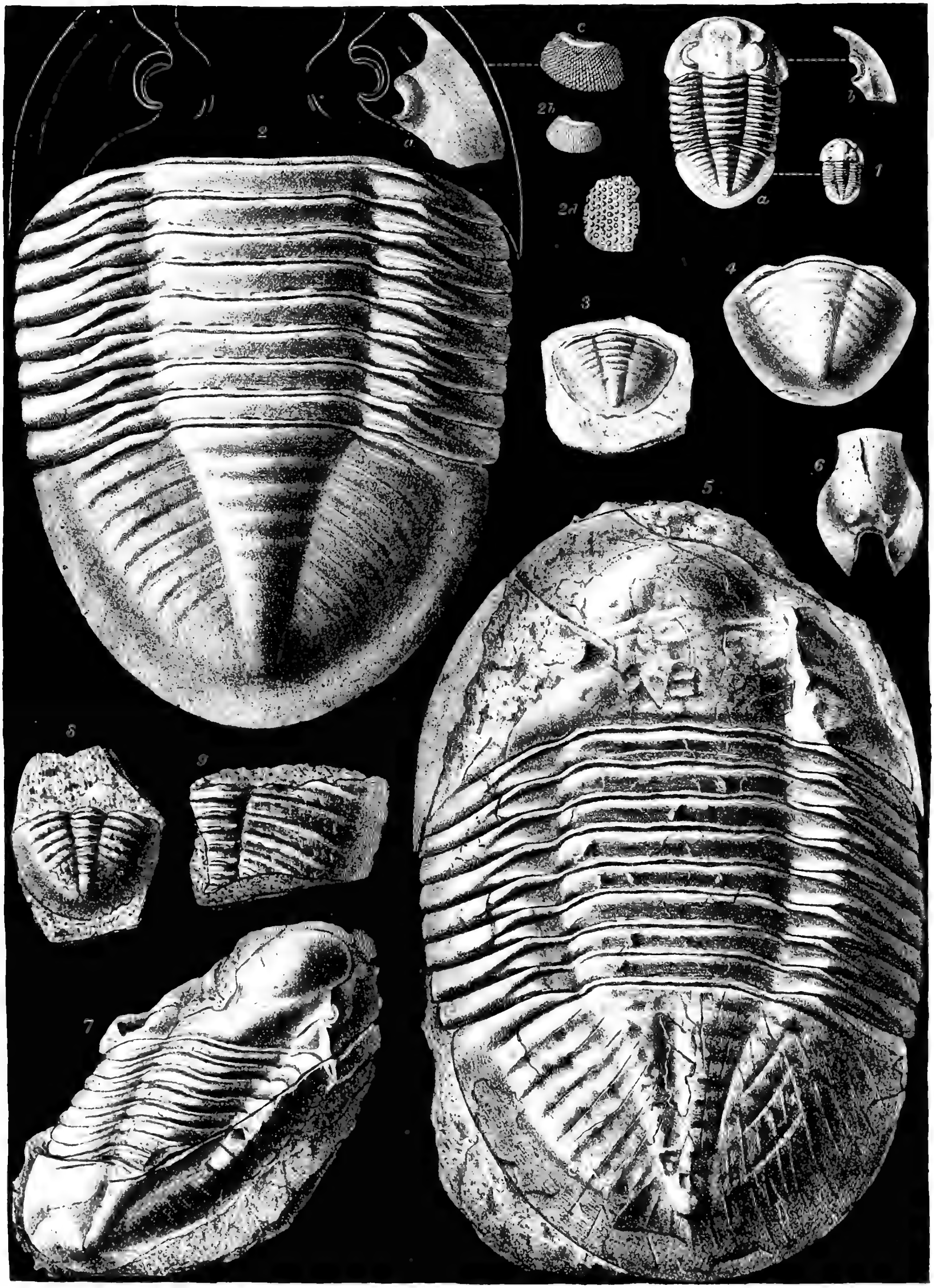


PLATE XXIV.

CARADOC ROCKS.

Figs. 1—5. *Asaphus* (*Isotelus*) *gigas*, DEKAY. From the Caradoc Rocks of Tyrone. (Mus. Pract. Geology.)

1. „ „ „ Young specimen, showing labrum. (Portlock's *I. planus*, pl. viii, fig. 1.)

2. „ „ „ Larger head. (Portlock's specimen, *I. sclerops*, pl. x, fig. 2.)

3. „ „ „ Tail of a large specimen.

4. „ „ „ Quite young. (*I. ovatus*, Portlock, pl. viii, fig. 5.)

5. „ „ „ Free cheek, showing eye and cast of lateral tubercle (*a*). *b* Is a cast in sealing-wax of the same outer portion of the cheek, showing the pit for the reception of the pleuræ in rolling up. (Portl., pl. vii, fig. 4.)

UPPER TREMADOC ROCKS.

Figs. 6—12. *Asaphus* (*Isotelus ?*) *Homfrayi*, SALTER. (From Mr. D. Homfray's cabinet, and Mus. P. Geology.)

6. „ „ „ Elongated and compressed specimen.

7. „ „ „ Young individual.

8. „ „ „ Labrum and epistome; the latter less perfect.

9. „ „ „ Labrum, pressed out of shape.

10. „ „ „ Tail, shortened by pressure, and showing the rudimentary rings on axis and sides.

11. „ „ „ Another specimen, similarly compressed.

12. „ „ „ Specimen shortened obliquely.

All the Tremadoc Slate specimens are from Garth, Portmadoc.

Figs. 13, 14. *Asaphus* (*Isotelus ?*) *affinis*, M'COY. Young and older specimen. (Mr. Ash's cabinet.)

LOWER SILURIAN

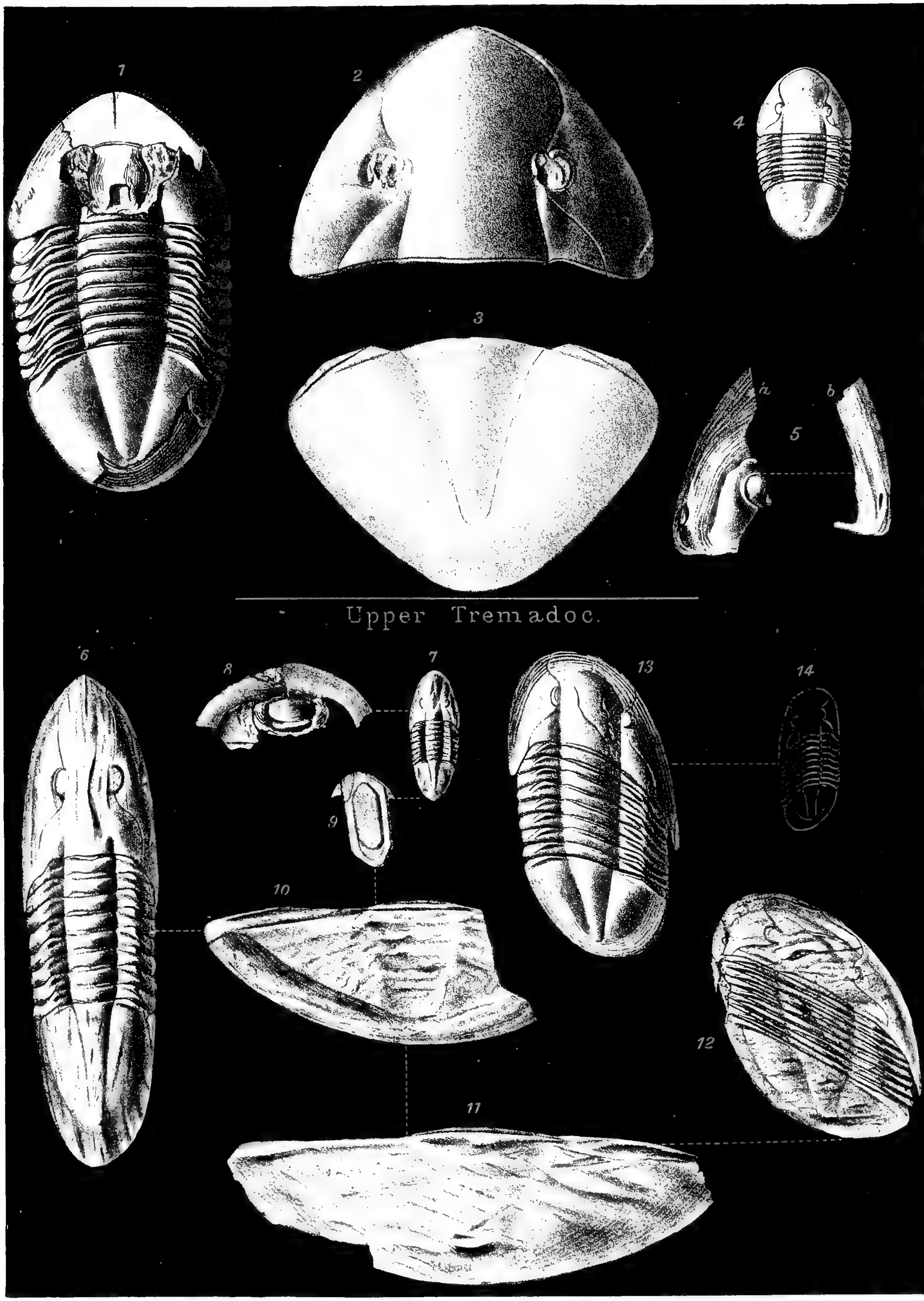


PLATE XXV.

CARADOC ROCKS.

Fig. 1. *Asaphus gigas*, Dekay, variety. This is from Portlock's specimen of *I. intermedius*, from his pl. ix, fig. 5.

Figs. 2, 3. *Asaphus* (*Cryptonymus*) *scutalis*, Salter.

2. ,, ,, ,, Head (Portl., pl. ix, fig. 4.) Tyrone. (Mus. Pract. Geology.)

3. ,, ,, ,, Body-rings and tail (labelled *I. intermedius* by Portlock). (Same collection.)

Fig. 4. *Asaphus*, sp. undetermined. From the Caradoc? Rocks of Mount Pleasant, Carmarthen. (Mus. Geol. Society.)

Figs. 5—10. *Asaphus* (*Brachyaspis*) *rectifrons*, Portlock.

5. ,, ,, ,, Under surface of the head, showing the entire epistome. Portl. *I. planus*, pl. viii, fig. 3. Tyrone. (Mus. Pract. Geology.)

6. ,, ,, ,, Side of head. Ditto. Portl., pl. ix, fig. 1 *b*.

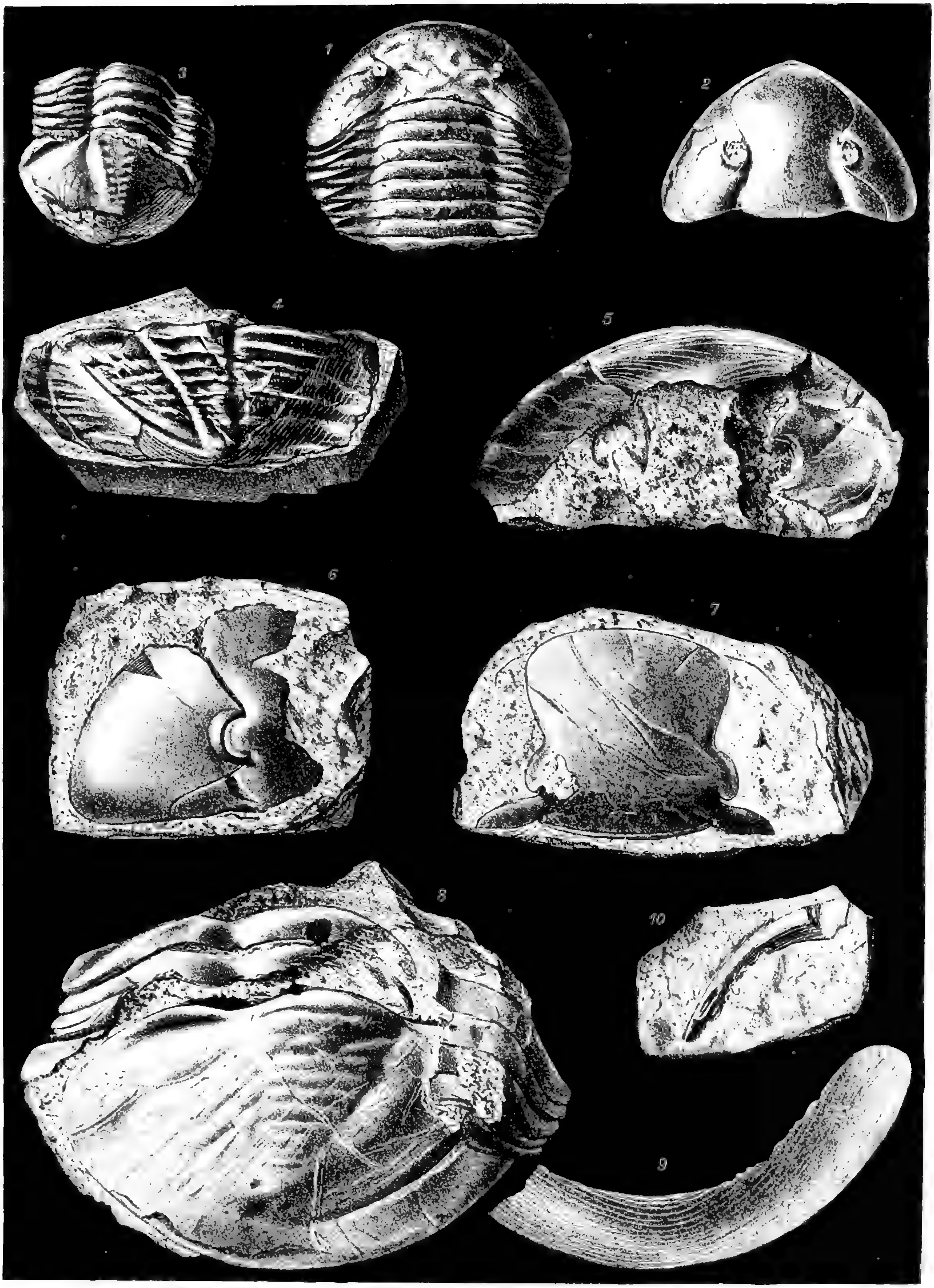
7. ,, ,, ,, Glabella only. Ditto. Ib., fig. 1 *a*.

8. ,, ,, ,, Body-rings and tail. Ditto. *I. arcuatus*, Portl., pl. ix, fig. 2.

9. ,, ,, ,, Fascia of underside of tail. Ditto. Ib., pl. ix, fig. 2.

10. ,, ,, ,, Under margin of cheek, showing the pit for the reception of the pleuræ.

All these are in the Mus. Pract. Geology.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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1864.

LONDON:

MDCCCLXVI.

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.

PART II,

CONTAINING

PAGES 29—52; PLATES I—VII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1866.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE, E.C.

Acanthoteuthis,[1] *Wagner.*

The shell is not known; probably identical with Belemnosepia. The hooks were in double rows along ten nearly equal arms. (Example—*A. prisca.* Oolite of Solenhofen.)

Belemnoteuthis, *Pearce,* 1842.

Shell consisting of a *phragmocone* like that of the Belemnite, a horny dorsal *pen,* with obscure lateral bands, and a thin fibrous *guard,* with two diverging ridges on the dorsal aspect.

Animal provided with *arms* and *tentacula* of nearly equal length, furnished with a double alternating series of horny hooks, from twenty to thirty pairs on each arm; *mantle* free all round; fins large, mediodorsal. (Example—*B. antiqua.* Oxford Clay.)

Conoteuthis, *D'Orb.*

Phragmocone slightly curved. *Pen* elongated, very slender. (Example—*C. Dupiniana.* Neocomian.)

In 1863 Karl Mayer presented, in the 'Journal de Conchyliologie,' the following classification of Jurassic Belemnites, which is illustrated by the collection in the Zurich Museum:

ACUARII. Lanceolate, laterally compressed, without canal or lateral grooves. Lias and Oolite.

A. Smooth. *AA.* Alveolus excentric.
AAA. Alveolus central.

B. With furrows at the apex.
BB. Alveolus central.
BBB. Alveolus excentric.

CANALICULATI. Lanceolate, with ventral depression, but no lateral grooves. Oolite.

A. Smooth. *AA.* Alveolus excentric.
AAA. Alveolus central.

B. Unisulcate. *BB.* Alveolus central.
BBB. Alveolus excentric.

C. Bicanaliculate.

[1] Professor E. Suess has lately given figures and descriptions of the Acanthoteuthidæ, 'Proceedings of the Imperial Academy,' Vienna, 1865.

HASTATI. Fusiform, with lateral grooves or canals. Lias and Oolite.

A. Smooth.
B. Unisulcate.
C. With lateral canals.

Each of the divisions thus indicated is subdivided into groups of allied species.

M. Duval-Jouve proposed a classification limited to the Belemnites of the Neocomian strata, which may be convenient for reference; though at the present time hardly a single species of the groups he mentions and describes so carefully has been found in England.

1. Bipartiti.—The sides marked by a deep furrow, which divides them into two equal parts; place of the siphuncle unknown. *B. bipartitus* of Blainville is an example.
2. Notosiphiti.—The siphuncle placed on the middle line of the *dorsal aspect* of the alveolus, opposite to the ventral canal of the guard; always compressed; the opening of the cavity notched on the sides.
3. Gastrosiphiti.—Siphuncle in the middle line of the *ventral aspect;* always cylindric or depressed; opening of the cavity terminating circularly or obliquely.

Before proceeding further it is desirable to fix the meaning of a few terms of continual use in describing the guard and phragmocone. In general figure a few Belemnites are very nearly *conical* in the retral part of the guard, having there straight sides and a nearly circular section; more frequently the section is not circular, and the figure is better termed *conoidal.* Again, in the middle of the guard, as usually found, some Belemnites are very nearly *cylindrical,* with parallel sides and a circular section; but as often other Belemnites have the section oval or in other ways deviating from a circle, and to such the term *cylindroidal* will be applied. Looked at in a general sense, the whole form of the guard is said to be *hastate* when between the apex of the phragmocone and the termination of the guard the outline is swollen; when this swelling is very slight the term *subhastate* may be employed; when, on the contrary, it is large and conspicuous the Belemnite is called *fusiform.* Forms which are cylindrical or cylindroidal in the middle of the guard, and conical or conoidal in the hinder part, are often conveniently called *lanceolate.* As to the termination of the guard, it is in the Belemnitellæ of the Chalk *mucronate;* in some Oolitic and Lias groups this form is nearly approached, and the term *submucronate* will be useful. In *Belemnitella attenuata* and some others the point is *produced;* and for the remaining forms *acute* and *obtuse,* with the help of the adverbs *very* and *slightly,* will probably suffice. For want of care in the use of two other terms in respect of the guard, great confusion arises. Belemnites are *compressed* when the diameter from *side to side* is less than that from the back to the front; *depressed* when the contrary occurs. The *axis of the guard* (called the "apicial line" by Voltz) is the line from the apex of the guard to the apex of the phragmocone; the *axis of the phragmocone* extends from its apex to the centre of the last septum. The relative length of these axes is of much interest and importance in diagnosis. Phragmocones are not always truly *conical;* they are usually a little compressed, and deserve to be called *conoidal.* The angle of inclination of their sides is believed to be nearly constant in the same species, for the same part of the slopes; but it varies in different species (12° to 32°), and in the same species it often varies a little between the apex and the last chamber. The angle most proper to take for characters of species is between side and side; but it is desirable, when good examples occur, to give also the angle of the back and front. The section of the alveolar chamber may often be had when the phragmocone cannot be obtained.

BELEMNITIC BEDS.

A full account of the geographical and geological distribution of Belemnites must be postponed till the species have been described; but it will be convenient here to indicate the principal zones, or beds of rock, in which they are found most abundantly. Not only is the group absent from existing oceans, but it is unknown in the whole Cænozoic period; for Beloptera and Belemnosis, which occur in Eocene strata, are probably of the family Sepiadæ.

In the Upper Chalk of Kent, Norfolk, and Yorkshire, with *Ananchytes ovata,* we recognise in abundance Belemnitellæ, the latest members of the family in Britain; at Maestricht beds of Chalk, thought to be somewhat higher in the series, also contain them in plenty. Comparatively rare in the lower parts of the Chalk, and not very frequent in Upper Greensand, they are plentiful in the Gault, but again rare in Lower Greensand. No member of the family has been found in the Wealden strata.

Belemnites appear below, but, excepting one dubious notice, I have no information of them in any part of the Purbeck or the Portland strata. They are abundant in Kimmeridge Clay, frequent in Coralline Oolite, less frequent in Calcareous Grit, but again become plentiful in the Oxford Clay, both in the upper part and lower part, as well as in the Kelloway Rock.

Again, they become rare in Cornbrash, and are almost unknown, except as fragments, in Forest-Marble. In Bradford Clay they are unknown to me, except by a notice in Smith's 'Stratigraphical System,' where a small slender species is quoted from Stoford, south of Bradford, in Wiltshire. Nor have I more than mere fragmentary indications in the Great Oolite, till at the base of it we find the canaliculated Belemnites of Stonesfield. Smith mentions a canaliculated species in the Fuller's Earth, but they are very rare in any of the beds between the two Oolites of Bath.

The Inferior Oolite contains many species, in the lower beds especially, and from this point downwards through the sands, and clays, and limestones, of the Liassic series, Belemnites are almost never absent from the section till we reach the zone of *Ammonites Bucklandi.* Only in the upper part of this zone have they been found by Mr. Sanders at Salford, and by Mr. Day at Lyme Regis. I have not, with my own hands, after three careful examinations of the same zone at Lyme Regis, obtained a single example; nor any trace of one, either in the lower parts of that zone or in the subjacent bands with *Ammonites planorbis.* None has ever been seen by me in the strata below from any place in the British Isles.

"Belemnite-Beds" are best exemplified in the Lias, where thin bands of strata are remarkably stored, and even crowded, with the guards of Belemnites. It will be enough to cite in the Southern Lias the well-known rich layer at the foot of Golden Cap, and on the front of Black Venn, near Lyme Regis. On the Yorkshire coast are several of these bands, in the Lower, Middle, and Upper Lias—different species in each of these cases. The Cephalopoda-Bed, as it is called, just at the junction of the Liassic Sands with the Inferior Oolite, is sometimes very rich in Belemnites, and so are parts of the Oxford Clay, the Red Chalk of Speeton, and the upper layers of the White Chalk. As far as mere number is in question, these may be called "Belemnite-Beds," but they are not so in the same sense as the Liassic layers already mentioned.

Till within a short time, the only examples of Belemnites in the strata of Britain, even approaching to completeness, were found in the Oxford Clay near Chippenham, where also shells of Ammonites were more than usually perfect; and other Cephalopoda retained the form of some of the softer parts. Lately, Mr. Day was successful in extracting from the Lias of Lyme Regis several specimens in which the hooks of the arms were preserved, the arms having disappeared, and the greater part of the phragmocone appeared in its place as regards the sparry guard. Possibly, by a careful search in the Gault of Folkstone, the true shape and some further details of the smaller species of Belemnitellæ may be recovered.

The descriptions of species will now be entered upon, beginning with those of the Lias.

BELEMNITES OF THE LIAS.

Belemnites acutus, *Miller*. Pl. I, fig. 1.

Reference. *Belemnites acutus*, Miller, 'Geol. Trans.,' 2nd series, vol. ii, p. 60, pl. viii, fig. 9 (read April, 1823), 1826.
B. brevis, var. A, Blainville, 'Mém. sur les Belemnites,' p. 86, pl. iii, figs. 1, 1 *a*, 1827.
B. acutus, Sowerby, 'Min. Conch.,' p. 180, t. 590, fig. 7 (not fig. 10), 1828.
B. acutus, D'Orbigny, 'Terr. Jurass.,' p. 94, t. ix, figs. 8—14, 1842.
B. brevis primus, Quenstedt, 'Cephal.,' p. 395, t. xxiii, fig. 17, 1849.

Guard. Conoidal, compressed, terminating in a sharp, nearly central point, somewhat drawn out; on each side frequently a broad shallow groove, not reaching to the point; apex often striated, but not grooved.

Transverse section oval, with flattened sides; the ventral aspect broader than the dorsal; axis a little excentric (Pl. I, fig. 1, *s''*).

Greatest length observed, 2·75 inches; greatest diameter, 0·66; axis, 1·00.

Young specimens are longer in proportion, and very acute (Pl. I, fig. 1, J).

Proportions. The normal diameter (*v*, *d*) at the apex of the phragmocone being taken at 100, the ventral part of it is from 36 to 44, the dorsal 56 to 64; the shorter diameter at the same point is 87; the axis of the guard 300. In young specimens the axis is 400 or more.

Phragmocone. Oblique, with excentric apex; the *sides* are nearly straight, and inclined at an angle of 27° or 28°;[1] the *angle* included between the dorsal and ventral lines is about 32°. *Section* elliptical, as 100 to 91. *Septa* not observed, except near the apex of the phragmocone.

Varieties. *α*. Lateral grooves distinct (specimens figured).

β. Lateral grooves obsolete (not figured).

Observations. The type specimens employed by Miller are unknown. There is in the museum of the Bristol Institution a tablet marked *B. acutus*, Lower Lias, Cheltenham, bearing two specimens. One, dark-gray in colour, corresponds to some of my specimens from the same locality, presented to me by my much regretted friend H. E. Strickland, Esq. The other, composed of yellow spar, fits well enough in figure to Miller's outline, but is of a different species. The figure of this author is quite indeterminate, nor is Sowerby's sufficient for identification. But there is no reason for disturbing the common consent of

[1] D'Orbigny gives the angles as 18° to 24°, probably a mistake.

English and foreign palæontologists, by which the name of *B. acutus* is fixed on the short, compressed, pointed forms here described as containing two principal varieties. Equally general is the consent to adopt as a synonym the first of three varieties, or rather species, ranked by Blainville as *B. brevis;* and by examination of foreign specimens referred to that fossil by M. Hébert, I find specimens of both varieties among them. In the original description of Blainville the axis of the guard is described as medial throughout. Such is, I think, never the case with English examples, though the excentricity varies. D'Orbigny describes the axis as a little excentric. The same author gives a drawing to represent a section of the phragmocone, with sides much less inclined than usual, and with septa unusually distant. I have not yet obtained a good section of a phragmocone. D'Orbigny refers to an angular variety in his own collection, 'Terr. Jur.' (pl. ix, figs. 13, 14). His specimens are a little bent, as sometimes occurs at Lyme Regis and Cheltenham. This author notices the varying length of the guard in proportion to the diameter, the longer specimens being supposed masculine. He did not perceive any grooves on his examples.

Locality and Distribution. In Lower Lias beds, with *Ammonites Bucklandi,* at the base of Black Venn, Lyme Regis (*Day*). In Lower Lias at Weston, near Bath (*Sowerby*), and at Salford (*Sanders*). In Lower Lias beds at Hatch, near Taunton, with *Amm. obtusus* (*Moore*). Antrim, in Lower Lias (*Phillips*). Near Cheltenham, in middle part of Lower Lias (*Strickland*). Robin Hood's Bay, Yorkshire, in upper part of Lower Lias (*Oppel, Phillips*). Thus in the British Islands it seems confined to Lower Lias.

Foreign Localities. In Lower and Middle Lias (communicated by M. Hébert). La Grange aux Bois, Charolles, St. Cyr (Côte d'Or), Argenton. D'Orbigny gives other stations.

BELEMNITES PENICILLATUS, *Sowerby.* Pl. I, fig. 2.

Reference. *Belemnites penicillatus,* Sow., 'Min. Conch.,' p. 181, t. 590, figs. 6, 9, 1828.

GUARD. Short, much compressed, cylindroid, except in the posterior part, which curves round to an obtuse, nearly central apex; dorso-lateral grooves variable.

Transverse section oval; ventral aspect somewhat broader than the dorsal; axis nearly central.

Greatest length observed, 2·75 inches; greatest diameter, 0·75; axis, 1·00.

Proportions. The longest diameter of the apex of the phragmocone being taken at 100, the ventral part is 48, the dorsal 52; the shorter diameter 76; the axis 150 in old, under 300 in young specimens.

PHRAGMOCONE. Almost truly conical, nearly straight on all sides; its apex almost central; angle 24°; section slightly elliptical, within the oval guard, which is much thickened on the ventral and dorsal faces.

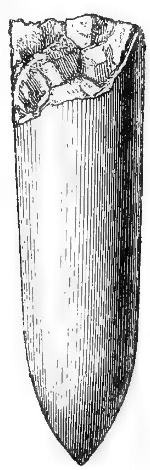
VARIETIES. *α.* Lateral grooves distinct (fig. 2, *b'*, *b'''*).

β. Lateral grooves obsolete (fig. 2, *b''*; and Sow., 'Min. Con.,' t. 590, fig. 6).

Observations. In general form this species differs very sensibly from *B. acutus*, as given in these pages; in the transverse section not less so, this having the apex of the phragmocone almost exactly in the centre of the figure, which would be pretty regularly oval but for the flattened sides. Facettes, or grooves, are almost always traceable on the flattened sides, and seldom absent from the apex on the dorsal aspect. They are, however, often obscure enough to escape uncritical observation. With *B. digitalis* it agrees in some degree as to general figure, but as to the proportions of the ventral and dorsal radii of the sheath, and as to the form and situation of the phragmocone, not at all. Very many of the specimens have a rough striation about the apex, arising from some decay there; and, from the same cause, a sort of umbilical depression occurs in place of the original apex, which in the young state was obtuse-angled and entire.

It is necessary to add an additional figure (Diagram 16) for the purpose of preventing mistake when some apparently even-surfaced specimens, with a very symmetrical outline, occur. In most of my drawings especial care is taken to make the groovings fully as evident as they appear in the objects. For this purpose the light is made

DIAGRAM 16.



incident at a lower angle than is usual, so as to mark the longitudinal undulations with distinct light and shade. If this be not done many Belemnites may be regarded as "without grooves," which yet really are furrowed. In the ordinary light such specimens as those in Pl. I, fig. 2, *l'* and *l''*, would not appear quite so strongly furrowed, and others, like that in Diagram 16, may be thought to be perfectly smooth.

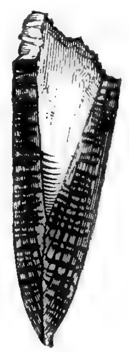
Belemnites penicillatus is the name given by Blainville to the specimen figured in his work (pl. iii, fig. 1). The name had been previously employed by Schlotheim ('Petrif.,' No. 10), for a Belemnite which Blainville supposes may be the same as his examples, which were from the Lias of Nancy.[1] Hardly any foreign author now employs this name; but it appears desirable to revive it, on the authority of Sowerby, who believed his fossils from Lyme Regis to be the same species as Blainville's. The specimens from the Belemnite-bed of Golden Cap have been sometimes referred to *B. Nodotianus* of D'Orbigny ; but that species is represented with a distinct acro-ventral groove, which rarely, if ever, appears in this, and the section given of its phragmocone is very oval, while in this it is almost circular. The two forms are, however, much allied, though not specifically the same. I have seen only one English specimen which appears to agree with *B. Nodotianus.*

Locality. Abundant under Golden Cap, Lyme Regis (*Anning*). Shorn Cliff, Lyme Regis (*Sowerby*). In Lower Lias, with *Amm. Bucklandi*, at Paulton, near Bath, and with *A. obtusus* at Hatch, near Taunton (*Moore*). In Lower Lias (middle part) near Cheltenham (*Strickland*). In Lower Lias, with *A. Turneri*, near Bristol (*Stoddart*). In Lower Lias, Antrim (*Phillips*); and Robin Hood's Bay, Yorkshire (*Phillips*).

BELEMNITES INFUNDIBULUM, n. s. Pl. I, fig. 3.

GUARD. Short, conical, arched upwards; apex acute, usually striated on the dorsal and ventral faces; two obscure lateral facettes extended and widening over the alveolar region. Transverse section nearly circular, with the axis a little excentric, and nearly straight; the young forms similar to the full grown.

DIAGRAM 17.



Greatest length observed, 2·5 inches; greatest diameter, less than 0·7 ; axis of guard, 0·7.

[1] D'Orbigny twice refers to *B. penicillatus*, once as the equivalent of *B. irregularis*, Sch., and again as a synomym of *B. compressus*.

Proportions. The longest diameter at the apex of the phragmocone being taken at 100, the ventral part is 46, and the dorsal part 54; the axis of the guard 160.

PHRAGMOCONE. Quite straight, with a slightly oval section, ending in a spherule; sides inclined 21°, ventro-dorsal inclination 23°. Septal diameter seven times the depth; axis of the phragmocone half as long as the axis of the guard; alveolar cavity three times as long as the axis of the guard.

Observations. The substance of the guard is usually a clear, brown, calcareous spar, with large radiating pencils of fibres. In some specimens the striations near the apex gather into interrupted longitudinal plaits, especially on the dorsal aspect. In one case the whole surface is marked by little ridgy swellings; in others quite smooth, except near the apex.

Among foreign specimens from Mokon, near Mezières, mostly referred by M. Hébert to *B. brevis*, var. B, Blainville, I have seen some which have the essential characters above assigned, though generally somewhat compressed. Among them one or two may be chosen which fairly match our English examples. Specimens of Lias Belemnites are occasionally seen in foreign museums bearing the names of *B. brevirostris*, D'Orb. (also called *B. curtus* on plate x, figs. 1—6, of this author's 'Terr. Jurassiques,' and *B. rostriformis* (Qu.), which come near to our specimens. The former is known to me by many examples, all of which are straight; the latter is a somewhat oblique, not arched, very short, compressed Belemnite, with acro-lateral grooves, and is ranked among the *Belemnites tripartiti* by Quenstedt. It seems, therefore, that a new designation is necessary for this not common fossil, for which the only synonym I can suggest is *B. brevis*, var. B, in part, of Blainville. It is not identical with what Prof. Morris mentions as *B. brevirostris* from near Cheltenham.

Locality. In Lower Lias, near Bristol, with *Amm. Turneri* (*Stoddart*); Lyme Regis and Bath (*Phillips*). Foot of Black Venn, Lyme Regis, with *A. Bucklandi* (*Day*).

BELEMNITES EXCAVATUS, n. s. Pl. II, fig. 4.

Reference. Buckland, 'Bridgewater Treatise,' p. 70, pl. xliv′, fig. 14, 1836, where it is called *B. brevis* (?), a name previously employed for a very different species by Blainville.

GUARD. Rapidly tapering to a blunt end, with obscure lateral furrows. The axis excessively short. Sections show the substance of the guard everywhere nearly of equal thickness, like the finger of a thick leather glove.

Proportions. The diameter, *v d*, being taken at 100, the axis is of unexampled shortness—less than 100; thus in form somewhat reminding us of *Acanthoteuthis*, though its texture is of the ordinary kind; transverse diameter less than the ventro-dorsal diameter, especially toward the apex.

Phragmocone. Unknown, excepting that its section was nearly circular, and that its angle was about 28°.

Locality. Lyme Regis, from a calcareous band, probably in the upper part of the Lower Lias. Dr. Buckland's collection one specimen. Professor Phillips's collection, one specimen.

Belemnites calcar, n. s. Pl. II, fig. 5.

Guard. Conoidal, straight, tapering to a blunt apex; sides planate, somewhat inclined to one another; ventral and dorsal surfaces rounded; the ventral aspect broadest. Transverse section oblong, axis very short.

Proportions. The diameter, *v d*, being taken at 100, the axis is of about the same length; the transverse diameter about 90.

Phragmocone. Only partially known. One specimen of Dr. Buckland's (fig. 5, *s''*) shows several close displaced septa in the forward part. Its axis must have been five or six times as long as that of the guard. In a specimen belonging to Mr. C. Moore, from Weston, the alveolar parts of the guard are crushed over the alveolar chamber, as in the specimen from Lyme (fig. 5, *l'*, *l''*); whether they contain any septa can only be known by making sections; and for this more specimens are required.

Locality. Lyme Regis, from the Lower Lias beds, with *Ammonites Bucklandi* (*Geol. Survey* collection, No. 612). Weston, near Bath, in Lower Lias, with *A. Bucklandi* (*Moore's* collection). The specimen Pl. II, fig. 5, *l'''*, is from the Belemnite-beds at the base of the Middle Lias of Lyme Regis. It may possibly be of a different species (*Geol. Survey* collection, No. 613).

Observations. In general figure this Belemnite agrees with *B. brevirostris* of D'Orbigny ('Pal. Fr. Céphalop.,' pl. x, figs. 1—6; on the plate it is called *curtus*), but that species has distinct lateral grooves, which do not appear on the English specimens. It belongs to the Upper Lias of France and Germany; ours as yet appears to be confined to older beds. There is also a resemblance to the incomplete specimen of *Belemnites acuarius macer* figured by Quenstedt ('Cephalop.,' pl. xxv, figs. 27, 28, 29, 30); but those figures are deficient of the extended and striated guard figured on the same plate (pl. xxv, figs. 21, 22). The striations are the effect of the decomposition which has removed the apex. On the same plate fig. 25 represents an individual "der noch die Verlungerung nicht hat," and fig. 26 another; from which it might be supposed that such individuals as ours may be incomplete, and might, indeed, be subject to the same elongation as those of Quenstedt. His specimens are from the uppermost bands of the Lias of Heiningen, ours from the Lower Lias.

Belemnites dens, *Simpson.* Pl. II, fig. 6.

Reference. *Belemnites dens,* Simpson, 'Fossils of the Lias of Yorkshire,' 1855 (no figure).

Guard. "Length of guard not twice its width, much depressed, sides straight; finely striated longitudinally, or corrugated and roughened most towards the blunt apex, with small tubercles. Some are longer in proportion."

Locality. "Lower Lias, Robin Hood's Bay, Yorkshire."

The above is the published description of the curious fossil of which I here present a sketch, in hopes of being able to add more details hereafter. I have seen only one specimen, which is in the Whitby Museum. The striations are like those seen on other Belemnites, as *B. elongatus,* and are original marks of structure left by the secreting membrane, or periostracum, not the effect of decomposition, as in *B. acuarius macer* of Quenstedt ('Cephalop.,' pl. xxv, figs. 27, 28, 29).

Belemnites clavatus, *Blainville.* Pl. III, fig. 7.

Reference. *B. clavatus,* Blainville, p. 97, pl. iii, fig. 12, 1827.
B. pistilliformis, Sow., 'Min. Conch.,' p. 117, t. 589, fig. 3, 1828.
B. clavatus, Quenstedt, 'Cephal.,' p. 398, t. xxiii, fig. 19, 1849.
B. clavatus, D'Orb., 'Pal. Fr. Terr. Jurass.,' p. 103, t. xi, figs. 19—23, 1842.

Guard. Very elongate, fusiform, contracted in all the region about the alveolar apex, evenly swollen between this and the apex, which is pointed. On the lateral faces of the contracted parts of the sheath are traces, more or less distinct, of two longitudinal furrows, which cease on the expanded posterior part, and do not approach the apex.

Sections show the guard to be composed, where it covers the phragmocone, and for a certain space behind the alveolar cavity, of pale, perishable, longitudinal laminæ, which accounts for the frequent absence of those parts, and the production of the form of *Actinocamax,* Mill. Transverse sections nearly circular, with traces of the grooves about the alveolar region. With age, the whole figure becomes more lanceolate, and thickens over the alveolar region.

Extreme length observed, 4 inches.

Proportions. The axis, in ordinary (middle-aged?) specimens, is from five to ten times as long as the diameter at the alveolar apex. It is nearer to the ventral side; in some specimens very much so, in others very little.

Phragmocone. In a specimen discovered by Mr. Day at Lyme Regis (Pl. II, fig. 7, *s*) the phragmocone is seen in section, and thirty septa are traceable in a length of 0·6 inch. They are converted to iron-pyrites, and seem to be single plates with long flanges. The conotheca is traceable, covered by the thin expansion of the guard. [Quenstedt ('Jura,' p. 137) conjectured that *Orthoceratites elongatus* of De la Bèche might be the phragmocone of this species, with its septa very much further apart than is usual in the genus. But that fossil constitutes the *Xiphoteuthis* of Huxley.] The alveolar angle is 18° or 20°, but by compression often appears larger.

Variations. Considerable in respect of the general form and degree of compression of the guard, the excentricity of its axis, and the distinctness of the two lateral furrows in the lower part of the alveolar region. (For notices of these circumstances, see α, β, γ, δ.)

α. Guard with only very faint traces of lateral furrows, and the axis but little excentric.

β. Guard distinctly marked on the alveolar region with two narrow furrows, which vanish on the expanded posterior part. Axis but little excentric. Transverse sections very slightly oval.

Young specimens are elegantly fusiform, and without lateral furrows; with age, laminæ are added over all the surface, so as to elongate the apicial region and carry back its swollen part, while in front of this the long, generally furrowed part is of nearly equal diameter. Substance a clear yellowish spar, often white externally, easily decomposing in the contracted part, so as to lose the alveolar portion.

γ. Guard compressed, marked with two lateral furrows; axis excentric, owing to the thickening of the outer layers on the dorsal aspect. This appears to be the *B. spadix ari* of Simpson's 'Lias Fossils,' p. 30.

δ. Guard subcylindrical, without lateral furrows; axis very excentric. (Probably *B. fusteolus*, Simpson, 'Lias Foss.')

The varieties γ and δ are not in general so much contracted in the post-alveolar region as the others.

Observations. Sowerby, who gives good figures, observes, "It is very possibly the young of *Belemnites elongatus*." The remark is not applicable to the fossil which he figures under that name, but there are elongate subcylindrical forms at Lyme Regis, which may perhaps, on further research, be proved to belong to this species grown old. The geological range does not, according to present information, reach the Upper Lias in England.

Localities. In Lower Lias, Hatch, near Taunton, with *Ammonites raricostatus* and *A. obtusus* (*Moore*). In the upper part of the Lower Lias, under Huntcliff, Yorkshire (*Phillips*). In the upper part of the Lower Lias of Robin Hood's Bay, Yorkshire (*Phillips, Cullen*). In the Belemnite-bed at the base of Middle Lias, Golden Cap, Lyme Regis (*Anning, Day, Etheridge, Phillips*). In ironstone-beds east of Staithes, top of Middle Lias, Yorkshire (*Phillips*).

BELEMNITES COMPRESSUS, *Stahl.* Pl. III, fig. 8.

Reference. *Belemnites compressus,* Stahl, 'Correspondenzblatt der Würt. Landw. Vereins,' pl. xxxiii, fig. 4, 1824.
B. Fournelianus, D'Orb., 'Terr. Jur.', p. 97, pl. x, figs. 7—14, 1842.
B. compressus, Quenstedt, 'Cephal.,' p. 405, pl. xxiv, figs. 18, 19, 1849.

GUARD. Much compressed, expanded posteriorly, and ending in an obtuse or rounded apex; anteriorly contracted, and sometimes quadrate over the alveolar region. In some specimens the obtuse point is replaced by a cavity plaited at the edges, as in *B. umbilicatus* of Blainville. From the apex a short broad groove proceeds nearly along the middle of each side, and extends towards the alveolar region. On that region one distinct, narrow, dorso-lateral groove appears, and extends towards the apex; a short broad groove is also seen in some specimens on the anterior part of the ventral face of the alveolar region.

Transverse sections show an oval outline and a nearly central axis.

Greatest length observed, 2 inches; but it grows to greater length. (Quenstedt, 'Cephal.,' pl. xxiv, fig. 18.)

Proportions. The diameter, *v d,* at the apex of the alveolus being taken at 100, the ventral part is 48, the dorsal 52, the transverse diameter 75, and the axis about 300. This proportion of the axis varies; the individuals with longest axis are supposed by D'Orbingy to be males.

PHRAGMOCONE unknown. The alveolar angle is 28°.

Variations. Considerable, in regard to the completeness of the grooves and striations and the degree of expansion near the apex. A curious monstrosity occurs among Mr. Moore's specimens from Ilminster. In some specimens from Lyme two parallel narrow grooves appear on each side; in others one broad shallow groove only.

Locality. Lyme Regis, in Belemnite-beds of Middle Lias (*Geol. Survey*). Glastonbury, in Middle Lias (*Oxford Museum*). Ilminster, Middle Lias (*Moore*). I have seen no specimen on the coast of Yorkshire.

BELEMNITES BREVIFORMIS, *Voltz.* Pl. IV, figs. 9 A, 9 B, 10A, 10 B, 10 C, 10 D.

Reference. *B. breviformis,* Voltz, 'Obser. s. Bélem.,' p. 43, pl. ii, figs. 2, 3, 4, 1830.
B. breviformis amalthei, Quenstedt, 'Cephal.,' p. 405, pl. xxiv, figs. 21—23, 1849.

GUARD. Short, lanceolate, cylindroidal, subtetragonal, tapering to a pointed summit, which is more or less recurved towards the back.

Longitudinal sections show the axis to be always more or less curved, especially near the apex, and nearer to the ventral than the dorsal face; much nearer towards the apex. Transverse sections show a tendency to flatness of the sides, so as to give an approach to a certain squareness in the outline. Diameters nearly equal.

Size rarely exceeding 2 inches; diameter rarely exceeding $\frac{2}{3}$ of an inch.

Proportions. The normal diameter being 100, the ventral part of it is 37, the dorsal part 63; the transverse diameter is also 100 (more or less). The axis, 200 to 300.

Phragmocone. Oblique, with a circular section, more or less inflected towards the apex, and terminated by a sphericle. Concamerations numerous; siphon not affecting the sutures of the cells. Angle 25° to 27°.

Varieties. According to M. Voltz, who described this species after inspection of more than fifty individuals from Gundershofen, in Upper Lias, three varieties occur:

(a) Guard somewhat depressed, its summit acutely conical, without distinct inflexion or furrows (Voltz, pl. ii, fig. 2).

(b) Summit submucronate (Voltz, pl. ii, fig. 4).

(c) Summit mucronate, axis very near the ventral side (Voltz, pl. ii, fig. 3).

Observations. The species called *breviformis* by Voltz, if allowed to include all the varieties which have been referred to it, must be quoted from Middle Lias, Upper Lias, and Inferior Oolite. Voltz supposes that *Belemnites brevis*, var. b, of Blainville (pl. iii, fig. 2), may be identical with *B. breviformis*, var. c, Voltz; and as far as the figure of Blainville is evidence, his opinion seemed just. But by late researches of M. Hébert, who has examined many specimens of the variety mentioned by Blainville, it seems to be really a distinct species, for which the name of *brevis* may be retained. This author is of opinion that *B. brevis*, D'Orb. ('Pal. Franç., pl. ix, figs. 1—7; in the text it is called *B. abbreviatus*), is identical with the species of Voltz.

Varieties. I possess some half-dozen individuals of this species from Lyme Regis, some of which were collected by myself from the Belemnite-bed, under Golden Cap; others supplied by Miss Anning, probably from the same locality. From Gundershofen M. Voltz was so good as to send me five specimens, showing the varieties a, b, c, which he includes in the species. M. Hébert also sent me a larger series from the same place. It is evident that these all correspond, the English specimens being chiefly of the first variety (a) of Voltz. All agree in a lanceolate figure, with an approach to cylindrical section (or a little planate on the sides), and in a summit quite free from systematic grooves. The apex tends to recurvation (and in var. b, c of Voltz to submucronation). The points of doubt which arise on comparison of specimens from England and Germany are unimportant, but there are peculiarities in the description of M. Voltz which seem to require attention. He notices in his variety A the phragmocone as sensibly curved towards the ventral side; in a section of a specimen from Gundershofen I find this curvature, as (indeed his figures (pl. ii, D″ and D‴) show it to be) very slight. He mentions also a curvature of the axis of the guard, and it appears in the figures quoted; it is only just traceable in my specimen. There is no sensible change of figure from youth to age, except that the diameter grows larger in proportion.

In his variety B (Voltz, fig. 4, D) he figures the axis as decidedly curved, and passing very near to the ventral face in all the posterior parts; the phragmocone is represented as very sensibly curved; neither in B nor C are either ventral or lateral grooves. These varieties are not larger than var. A. In specimens which I possess from the Eston Nab Ironstone-beds, Prees, and Glastonbury, these characters are found precisely as in Voltz's figure and description, except as to the lateral grooves, which are traceable, more or less distinctly, in most cases. These individuals are larger than any of the specimens of Voltz, and correspond in magnitude with others from Alderton, in Gloucestershire, in which the lateral grooves are quite distinct. Admitting all these forms to belong to the species so well examined by M. Voltz, we have the following result for the British deposits:

VAR. α = var. A, Voltz. Guard having an acute conical termination, without distinct inflexion or grooves. Phragmocone very slightly incurved (Pl. IV, fig. 9 A, B).

Locality. In England, the Belemnite-bed under Golden Cap, Lyme Regis, base of Middle Lias; in Germany, Gundershofen, Upper Lias.

VAR. β = Var. B, C, Voltz. Guard terminated by a summit more or less prominent, acute, and inflected towards the back; no distinct lateral grooves. Phragmocone distinctly incurved (Pl. IV, fig. 10 A).

Locality. In England, Prees, Salop, in Middle Lias (*Morton*). Eston Nab, Yorkshire, in ironstone of the Middle Lias (*Phillips*). Glastonbury, in Middle Lias (*Phillips*).

VAR. γ. Guard terminated by a submucronate summit, more or less prominent from the ventral half of the substance, and more or less inflected towards the back. Lateral furrows near the back always traceable (Pl. IV, fig. 10 B, 10 C, 10 D).

Greatest length observed, 2·5 inches; greatest diameter, 0·6 inch.

Longitudinal sections show the axis to be excentric, arched, and much nearer to the ventral side, remarkably so at the apex of the phragmocone, least so towards the apex of the guard. Transverse sections show the sides to be flattened, so that the sparry substance is thinner there over the alveolus. The lateral grooves at the apex are continued more or less distinctly into these flattened spaces.

Phragmocone arched, ending in a spherule; angle 27° in the anterior part; nearly 30° towards the apex. Transverse section nearly circular. Septa frequent.

If it be found eventually desirable to separate these varieties, it will be best, I conceive, to make the division so as to insulate the variety *a*, which appears to me rather indeterminate, and to resemble the young of other species too much to be quite satisfactorily identified among the Lyme specimens.

Localities. Alderton, Gloucestershire, in marlstone (*Phillips*). Bredon Hill, marlstone (*Strickland*). Eston Nab, and East of Staithes, Yorkshire, in ironstone above the marlstone (*Phillips*). Ilminster, in marlstone of Middle Lias (*Moore*); this is shorter and stouter than usual.

Synonyms. D'Orbigny refers the fossils figured by him pl. ix, figs. 1—7, to this species, expressly referring to Voltz, pl. ii, figs. 2, 3, 4. He calls it in the text *B. abbreviatus* of Miller and Sowerby; on the plate and in the text it is entitled *B. brevis*, Blainville. Authors who quote D'Orbigny in the 'Pal. Franç.' should observe the difference of the names on the plates and in the text. The specimen figured by D'Orbigny does not well agree with Voltz's species; it is larger, has no trace of lateral furrows, and according to the drawing a straight-sided phragmocone, with a decidedly oval section. That it was one of the varieties included by Miller in his *B. abbreviatus* may be readily supposed. It is not the exact equivalent of *B. breviformis amalthei* of Quenstedt (pl. xxiv, figs. 21—23), which has furrows near the apex, but is rather comparable to *B. breviformis*, Quenstedt 'Cephal.,' pl. xxvii, figs. 22—27; (*B. Gingensis* of Oppel), an Oolitic rather than Liassic form, of the South of England, which will be noticed immediately.

Belemnites Gingensis, *Oppel.* Pl. V, fig. 11.

Reference. *Belemnites breviformis*, Quenstedt, 'Cephalop.,' p. 428, t. xxvii, figs. 23—26, 1849.
B. Gingensis, Oppel, 'Jura,' p. 362, 1856.

Guard. Short, conoidal, contracted, and curving rapidly to an acute, produced, submucronate, rather recurved summit; no distinct grooves about the summit; no distinct flattening of the sides.

Sections show the general outline nearly circular, the axis very excentric and arched, and very near the ventral face.

Greatest length observed (the edge being very thin) under $2\frac{1}{2}$ inches; greatest diameter, under $\frac{3}{4}$.

Proportions. The diameter at the apex of the phragmocone being 100, the ventral radius is about 30, the dorsal 70; the axis varies between 160 and 210; the diameters are nearly equal.

Phragmocone. Incurvate, with an angle of 28°, and a nearly circular section. Septa numerous, distant from each other about $\frac{1}{8}$th of the diameter. Siphuncle marginal, moniliform, quite free from the external layer of the conotheca, and completely bordered by its own shell (a single plate?). The flanges are short.

Locality. In the Inferior Oolite of Dundry Hill, with *Ammonites Humphreysianus* (*Bristol Museum*). In the same beds at Wotton-under-Edge, Frocester Hill, Cam Down, Bridport (*Phillips*). Near Cheltenham (*Buckman*).

Observations. The specimens figured are, without doubt, to be referred to the species first separated from the ordinary *breviformis* by Oppel. I have seen foreign examples. The figures given by Quenstedt show some degree of lateral compression, but I cannot doubt the identity of his species with ours from Gloucestershire and Somersetshire. D'Orbigny's figures ('Terr. Jur.,' pl. ix, figs. 1 and 3), which are said to be from the Upper Lias, agree with our specimens well enough, but the transverse section of the phragmocone (fig. 4) is so remarkably oval that, if not due to compression, there must be some mistake. The phragmocone is represented in fig. 2 of the same plate, as quite straight on the ventral side.

BELEMNITES INSCULPTUS, n. s. Pl. V, figs. 12, 13.

Reference. (I can find no satisfactory figure or description of this Belemnite.)

GUARD. Short, conoidal, tapering rapidly to a produced, submucronate, somewhat recurved summit, from which two broad, shallow, lateral furrows proceed, growing less distinct over the alveolar region.

Transverse sections show the outline to be nearly circular, but flattened more or less on the sides; the axis very excentric towards the ventral face, and arched. Sometimes the dorsal aspect is widest, sometimes the ventral; it is flattened sometimes on the ventral face, as in *B. ventroplanus* of Voltz.

A section taken lengthways shows the axis to be excentric, and arched in accordance with the reflected apex.

Greatest length observed (edge of aperture very thin), $3\frac{1}{2}$ inches; greatest breadth, less than 1 inch.

Proportions. The diameter at the apex of the phragmocone being 100, the ventral radius is 42, the dorsal 58, the axis 120.

PHRAGMOCONE. Very oblique, arched, with a circular cross section. Conotheca concentrically undulated on the ventral face; concamerations numerous; angle m. 28°. Septal diameter eight or even nine times the depth. Axis of phragmocone traced to twice the length of the axis of the guard. Fifty septa in three quarters of an inch from the apex of the phragmocone.

Locality. Inferior Oolite, with *Ammonites Humphreysianus,* Dundry (*Sanders*), fig. 12.

In the Lias of Lyme Regis occurs very rarely an allied form represented in fig. 13, from specimens in the cabinet of Mr. Goodhall, inspected many years since. I only know the exterior of these examples. A longitudinal section of another specimen from

DIAGRAM 18.

Lyme, preserved in the collection of the Bristol Institution, shows how short is the axis of the guard (Diagram 18). This Belemnite is not mucronate. If additional specimens come to my hands, I hope to determine its characters.

Belemnites latisulcatus, n. s. Pl. V, fig. 14.

Reference. (I can find no satisfactory figure or description of this Belemnite.)

Guard. Short conoidal, a little compressed, tapering rapidly in a curve on the ventral side to an obtuse recurved summit, from which two broad, distinct, dorso-lateral grooves proceed, widening over the alveolar region, and margined on the dorsal side by a distinct ridge.

Sections. The ventral aspect somewhat wider than the dorsal.

Proportions. The diameter (*v d*) at the apex of the phragmocone being 100, the ventral radius is about 45, the dorsal 55, the axis 180, the transverse diameter 94.

Phragmocone. Not distinctly observed.

Locality. Upper Lias of Whitby, the specimen figured (*Phillips*). In the Museum of the Yorkshire Phil. Society is a specimen resembling this in general figure, but more slender, and with only short dorso-lateral grooves.

BELEMNITES PAXILLOSUS, *Schlotheim.* Pl. VI, fig. 15.

Reference. *Belemnites paxillosus,* in part, Schlotheim, 'Taschenb.,' pp. 51 and 70, 1813.
,, ,, Voltz, 'Bélemnites,' p. 50, pl. vi, fig. 2, and pl. vii, fig. 2, 1830.
,, ,, Zieten, 'Wurtemb.,' p. 29, pl. xxiii, fig. 1, 1830.
B. Bruguierianus, D'Orb., 'Pal. Fr. Terr. Jurass.,' p. 84, t. vii, figs. 1—5. The plate is really numbered pl. vi, and the name on it is *Belemnites niger,* also given on pl. v to another species. 1842.
B. paxillosus amalthei, Quenstedt, 'Cephal.,' p. 402, pl. xxiv, 1, 2, 4—8, 1849.
B. paxillosus, Oppel, 'Jura,' p. 152, 1856.

GUARD. Smooth, elongate, cylindroidal, convexo-conical towards the summit, which is often subtruncate or even concave, and marked by two short latero-dorsal smooth furrows, and in most cases by one or more medio-dorsal striæ, and sometimes one medio-ventral short stria.

Sections show the axis to be nearly straight in all the young forms, only bending near the apex in the older examples. The axis is a little excentric.

Greatest length of axis, $3\frac{1}{2}$ inches, and of whole guard, $6\frac{1}{2}$ inches; diameter at apex of alveolus not exceeding 1 inch.

The young have nearly the same general figure and proportions as the adult individuals, and exhibit the same diversities as to compression, and sometimes assume a subhastate shape. In very young forms the proportion of the axis of the guard is found to be somewhat less than in those of middle age. Thus in a specimen from Wurtemburg the proportion in the youngest guards is 260, but in the same full-grown individual 380.

Proportions. The diameter (*v d*) at the apex being 100, the ventral radius is 40 to 45, the dorsal 55 to 60, the axis about 350 to 450.

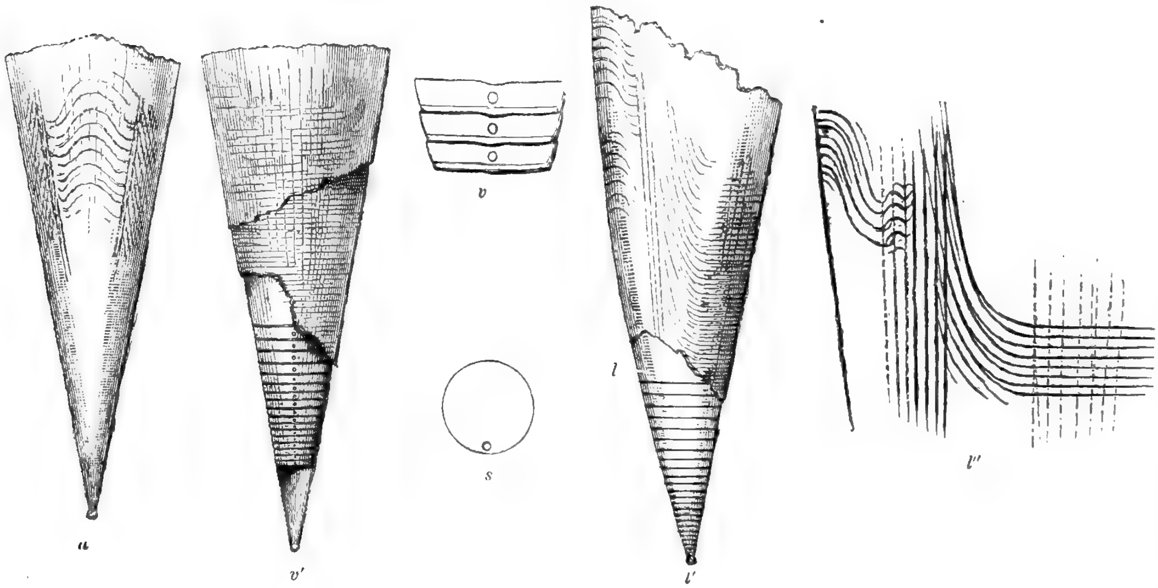
PHRAGMOCONE. Straight (or very nearly so), with a nearly circular section, the sides meeting at an angle of 22° to 24°; conotheca distinctly striated, the straight striæ bifurcate toward the ventral region (Voltz); chambers rather shallow, numerous, their septa almost directly transverse. (See figures of great value in Voltz, pl. vii, fig. 2.) The depth of the chambers is one seventh of their diameter. The axis ends in a spherule.

In a specimen from Ilminster the septa are traced in section through a length on the axis of the phragmocone equal to half that of the axis of the guard. These septa are to be counted to above 60 in a space of $1\frac{1}{2}$ inch, the anterior septa being broken off from their flanged extremities, and lost; the flanged extremities remain on the ventral side. Broken septa occur within others which are not broken.

Localities. In Middle Lias (marlstone), at Tilton-on-the-Hill, Liecestershire; Caythorp, in Lincolnshire, Belvoir Castle, and Oakham (*Phillips*). In Middle Lias (marlstone), Ilminster (*Moore*). In Middle Lias (marlstone), Staithes, Yorkshire (*Phillips*).

Observations. The history of this interesting Belemnite is contained in specimens from the marlstone and Upper Lias, to which, as far as yet appears, its geological period is limited. Voltz, indeed, quotes a specimen from Oolite near Caen. The British localities are almost exclusively in marlstone; the foreign stations include Upper Lias, in Wurtemburg. Variations are sensible in the guard, in regard to the transverse section, which is sometimes a little compressed; the general figure, which is occasionally a little swollen towards the apex, and sometimes bent upwards; and the terminal grooves and striæ, which latter on the dorsal and ventral faces are sometimes distinct and sometimes wholly wanting. Occasionally there are several of these, and in this case they may be due to decomposition of the laminæ. The lateral grooves are always short, and usually very distinct. In the interior the axis of the guard is more or less excentric than the proportions given above. The sides of the phragmocone, if not quite straight, as Voltz

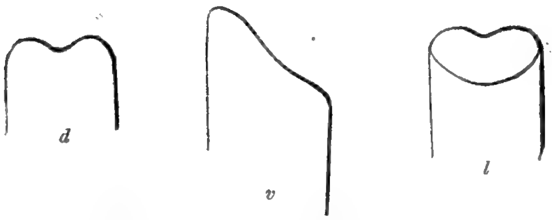
DIAGRAM 19.



affirms, are nearer to straightness than is usual when the axis is excentric. In D'Orbigny's fig. 5, the phragmocone is more incurved than is at all usual. Natural sections lengthways of this Belemnite are rather frequent in the ventro-dorsal plane, which, near the apex, is sometimes marked by a real fissure.

Mr. Moore's large collection of these Ilminster Belemnites contains phragmocones in different conditions of exposure, from which several facts of interest can be gathered, as the accompanying diagrams (19, 20) may show.

DIAGRAM 20.



In the first place, some traces of growth lines appear on the alveolar cavity, and thin layers adhering to the conotheca, which indicate the terminal edge of the guard to have been in the form seen sideways at *l*, dorsally at *d*, and in front at *v* (Diagram 20). Next the conothecal surface itself shows the structure lines; the dorsal aspect as in *d′*, the side aspect as in *l′*, enlarged in *l″*; and the ventral aspect as in *v′* (Diagram 19). The points to remark are the bifurcation of the arched side lines in *l″* before passing over the front in *v″*; the numerous transverse striæ in *v′* are from 6 to 8 to each concameration; and the undulated outline which the phragmocone deprived of conotheca presents (Diagram 19 *v′*) The transverse striæ in *v′* are not so numerous in the smaller parts of the conotheca; there are only very faint longitudinal medio-dorsal lines; the siphuncle makes no distinct appearance externally. The sides of the phragmocone are nearly straight; it is terminated by a distinct and rather large spherule. The angle is about 20° (19° to 23°); the cross section *s* nearly circular. The excentricity of the alveolar apex variable, in some specimens very slight. A gentle retral wave in each septum on the siphuncular line.

Belemnites apicicurvatus, *Blainville*. Pl. VI, fig. 16.

Reference. *Belemnites apicicurvatus,* Blainville, 'Mém. sur les Bélemnites,' p. 76, pl. ii, fig. 6, 1827.

Guard. Elongate, compressed, smooth. Alveolar region compressed, expanding towards the aperture; apicial region convexo-conical, obliquely inclined or even bent towards the back, marked by two latero-dorsal furrows, extending a short distance from the summit, and two still shorter, terminal, latero-ventral grooves. Between these four grooves are often sharp short plaits. In very perfect specimens the whole apicial region is minutely ornamented by longitudinal striations, which near the apex are straight and even continuous, but elsewhere undulate and anastomose. The anterior part of the alveolar region is sometimes roughly striated. Of the plaits at the summit, the medio-ventralis often very short and sharp.

Sections show the apicial line almost straight, nearer to the ventral face; the successively superposed laminæ of growth very distinct, the fibres faint, oblique, and somewhat curved near the apex; the substance honey-yellow spar. The ventral region is generally broadest, the sides of the alveolar portion are usually flattened. This species sometimes cracks naturally along the lateral faces.

Greatest length observed, 5·5 inches; greatest diameter, 0·85; axis of guard, 4 inches.

Proportions. The diameter (*v d*) at the alveolar apex being 100, the ventral radius is 37 to 40, the dorsal radius 60 to 63, the diameter from side to side 88, axis 450 to 600.

PHRAGMOCONE. Oblique, incurved ventrally, with oblique septa, and an elliptically compressed section; the dorsal and ventral faces (curved) inclined at an angle of 29°, the lateral faces (straight) at 25°. On the alveolar shell the dorsal region is defined by a somewhat prominent longitudinal line. If the diameter (*v d*) of the largest chamber be taken at 100, the diameter from side to side = 90, the depth of the chamber = 12, and the longest side of the alveolus 300. The axis of the phragmocone = half the axis of the guard.

Localities. The Belemnite-bed, base of Middle Lias, at foot of Golden Cap, Lyme Regis (*Miss Anning*). Cheltenham (*Strickland*).

Observations. Described by Brongniart as from Lyme Regis in 1826. It has been referred by D'Orbigny to *B. compressus* of Blainville, but its true affinity is to *B. elongatus*, as given by Sowerby, and to *B. paxillosus* of Voltz. It varies as to the degree of lateral compression and as to the terminal plaits and striæ.

BELEMNITES ELONGATUS, *Sowerby.* Pl. VII, fig. 17.

Reference. Sowerby, 'Min. Conch.,' p. 178, t. 590, fig. 1, 1828.
Quenstedt, 'Cephal.,' p. 402, t. 24, fig. 3, 1849.
Huxley, in 'Memoirs of the Geological Survey,' Monograph II, pl. i, figs. 2, 3, 1864.

GUARD. Rather compressed, cylindroidal about the apex of the phragmocone, thence tapering in regular sweep to the acute-angled point, and expanded towards the aperture; dorso-lateral grooves distinct for only one fourth or one third of the length of the axis, thence obscurely prolonged into the somewhat flattened sides; small plaits, striations, and granulations on the surface, especially near the apex; no ventral furrow; axis a little excentric, most so at the apex of the phragmocone.

Sections show the axis excentric, within a slightly oval outline, and nearly straight.

The largest individual yet observed is the fine specimen figured by Sowerby, and now preserved in the British Museum, which is complete from the apex to the last or nearly the last septum of the chambered cone, and measures 10½ inches in length. Of this the axis of the guard is about 3 inches, that of the phragmocone nearly 8 inches; longest diameter of section at the apex of phragmocone, 0·9 inch. My smallest specimen from Lyme Regis measures 0·38 inch diameter, and 1·65 long.

In this young individual the lateral grooves are quite distinct, and continued to the acutely tapered apex; two striæ appear on the dorsal aspect at the apex, and one small plait on the ventral aspect.

Proportions. Taking the dorso-ventral diameter at 100, the ventral radius is 40, the dorsal radius 60, the transverse diameter, 94; the axis of the guard is about 300, but is more or less according to age and range of natural variation. In my smallest specimen the axis of the guard is 345.

PHRAGMOCONE. Excentric; transverse section a little oblong, longitudinal section a little incurved, angle 25°.

Localities. Crick Tunnel, specimen figured (*Sowerby*). Belemnite-bed, Lyme (*Day*, *Etheridge*). Cheltenham (*Strickland*). I have not seen this species in the strata of the Yorkshire coast.

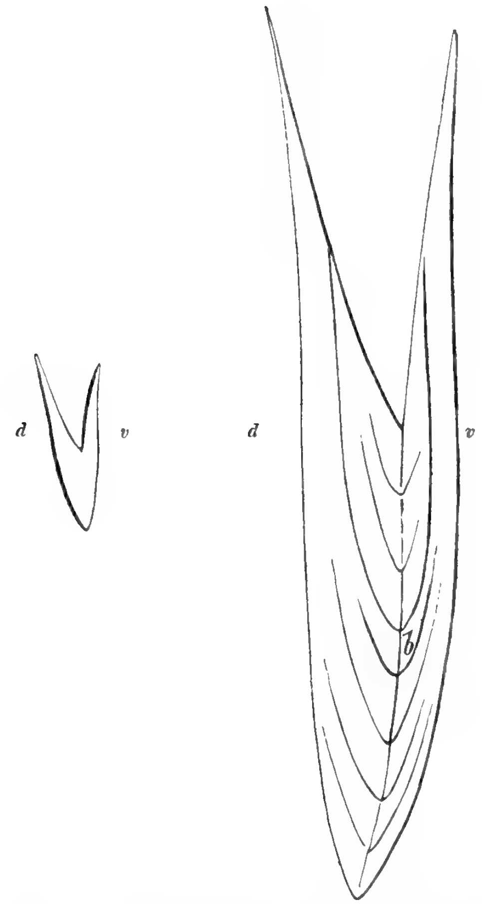
Observations. There is no certain knowledge of the specimens which served Mr. Miller for the type of this species, nor is the figure which he gives, or the description which accompanies it, at all critical. In fact, they have been interpreted so variously, and referred to so many different species, as to be of little or no authority. No grooves are mentioned on the guard, which is merely described as "slender, tapering to a conical point." The figure of Mr. Sowerby is taken from a fine specimen now in the British Museum, and gives a good general representation of the fossil. The description, however, is not only incomplete, but inexact on an important point. "Slender, cylindrical in the middle, gradually expanding to a broad base one way, and tapering to a point the other; round, and *free from furrows;* the chambered cavity two thirds of the length of the shell." The localities quoted are Charmouth, Bath, Crick Tunnel, all in the Lias. Instead of being "free from furrows," the specimen has the usual two dorso-lateral grooves near the apex clearly defined; on the ventral aspect at the apex is a little elevated plait, but no furrow. By these characters it belongs to the natural group of the "*paxillosi;*" the section of the guard is not quite round, even in old specimens, but always a little compressed, often sensibly so when young, with an excentric axis; the apex is more acute than is usual with *B. paxillosus,* and the phragmocone is very much more extended than in that species.

The figure given in the monograph of the Geological Survey, already referred to, agrees with the specimen in the British Museum and with several in my own collection sent me from the "Belemnite Bed" of Lyme Regis by Miss Anning. For the drawings on Plate VII, which represent the original specimen in the hands of Sowerby, I am indebted to Mr. H. Woodward. Adopting the specimens preserved in the British Museum and in Jermyn Street for types of the adult, I have attempted, chiefly by help of the specimens in my own drawers, to trace the younger forms, and determine the limits of variation to which the species is subject; but I am not sufficiently provided with specimens, especially for sections.

In a specimen from Upper Lias, in my collection, which has the distinct lateral grooves and the external characters of *B. elongatus,* there is a small, narrow, deep, stria on the ventral aspect, close to the apex, and another on the opposite dorsal aspect. In another example, also from the Upper Lias, and in my collection, both the dorsal and ventral surfaces are distinctly marked with one stria from the apex, so that if these be regarded as furrows, the apicial region is quadri-sulcate. The apices are in each case more pointed and more recurved than is usual with *B. paxillosus*. A longitudinal section of the former specimen shows the axis of the guard most excentric at the apex of the phragmocone, and the youngest (included) forms to have been relatively much shorter than the older.

In the accompanying sketches (Diagram 21) the smaller one shows the proportions of the sheath in the youngest traceable form of this specimen; the larger shows a middle-age

DIAGRAM 21.



form (*b*) included in a third a full-grown specimen, whose probable extension is given. In the three cases the proportion of the axis of the guard to the normal diameter (*v*, *d*), taken at 100, is 140 for the youngest, 260 for the middle-age, 300 for the full-grown. The proportion of the whole length of the guard to the contemporaneous length of the axis is in the first case 260, in the second 180, and in the third (inferred, not measured) it is nearly the same. In the first case the length of the whole guard is to its greatest diameter about as 200 to 100, in the second about 350 to 100, and this proportion is not materially altered with further growth.

EXPLANATION OF PLATE I.

FIG.

1. BELEMNITES ACUTUS.

d. Dorsal aspect.

l. Lateral aspect. The groove here seen is seldom so distinct.

v. Ventral aspect.

s. Section from the back to the front. The alveolus is excentric, and is expanded by compression: *v*, ventral; *d*, dorsal portion.

J, J. Young specimens, showing their elongate form.

a. Apicial portion of the guard, showing striation, which is not usual, and is referable to decay.

s″. Transverse section at the apex of the alveolus, showing the greater breadth of the ventral region, which, however, is here somewhat broader than usual.

2. BELEMNITES PENICILLATUS.

d. Dorsal aspect.

l′, *l″*, *l‴*. Lateral aspect; *l′* and *l‴* show lateral grooves and terminal striæ. These grooves are seldom quite untraceable, though they do not appear in *l″*, a younger specimen, which, however, is more striated, and at the apex umbilicate; these appearances in *l″* are due to partial decay.

v. Ventral aspect.

s. Longitudinal section, showing the straight-sided central alveolus.

s′ Transverse section, showing the elliptical section of the alveolus and the flattened sides of the guard.

s″ Transverse section of the guard, showing the central axis.

3. BELEMNITES INFUNDIBULUM.

d′, *d″*, *d‴*. Dorsal aspect, showing the usual striæ, which are enlarged in σ.

l′, *l″*. Lateral aspect, showing the usual inflexion of the apex.

v. Ventral aspect, on which the striæ are usually shorter. These striæ are not due to decay, but to original formation.

s″ Transverse section, nearly round, or subquadrate, or a little oval, according to the specimen and the place of the section.

σ. Enlarged striæ.

Fig. 1.

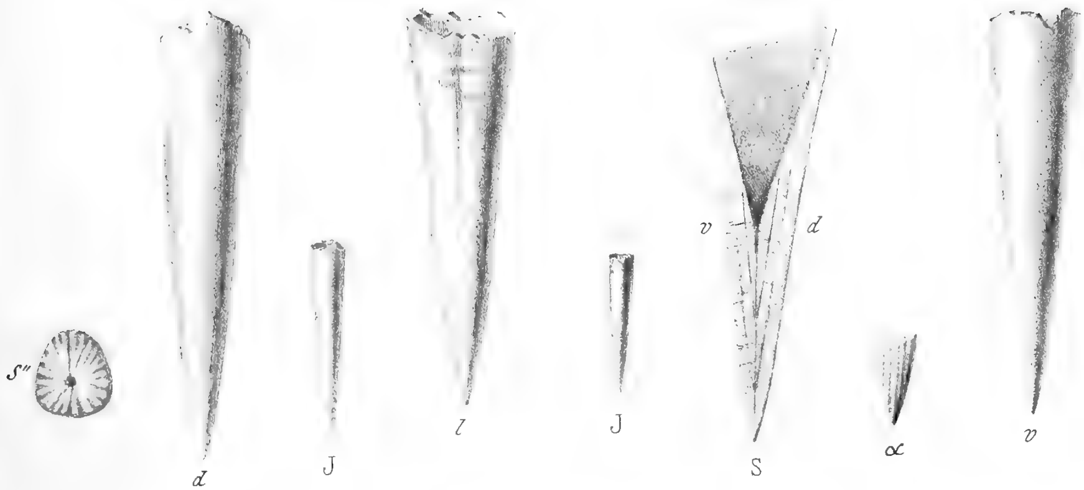
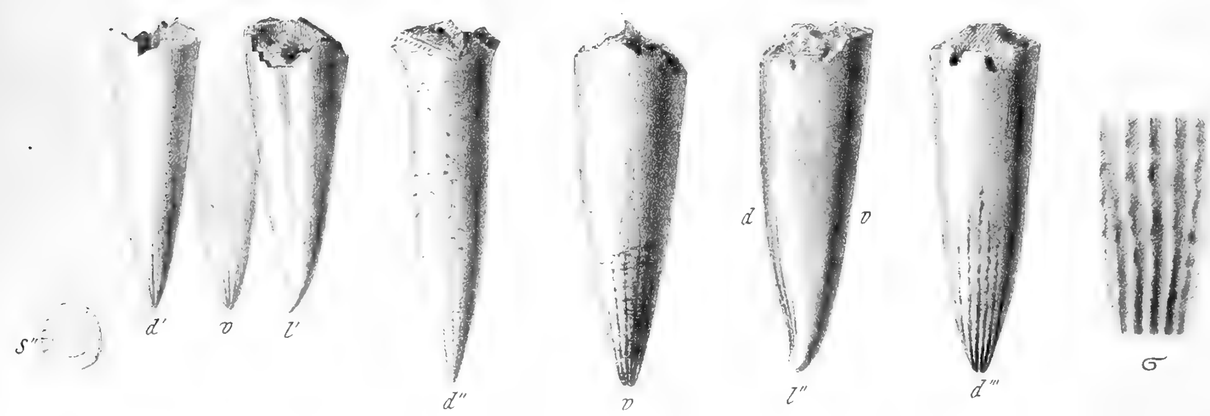


Fig. 2.

Fig. 3.



P. Lackerbauer lith. Imp. Becquet, Paris.

EXPLANATION OF PLATE II.

FIG.

4. BELEMNITES EXCAVATUS.

v. Ventral aspect. (Prof. Phillips's specimen.)

l. Lateral aspect; *d* and *v* mark the dorsal and ventral portions. The apex of the alveolar cavity is between those letters. (Prof. Phillips's specimen.)

s. Longitudinal section, showing the very thin sheath and very deep and ample alveolar cavity. (Dr. Buckland's specimen.)

s'. Transverse section across the alveolar cavity and guard. (Prof. Phillips's specimen.)

s'' Transverse section of the same specimen near the apex.

5. BELEMNITES CALCAR.

l', l''. Lateral views of the specimen belonging to the Geological Survey (No. 612).

d. Dorsal view of the same.

s. Transverse section of the same.

s. A rather oblique section across the alveolar cavity, in consequence of which the sheath appears thicker towards the apex than it would appear on a truly axial section. (Oxford Museum.)

l''' Lateral view of a specimen supposed to be of this species. Geological Survey Collection (No. 613).

6. BELEMNITES DENS.

l. General figure, seen laterally. The specimen is compressed, as may be seen by the transverse sectional outline, *s'*.

The striæ are seen magnified at σ' and σ''.

Fig. 4.

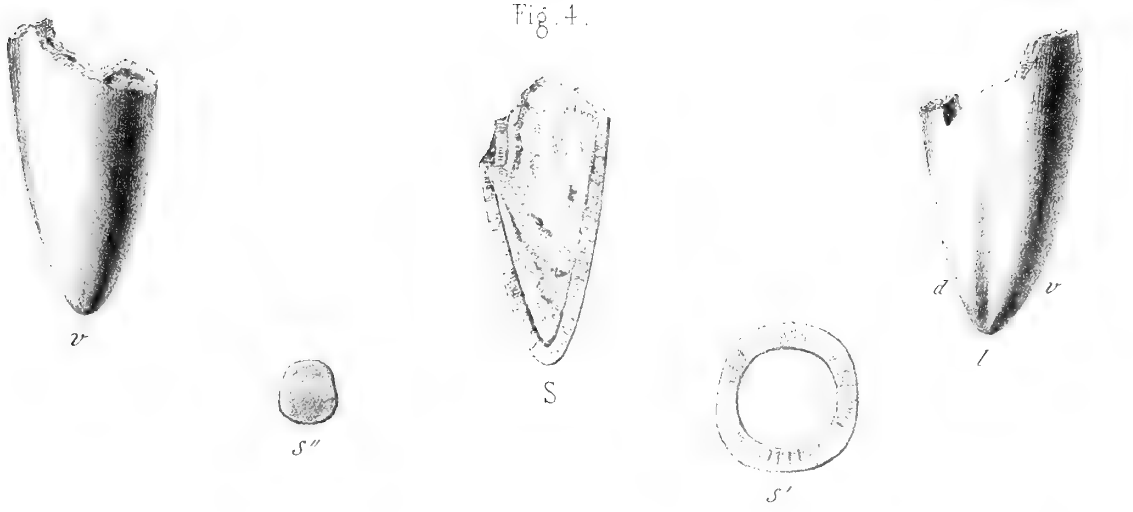


Fig. 5.

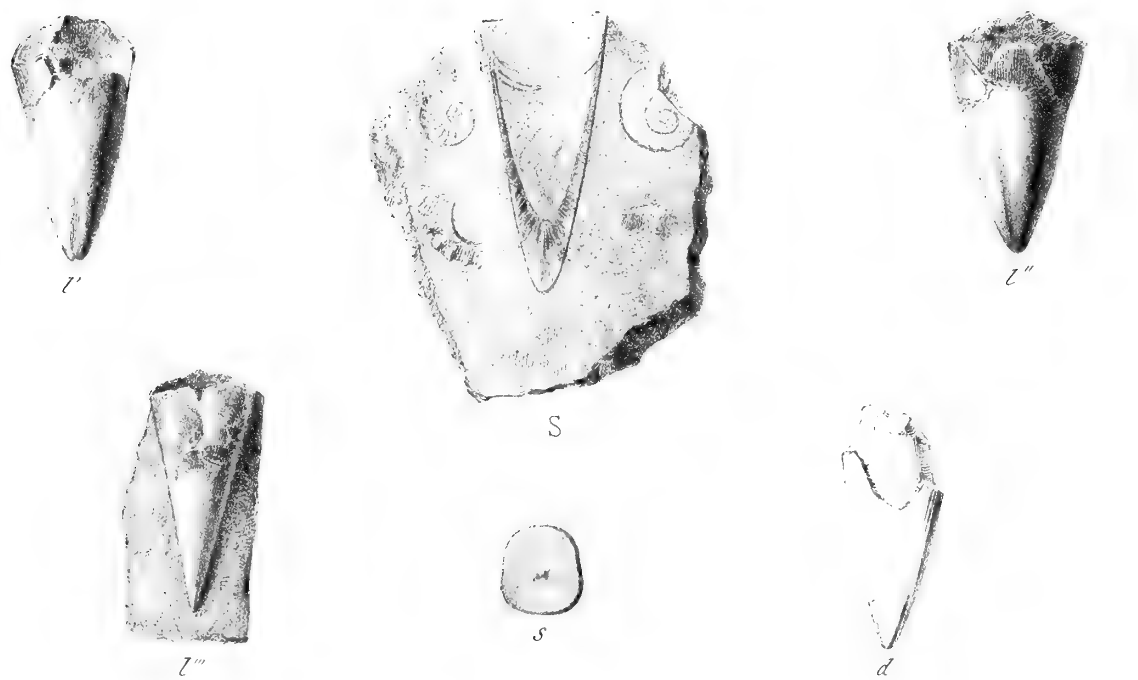
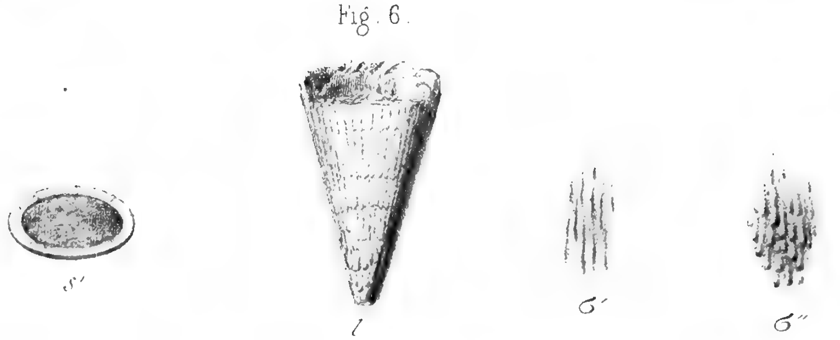


Fig. 6.



P. Lackerbauer lith

Imp. Becquet, Paris.

EXPLANATION OF PLATE III.

FIG.

7. BELEMNITES CLAVATUS.

- *l'*. Lateral view of a young specimen. I now possess much smaller specimens.
- *l''*. Lateral view of a slender elongate individual.
- *l'''*. Lateral view of a specimen which shows the furrow distinctly.
- l^{iv}. Lateral view of a more claviform variety.
- l^{v}. Frustum, showing the grooves.
- l^{vi}. Fusiform variety.
- l^{vii}. Larger individual, indicating that still larger examples should be looked for, showing less of the retral swelling.
- s, s. Longitudinal sections. One shows the phragmocone in connection with the guard.
- s'—s^{v}. Transverse sections at several points; the crossing the alveolar cavity, the last near the apex of the guard.

8. BELEMNITES COMPRESSUS.

- *l'*. Lateral view. At the central point between *d* and *v* is the apex of the alveolar cavity.
- *l''*. A large individual.
- *l'''*. Specimen very blunt at the end.
- l^{iv}. Malformation.
- *d*. Dorsal view.
- *v'*. Ventral view of specimen *l'*, showing a short ventral groove in the alveolar region.
- *v''*. Ventral aspect of specimen *l''*.
- s. Longitudinal section, to show the central alveolar cavity and axis of the guard.
- s'. Section across the alveolar cavity.
- s''. Section across the guard.
- s'''. Worn and umbilicated end of a specimen.

Fig. 7.

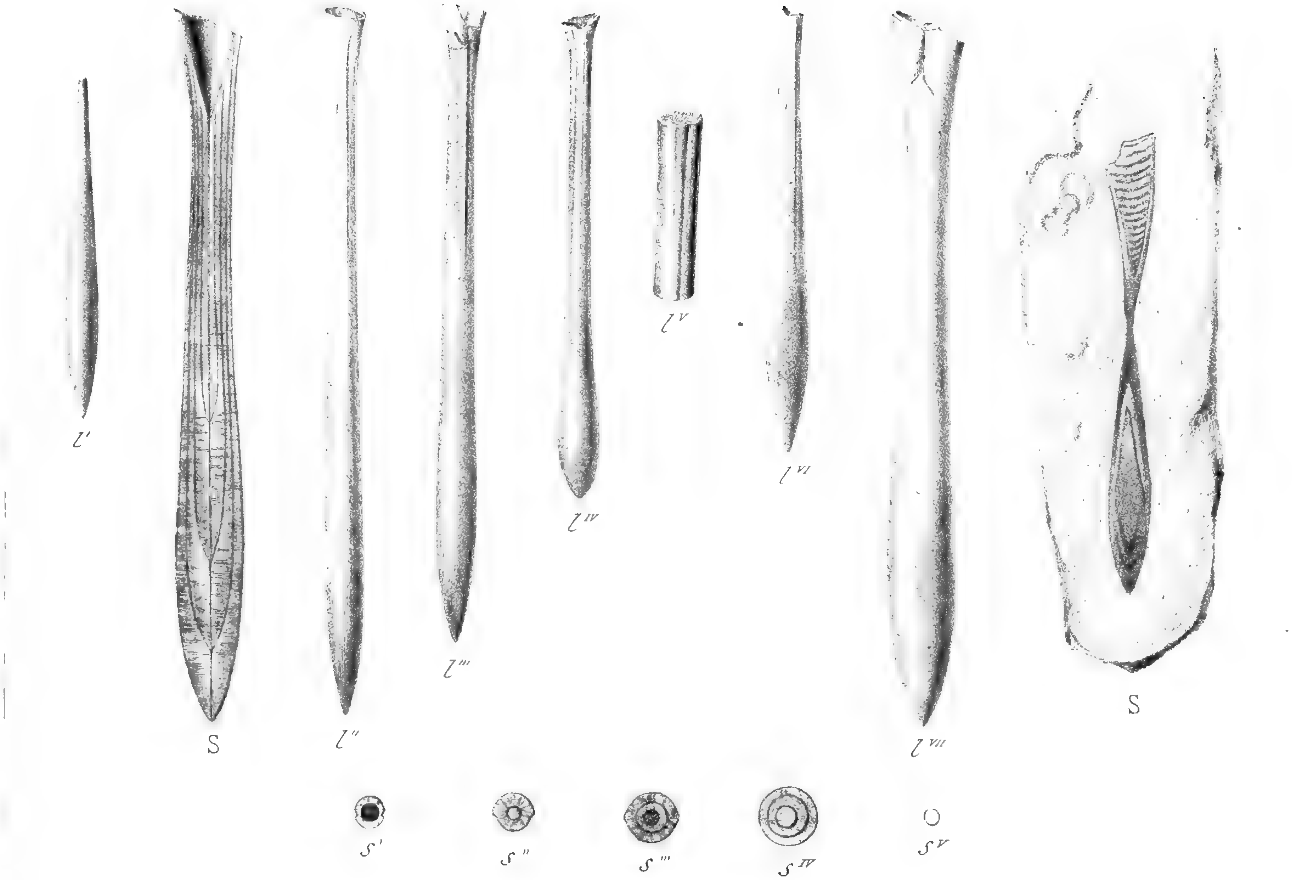


Fig. 8.

P. Lackerbauer lith.

Imp Becquet, Paris.

EXPLANATION OF PLATE IV.

FIG.

9A. BELEMNITES BREVIFORMIS, *var.* α (*var.* A, *Voltz*), from Lyme Regis.

- *v.* Ventral aspect.
- *l.* Lateral aspect.
- *s'.* Transverse section.

9B. BELEMNITES BREVIFORMIS, *var.* α (*var.* A, *Voltz*), from Gundershofen.

- *v.* Ventral aspect.
- *l.* Lateral aspect.
- s'. Longitudinal section, showing a nearly straight axis of guard, and a spherule at the apex of the phragmocone.
- s''. Section to show the form of a very young individual.
- s'''. Shows the spherule.
- s''''. The terminal laminæ of the guard.
- *s'.* Transverse section, showing a slight ventral flattening.

10A. BELEMNITES BREVIFORMIS, *var.* β (*var.* B, C, *Voltz*), from Prees, Salop.

- *d.* Dorsal aspect.
- *l.* Lateral aspect.
- *v.* Ventral aspect.

10B. BELEMNITES BREVIFORMIS, *var.* γ, from Ilminster.

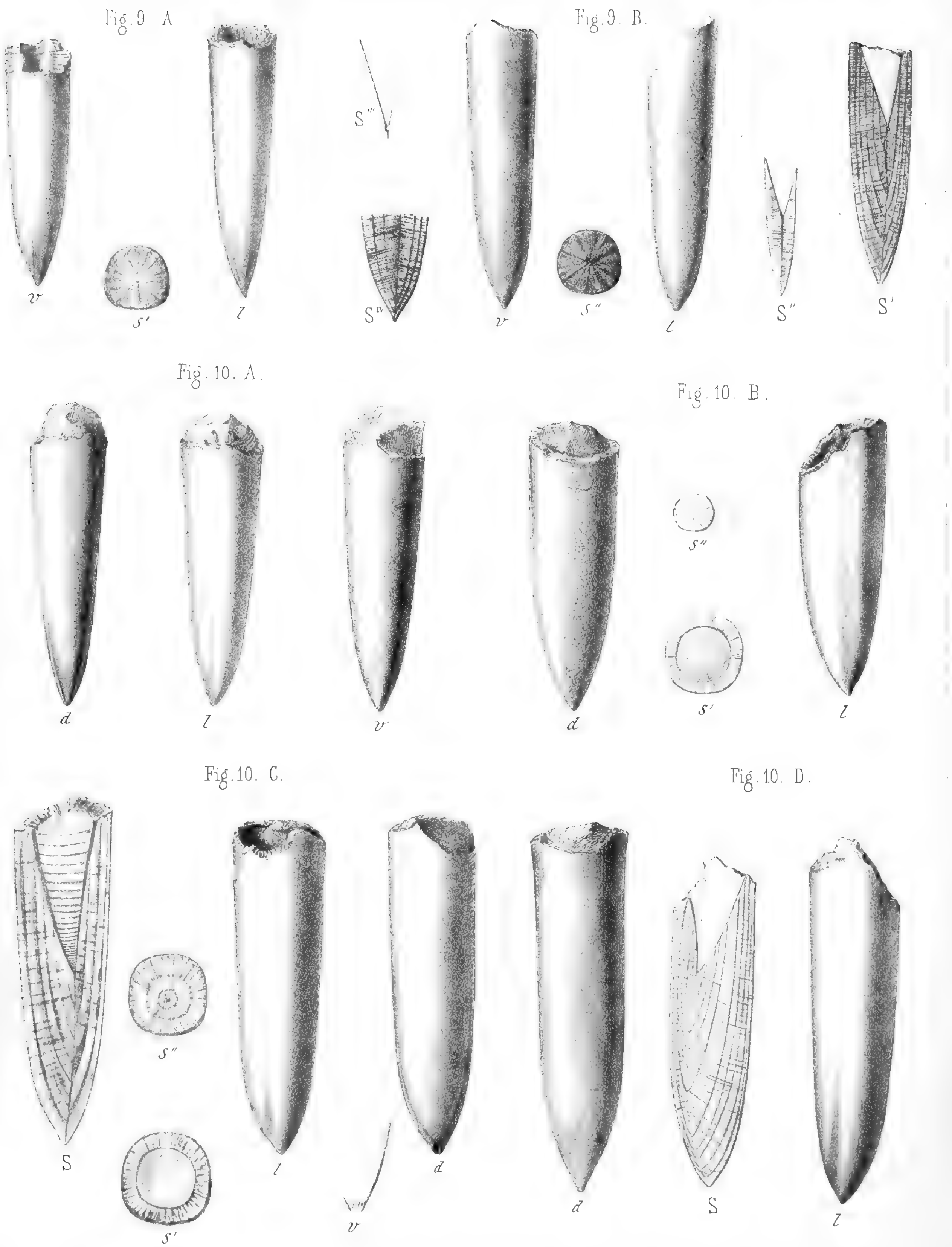
- *d.* Dorsal aspect.
- *l.* Lateral aspect.
- *s'.* Section across the alveolus.
- *s''.* Section across the guard, near the apex.

10C. BELEMNITES BREVIFORMIS, *var.* γ, from Alderton.

- *d.* Dorsal aspect.
- *v.* Ventral aspect.
- *l.* Lateral aspect.
- s. Longitudinal section.
- *s'*, *s''*. Transverse sections.

10D. BELEMNITES BREVIFORMIS, *var.* γ.

- *l.* Lateral view, and *d*, dorsal view, of a specimen from Glastonbury.
- s. Longitudinal section of a specimen from Eston Nab, in Yorkshire.



P. Lackerbauer lith.

Imp. Becquet, Paris.

EXPLANATION OF PLATE V.

FIG.

11. BELEMNITES GINGENSIS (Oolite).

v. Ventral aspect of a specimen from the lower part of the Inferior Oolite of Dundry.
l. Lateral aspect.
s. Longitudinal section.
f. Flanges of the phragmocone.
Σ'. Siphuncle crossing the septa.
Σ''. Same, enlarged.

12. BELEMNITES INSCULPTUS (Oolite).

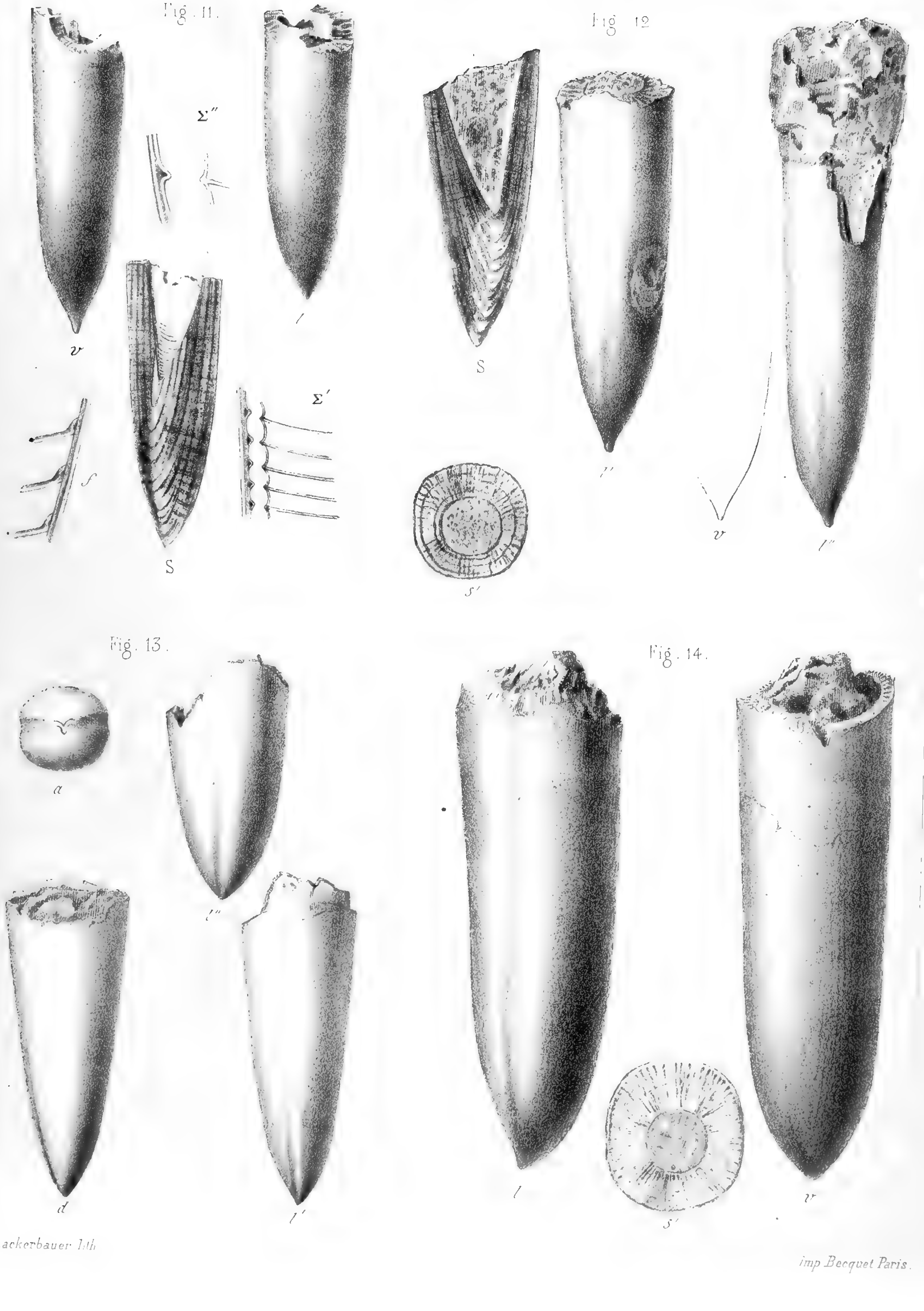
l′, *l″*. Lateral views of two specimens from the lower part of the Inferior Oolite of Dundry.
v. The ventral aspect.
s. Longitudinal section.
s′. Transverse section across the alveolar cavity.

13. BELEMNITE from the Lias, allied to *B. insculptus.*

d. Dorsal aspect of a specimen from the Lias of Lyme Regis.
l′. Lateral view of the same.
l″. Lateral view of a different specimen, with a very short axis to the guard.
a. View of the end, to show the two distinct grooves.

14. BELEMNITES LATISULCATUS.

l. Lateral view.
v. Ventral aspect.
s′. Section across the guard, through the alveolar cavity.



P. Lackerbauer lith.

imp. Becquet Paris.

EXPLANATION OF PLATE VI.

FIG.

15. BELEMNITES PAXILLOSUS.

l. Lateral view, } of specimen with eroded and striated apex.
v. Ventral aspect, } of specimen with eroded and striated apex.
d. Dorsal aspect, } of specimen with eroded and striated apex.

s. Longitudinal natural section of the guard, with a portion of the phragmocone not in section. Natural sections are frequent in this species.

s′. Longitudinal section of a younger individual.

s″. Transverse section of the guard at the apex of the alveolus.

s‴. Transverse section of the guard near the end.

φ. Phragmocone, seen laterally.

16. BELEMNITES APICICURVATUS.

l. Lateral view, showing the short groove near the point.

v. Ventral aspect.

d. Dorsal aspect.

s. Longitudinal section.

s. Section across the alveolar region.

s‴, s^{iv}, s^{v}. Sections nearer and nearer to the end.

φ. Side view of the phragmocone, always more arched than in *B. paxillosus.*

σ. Striæ magnified.

Fig 15.

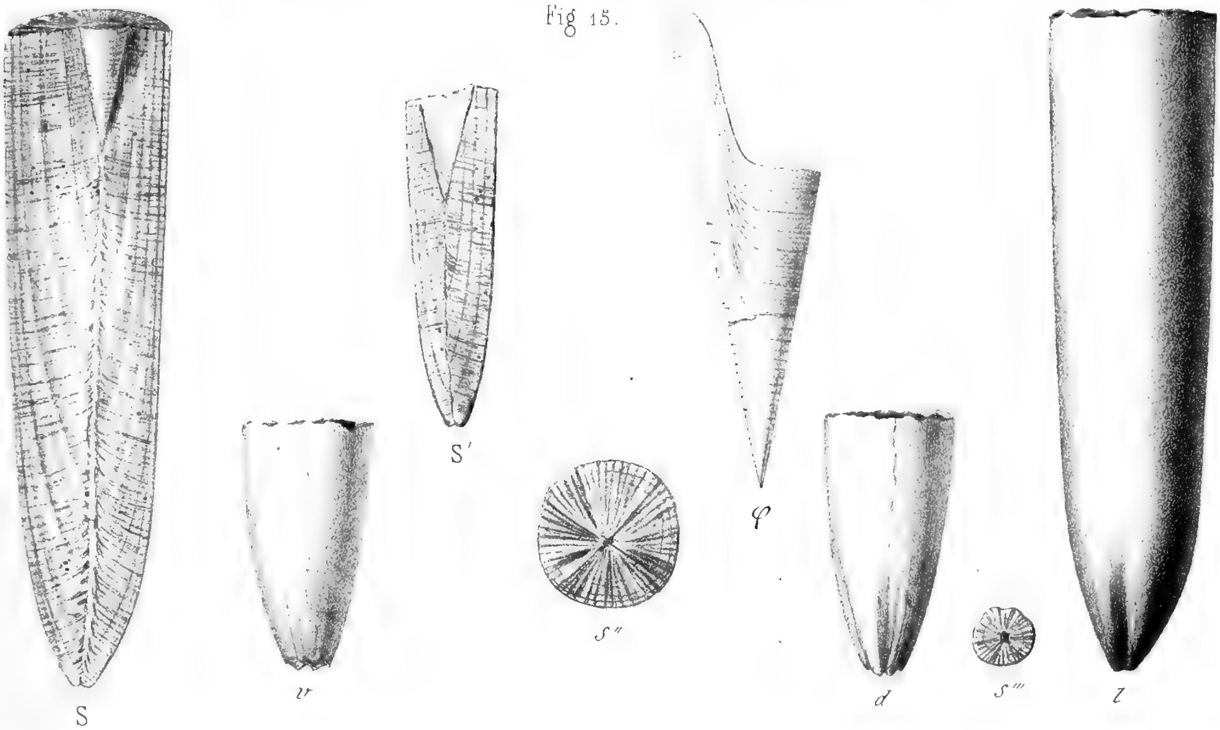
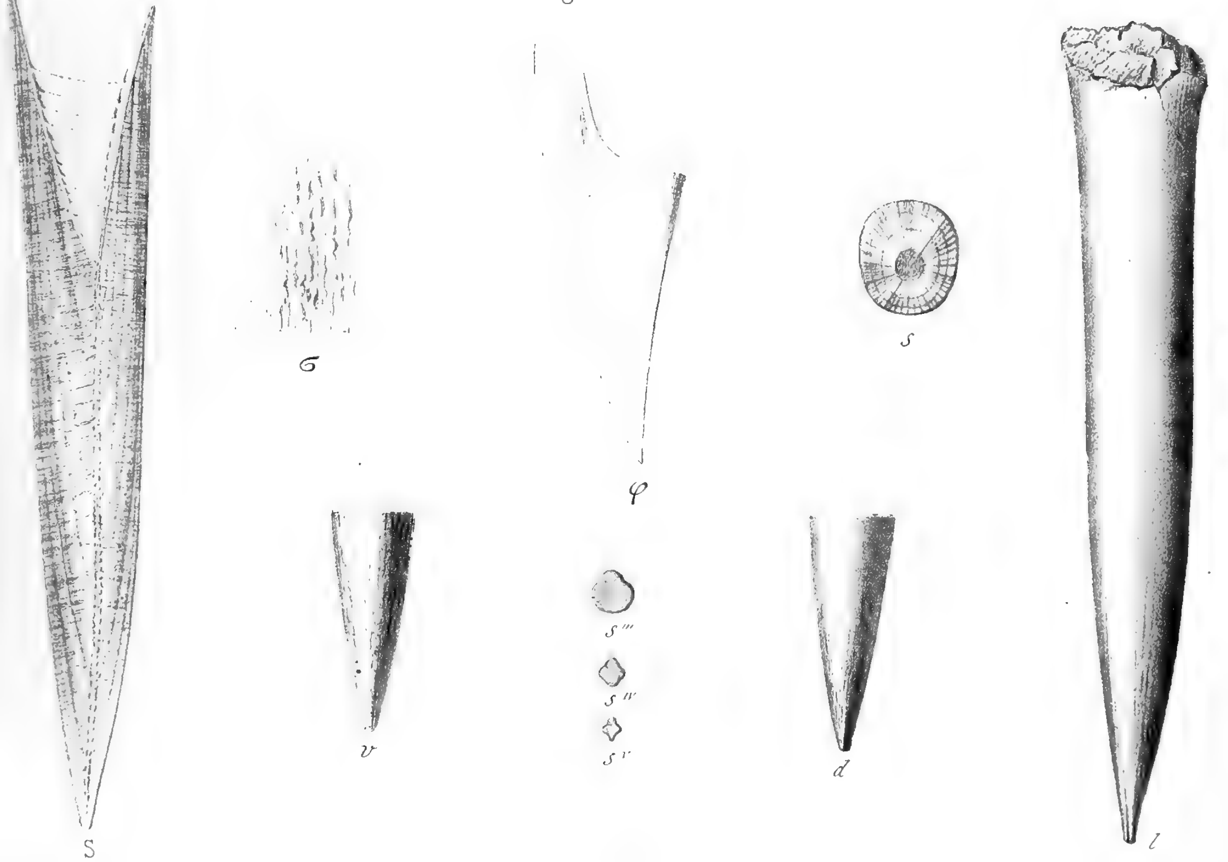


Fig. 16.



P. Lackerbauer lith.

Imp. Becquet, Paris.

EXPLANATION OF PLATE VII.

FIG.

17. BELEMNITES ELONGATUS.

l. Lateral view (right side) of the specimen in the British Museum (*d—v*, the place of the apex of phragmocone.

l'. The opposite side of the same towards the point. (This figure is accidentally reversed, so as to appear to be the right side.)

v. Ventral aspect of retral part of guard.

d. Dorsal aspect of the same.

s. View of a septal plate, showing the siphuncle at *v.*

s''. Transverse section near the apex.

s'''. Transverse section still nearer to the apex.

a. End view of the apex of guard.

Fig. 17.

P. Lackerbauer lith.

Imp. Becquet, Paris.

THE

PALÆONTOGRAPHICAL SOCIETY.

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THE

BRITISH

PLEISTOCENE MAMMALIA.

BY

W. BOYD DAWKINS, M.A., F.G.S.,

AND

W. AYSHFORD SANFORD, F.G.S.

PART I.

INTRODUCTION.
(Pages i—l.)

BRITISH PLEISTOCENE FELIDÆ.
FELIS SPELÆA, Goldfuss.
(Pages 1—28; Plates I—V.)

LONDON:
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1866.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

PREFACE.

Since the time when Baron Cuvier published the last edition of his great work, the 'Ossemens Fossiles,' in 1825, the materials for working out, in detail, the British Pleistocene Mammalia, of which Professor Owen had given an admirable outline in 1846, have been steadily and rapidly increasing. Our great National Museum has been supplemented by other public ones in most of the principal towns, in which the past Fauna and Flora of their respective districts are carefully preserved. The zeal of private collectors also has added very largely to the heap of accumulated facts, which only have to be compared and brought to a focus to enable us to realise, in all their varieties of size and form, the animals that lived upon that portion of the Pleistocene continent which now forms Great Britain and Ireland. Zoology also has made great strides, and, armed with a more perfect knowledge of the present order of things, we are daily becoming more fitted to investigate profitably the past. In undertaking to bring the Mammalogy of the Pleistocene up to the requirements of the day, we are conscious of our own shortcomings and of the magnitude of the task. We propose, by adopting the form of a series of Monographs upon each species, and by not commencing a second species until we have exhausted all the attainable information upon the one we may have in hand, to leave the work in such a state that it may be continued by any successors without alteration of plan.

We do not pledge ourselves to bring out the Monographs in zoological order, but just as our materials may admit of the complete description of any Pleistocene genus. This arrangement, as each Monograph will be distinct from the rest, like those composing M. de Blainville's 'Ostéographie et Odontographie,' will not affect their being bound up in their proper order on the completion of the work.

For any information as to the remains of Pleistocene Mammals in private cabinets, or anywhere else in Great Britain or Ireland, we shall be extremely obliged, as we wish to give the distribution and relative numbers of every fossil Pleistocene species.

W. BOYD DAWKINS.
W. AYSHFORD SANFORD.

February, 1866.

CONTENTS OF INTRODUCTION.

BRITISH PLEISTOCENE FELIDÆ.

Felis spelæa, Goldfuss.[1]

When simply numbers are placed at the commencement of the lines of the Tables of Measurement, they invariably signify—

1. Extreme length or antero-posterior measurement in inches.
2. Minimum circumference.
3. Maximum transverse measurement of proximal articulation.
4. Vertical ditto ditto.
5. Maximum transverse measurement of distal articulation.
6. Vertical ditto ditto.

DESIDERATA FOR THE COMPLETION OF THE MONOGRAPH ON *FELIS SPELÆA*.

British specimens of nasal and internal bones of the cranium; vertebræ; atlas; axius; sacrum.
,, ,, complete humerus, or proximal end of the bone; distal end of ulna.
,, ,, carpal bones, viz., cuneiform, trapezium, trapezoid, magnum.
,, ,, complete, or proximal end of femur.
,, ,, complete, or proximal end of fibula.

Bones of any other species of Felis or Machairodus from the British Pleistocene. The species at present known to exist in Britain are *Machairodus latidens, Felis pardus, F. catus.* But the lynx and, perhaps, the serval might be expected. The authors of this Monograph would be glad of the opportunity of examining any bones or teeth of Carnivora; and the utmost care will be taken of bones, addressed either to W. Boyd Dawkins, Esq., Geological Survey, Jermyn Street, or to W. A. Sanford, Esq., Nynehead Court, Wellington, Somerset. Or should the possessors not wish to send them, the authors would be glad of the opportunity of simple examination.

[1] Unfortunately we have been unable, from want of time, to publish the Plates and Descriptions of the Bones of *Felis spelæa* in the order in which they should naturally appear. We trust that this may be rectified in our future Monographs.

INTRODUCTION.

§ 1. In going backward in time from the historical period in Britain, we find ourselves landed in the realms of archæology without any guide to absolute date, and without any connected record of events previous to the first landing of Julius Cæsar upon our shores. The investigation of the contents of peat-mosses, of alluvia of rivers, and of a large number of caverns occupies our attention; and while the remains of man are widely spread, we miss the larger Carnivora, the Pachydermata, and others of the Pleistocene Mammalia. For this period, as embracing the deposits more usually termed *recent*, and extending from the Pleistocene down to the beginning of history, we adopt the name Prehistoric. It is eminently the field of the archæologist, who subdivides it, according to the traces of man that it contains, into the iron, bronze, polished stone, rude unpolished stone, and flint periods.[1] From his point of view we have nothing to do with it; but for the sake of showing the relation of the Pleistocene fauna to that now living in Britain, we are obliged to treat it zoologically. It forms a distinct zoological period, separable from the Pleistocene, but passing insensibly into the Historic period.

§ 2, A. *Prehistoric caverns.*—Caverns, as affording shelter from the weather, have been the resort of man and wild animals in all times, from the Pleistocene to the present day. Hence, very frequently in the same cave remains of different epochs are found. In Kent's Hole, for instance, overlying the mass of bones dragged in by hyænas in Pleistocene times, and in parts hermetically sealed by stalagmite, there was a stratum of dark earth containing the remains of the feasts and fires of some early people—bone implements, chert and flint arrowheads, "a hatchet of syenite," sandstone spindles, shells of mussel, limpet, and oyster, a palate of *Scarus,* and numerous fragments of pottery. This last "is of the rudest description, made of coarse gritty earth, not turned on a lathe, and sun-baked; on its external margin it bears zigzag indentations, not unlike those from the barrows of Wilts." Its ornamentation and texture are like those of the rude pottery obtained

[1] See Sir John Lubbock's 'Prehistoric Man,' 8vo, 1865. London.

by the Earl of Enniskillen, F.R.S., from the Bears' Den of Kühloch, and that from the Pile-dwellings of Switzerland in the collection of the late Mr. H. Christy. In some places the stalagmite had been broken through, apparently for purposes of sculpture; and human bones, and flints of all forms, "from the rounded pebble, as it came out of the chalk, to the instruments fabricated from them, as the arrow- and spear-heads, and hatchets, were confusedly disseminated through the earth, and the whole agglutinated together by stalagmite. Flint cores were lying by the sides of the flakes struck from them."[1] The remains also of the wild boar, red deer, fox, rabbit, and rodentia, were obtained from the same layer, and are in part preserved in the Museums of London and Oxford. The metatarsals and -carpals in the Oxford Museum, obtained from the upper portions of the contents of the cavern in association with charcoal, belong to the small short-horn *Bos longifrons*.

To the absolute date of these remains there is at present no clue; but that the cave was inhabited after, to the disappearance of the characteristic Pleistocene mammalia found in the cavern, by savages closely allied to those whose remains are found in hut-circles and tumuli, there can be no doubt. The careful exploration now being conducted by the British Association will doubtless throw great light upon the relative age of the various layers, and possibly the absolute age of some of the superior ones.

§ 2, B. The Paviland cave, described by Dr. Buckland, affords another instance of the mixture of Pleistocene and Prehistoric remains. To the one period belong the elephant, rhinoceros, horse, and hyæna; to the other, the human skeleton (which equals in size the largest male skeleton in the Oxford Museum), the bones of ox and sheep, the whelk, limpet, littorina, and trochus, that had been introduced for food. Certain small ivory ornaments found along with the skeletons Dr. Buckland considers to have been made from the tusks of the mammoth in the same cavern, and he justly remarks—"As they must have been cut to their present shape at a time when the ivory was hard, and not crumbling to pieces, as it is at present on the slightest touch, we may from this circumstance assume for them a very high antiquity."[2] May we not also infer from the fact of the manufactured ivory, and the tusks from which it was cut, being in precisely the same state of decomposition, that the tusks were preserved from decay during the Pleistocene times by precisely the same agency as those now found perfect in the Polar regions—by the intense cold; that long after the mammoth had become extinct the tusks thus preserved were used by some race that has passed away; and that at some time subsequent to the interment of the ornaments with the corpse a great climatal change has taken place, by which the temperature in England, France, and Germany has been raised, and decomposition set in in the organic remains that up to that time had remained for ages in their natural condition? The presence of the remains of sheep under-

[1] 'Cavern Researches,' by the late Rev. J. MacEnery, F.G.S., edited by E. Vivian, Esq., 4to, 1859 (the larger edition).

[2] Buckland, 'Reliquiæ Diluvianæ,' 4to, 2nd edit., 1824, p. 90.

neath the bones of elephant, bear, and other animals, coupled with the state of the cave-earth, which had been disturbed anterior to Dr. Buckland's examination of the cave, would prove that the interment was not of Pleistocene date. No traces of sheep or goat have as yet been afforded by any Pleistocene deposit of Britain, France, or Germany.

§ 2, c. These two instances of the presence of remains of Pleistocene and Prehistoric age in the same cavern are two out of a large number in which a similar mixture of organic remains are met with. Instances also may be multiplied of caverns containing remains of Prehistoric age alone without others. Thus, Professor Owen quotes a cave at Arnside Knott, near Kendal, that yielded wild boar (*Sus scrofa*), brown bear (*Ursus arctos*), and other existing species of Mammalia.[1]

§ 2, d. During our explorations of caverns in Somersetshire we explored three of Prehistoric age. In 1859 a small cave at the head of Cheddar Pass yielded a large quantity of bones. Prior to our examination, on its first discovery, some of the remains were deposited in the Museums of Bristol and Oxford. The list of Mammalia comprises, besides man, the wolf, fox, badger, wild boar, goat, roebuck, *Bos longifrons*, and horse. A human skull from this cave, preserved in the Oxford Museum, is very well developed,[2] and may have belonged to a person of considerable capacity.

§ 2, e. In 1863 we examined a second cave, also in the Mountain Limestone of the Mendip range, in Burrington Combe, and named it from its discoverer Whitcombe's Hole. It was very nearly blocked up with earth mingled with charcoal, and contained a large quantity of the remains of ox, red deer, goat, wolf, fox, badger, rabbit, and hare. In the lower portion of the cave, where the floor dips downwards, we disinterred fragments of a rude unornamented urn of the coarsest black ware, with the rim turned at right angles, and an angle iron which more closely resembled those found strengthening the angles of wooden chests in the Roman graves on the banks of the Somme than anything else we have seen. The accumulation of bones and charcoal proves that the cave was in-

[1] 'British Fossil Mammals,' 8vo, 1846, p. 429.

[2] We are indebted to Professor Phillips, M.A., LL.D., F.R.S., for the following note upon this skull:—"The cranium is dolicho-cephalic, elevated in the parietal region, very narrow behind, with a very distinct occipito-parietal slope, narrow and evenly convex in the front; substance thin; individual young, probably female. This cranium most nearly resembles one from the cave at Llandebie (now in the Oxford Museum), which is filled with stalagmite, and was accompanied by bones of elk, bear, and *Bos longifrons*. The dimensions are—

Length	in inches	7·22
Breadth, parietal . .	„	5·32
„ frontal . .	„	3·75

"The last measurement is taken along the supraciliary line, for it is hardly a crest in this individual.

"Do you ask what race of men this belonged to? I answer that I have seen plenty of men and women with such crania in the south of England and South Wales."—*Oxford, Sept.* 1, 1865.

habited by man for some considerable time, like those of Perigord.[1] The interment is clearly of a later date than the occupation, because it is made in the mass of earth, bones, and charcoal, which resulted from the latter. The interval between the two is of doubtful length.

§ 2, F. In the same year we explored the cave, Plumley's Den, like the preceding in Burrington Combe. It consists of two large chambers, connected together by two small passages, not more than a few inches high. The natural entrance, but a little larger than a fox-hole, was in the roof of the first chamber, and through this we had to drop down into the cave. Subsequently we blasted a second entrance. The first chamber was at least half-full of broken rocks, forming a talus immediately below the natural entrance, through which in part they may have been introduced. They were covered with a mortar-like mass of decomposing stalagmite. Underneath them we found a group of four skulls, more or less crushed and fractured. One of these belonged to a small variety of the *Bos taurus,* probably that variety so abundant in deposits of Prehistoric age, *Bos longifrons.* Two others belonged to a species of the goat tribe, and approach more closely to the *Ægoceros Caucasica*[2] of Asia than any recent species with which we are acquainted, the horncores being oval, in section, very nearly parallel, and slightly recurved. We have met with a similar form in a deposit of bones at Richmond, in Yorkshire ; but in the absence of the necessary materials for comparison from the Museums of London, Oxford, and Paris, we do not feel justified in imposing a new specific name. The fourth skull belonged to *Sus scrofa,* and had a round hole in the frontals, about the size of a crown-piece, which had the appearance of being made by human hands. The presence of the lower jaws by the side of their respective skulls indicates that they were deposited in the cave while the ligaments still bound them together. They were all more or less covered with decaying stalagmite. Between the interstices of the stones covering the floor were numerous bones and teeth of wolf, fox, mole, arvicolæ, badger, bat, the metacarpal of red deer, the radius of Bos, and the remains of birds. The outer chamber was remarkable for the absence of earth of any kind, except underneath the natural entrance, where there was a thin coating. The lower chamber, on the other hand, running in the same slope as the outer, has its lower end entirely stopped up with a fine red earth, deposited by a stream, traces of the flow of which, during heavy rains, were evident. How the animal remains were introduced—for there were no marks of gnawing upon them, and no fragments of charcoal in the cave—is altogether a matter of conjecture. But the fact of finding the skulls grouped together, coupled with the presence of the hole in the frontals of the *Sus scrofa,* inclines us to believe that they may have been introduced by the hand of man. The entrance was far too small to admit of an ox falling into the cave by accident, and scarcely large enough to admit of a goat or deer squeezing themselves through.

1 'Revue Archéologique,' 1864.

2 Gray, 'Cat. of Bones of Mammals in British Museum,' 8vo, 1862, p. 249.

§ 2, G. From a cave in the limestone cliffs at Uphill, near Weston-super-Mare, Mr. James Parker obtained the following remains:—Human crania and bones, accompanied with rude pottery and charcoal, the bones of wild cat, wolf, fox, badger, *Bos longifrons*, and a second species ox of larger size; the red deer, *Sus scrofa*, and water-rat. A large percentage of these belong to young animals, and some are gnawed by dogs, wolves, or foxes. This must not be confounded with the cavern at Uphill from which Messrs. Beard and Williams obtained Pleistocene Mammals.

§ 2, H. The Heathery Burn Cave, in Yorkshire, explored by Mr. John Elliot, yielded, besides the remains of man, those of the otter, badger, goat, roedeer, hog, and water-rat. With reference to the human remains, Professor Huxley observes—"I see no reason for believing them to be of older date than the river-bed skulls," *i. e.* those found in the valley of the Trent, associated with *Bos longifrons*, goat, red deer, wolf, and dog.[1]

We have selected these as examples of Prehistoric caverns, and as representing the fauna of the vague interval between the Pleistocene and our own times.

§ 3. In the alluvia of rivers and in peat-bogs the remains of animals of Prehistoric age are found in large numbers, and correspond remarkably with those of the caverns. Thus, the Manea Fen, in Cambridgeshire, has yielded *Ursus arctos;* the peaty mud near Newbury the beaver, wild boar, roedeer, red deer, wolf, goat, horse, otter, water-rat, bear, *Bos longifrons*, and *B. primigenius;* the peat and the marly beds below of Ireland the *Megaceros*, associated with the *Bos longifrons*, the red deer, and the reindeer (*C. tarandus*). The peat of Hilgay, in Norfolk, has furnished the beaver and Irish elk, while that of Ross-shire the traces of the reindeer, in an antler presented by Sir P. Malpas de Grey Egerton, Bart., to the British Museum. The reindeer also is described by Professor Owen[2] as occurring beneath a peat-moss near East Dereham, in Norfolk. The remains of *Bos longifrons* are most universally found with red deer, roedeer, wild boars, otters, and beavers. The marl underneath the peat of Scotland has also yielded the gigantic skulls of the great Urus, *Bos primigenius*. From the very recent character of the osseous substances of these, Professor Owen infers that this animal may have maintained its ground longer in Scotland that in England.

"In the Museum of the Natural History at Newcastle is a remarkably fine shed antler of the true elk, *Alces malchis*. It was found in Chirdon Burn, near the bottom of the recent peat-formation, resting partially on the coarse gritty marl formed by the weathering of the subjacent strata."[3] It measured, when perfect, from tip to tip, 2 feet 10 inches; from burr to extreme end, 2 feet 10 inches; round the burr, 10 inches; and round the beam nearly 8 inches. The *gisement* of the fossil stamps it as being of the same relative

[1] 'Geologist,' 1862. [2] Op. cit.

[3] 'Trans. of Tyneside Naturalists Field Club,' vol. v, part ii, p. 111. Paper by Mr. Richard House, 1861.

Prehistoric age as the Urus of Scotland and the Megaceros of Ireland, found in the marl at the bottom of the peat. It is worthy of remark that this animal was eaten by the dwellers in the Lake-villages of Moosedorf, Wauwyl, Meilen, Robenhausen, Concise, and Bienne, according to Professor Rütimeyer.

In digging the foundations of the large works at Crossness Point for the southern outfall of the metropolitan sewage a most interesting collection of Prehistoric Mammalia was made from the peat and silt. We identified red deer, *Bos longifrons*, goat, beaver, horse; and among the remains forwarded to the British Museum is a remarkably fine antler of reindeer (*Cervus tarandus*), which Mr. Houghton, the engineer, informs us came from the bottom of the peat at a depth of fifteen feet below the surface. A large number of cases of similar discoveries may be quoted, as in the estuarine mud of Selsea, of the hind and fore legs of *Bos longifrons*, with all the bones, to the smallest sesamoids, in place, or in a silted-up river-bed at Waterbeach Mills, near Cambridge, of the same animal, associated with the red deer, goat, horse, and wolf.

§ 4. The following list, which probably will be largely increased, represents the mammalia derived from the Prehistoric deposits, and includes those species that began to live in the Pleistocene, and are living in Britain at the present day, and which therefore must have lived in the Prehistoric Period, although their remains have not yet been discovered in it. The latter are marked with an asterisk. It consists of thirty-four species.

Homo sapiens, *Lin.*
Rhinolophus Ferrum Equinum, *Leach.*
Vespertilio noctula, *Geoff.*
Talpa Europæa, *Lin.*
Sorex vulgaris,* *Lin.*
Felis catus ferus, *Schreb.*
Canis familiaris, *Lin.*
„ vulpes, *Lin.*
„ lupus, *Lin.*
Mustela erminea,* *Lin.*
„ martes,* *Lin.*
„ putorius,* *Lin.*
Lutra vulgaris, *Erxl.*
Meles taxus, *Schreb.*
Ursus arctos, *Lin.*
Mus musculus, *Lin.*
Castor fiber, *Lin.*
Arvicola amphibia, *Desm.*
„ pratensis,* *Bell.*
„ agrestis,* *Pall.*
Lepus timidus, *Fabr.*
„ cuniculus, *Lin.*
Equus caballus, *Lin.*
Alces malchis, *Gray.*
Megaceros Hibernicus, *Owen.*
Cervus Tarandus, *Lin.*
„ elaphus, *Lin.*
„ capreolus, *Lin.*
Ovis aries, *Lin.*
Capra ægagrus, *Gmel.*
„ hircus, *Gmel.*
Bos longifrons, *Owen.*
„ Urus, *Cæsar* (= B. primigenius, *Boj.*)
Sus scrofa, *Lin.*

The absence of the squirrel and dormouse from this list may, perhaps, be owing to their arboreal habits, which would render the chances of their bones being found in caverns or river-deposits very remote. Both genera and perhaps both the English species occur in the French Pliocene strata.

All these animals are still living in Britain at the present moment, except the Irish elk (*Megaceros Hibernicus*), which is entirely extinct; the reindeer and moose (*Alces malchis*), which are now confined to the colder regions of Northern Europe, Asia, and America; and the *Bos longifrons*, and *B. primigenius*, the beaver, the wolf, the wild boar, and the *Ursus arctos*, which lived on these into the Historical period. The *Bos longifrons* —which, in our opinion, will ultimately be found to be specifically identical with *Bos taurus*—was the variety that supplied the Roman legionaries in Britain with beef;[1] the *Ursus arctos* was probably, from an allusion of Martial,[2] exported to Rome for the sports in the theatre; and the beaver was still living in the river Teivy, in Cardiganshire, when in 1188, Giraldus Cambrensis accompanied Archbishop Baldwin on his tour through Wales to collect volunteers for the First Crusade. This latter animal, according to Boethius, lingered on in Loch Ness till the fifteenth century. The wolves, sufficiently abundant in the Andreads Wold to eat up the corpses of the Saxons left on the field by Duke William[3] after the Battle of Hastings, lingered on in England till 1306, in Scotland till 1680, and in Ireland, protected by the uncultivated wilds and the misrule of the country, until the year 1710. The last wild boar was destroyed in the reign of Charles I.

The Irish elk (*Megaceros Hibernicus*), whose remains are so very abundant in the Pleistocene deposits, is the only species that can be proved to have become extinct in the Prehistoric period.

Whether or no the great *Urus* and the small short-horn (*Bos longifrons*) be extinct, or live, the one in the larger domestic cattle of Europe, as the Flemish oxen,[4] and those of Holstein and Friesland, the other in the smaller breeds, has not yet been satisfactorily decided.

In the Prehistoric period the dog, the goat, and the sheep, make their appearance for the first time in the world's history. *Bos longifrons* also has not yet been proved to have lived in the preceding period, the evidence for its coexistence with the extinct Pleistocene mammalia being founded on some remains cast up by the sea at Clacton and Walton, which therefore may have been derived from a much later deposit than the Preglacial Forest-bed.

The remains of the Irish elk and the reindeer may, perhaps, indicate an earlier division of the Prehistoric period, but upon this point we must be content to wait for more evidence. The occurrence of the latter animal in Prehistoric deposits proves that in Britain, as in the

[1] See Boyd Dawkins, 'Sussex Archæological Collections,' vol. xvi.

[2] "Nuda Caledonio sic pectora præbuit urso
Non falsâ pendens in cruce Laureolus."

[3] 'De bello Hastingensi Carmen,' by Guido, Bishop of Amiens, who died in 1075.
"Lustravit campum, tollens et cæsa suorum,
Corpora, Dux, terræ condidit in gremio;
Vermibus atque *lupis* avibus canibusque voranda,
Deserit Anglorum corpora strata solo."

[4] As Professors Nilsson and Rütimeyer suggest 'Ann. and Mag. Nat. Hist.,' 1849; 'Fauna der Pfahlbauten,' 4to, Basle.

south of France, it lingered on after the disappearance of its Pleistocene congeners—the lion, the hyæna, and the great pachyderms.

§ 5. *Inferences as to Prehistoric Climate in Britain, &c.*—The evidence of a gradual increase of temperature in France and Germany during the historical period seems to us perfectly incontrovertible. Firstly, the Rhine and the Danube[1], during the first four centuries, were frequently frozen over in the winter, so that the barbarians, "who often chose that severe season for their inroads, transported, without apprehension or danger, their numerous armies, their cavalry, and their heavy waggons, over a vast and solid bridge of ice."[2] On the banks of the Danube the wine was frequently frozen into great lumps.[3] Secondly,[4] Cæsar mentions the reindeer as existing in the great Hercynian Forest that overspread Northern Germany, along with the gigantic *Urus* and the elk. This statement of Cæsar is singularly corroborated by the discovery in the peat-bogs of Pomerania[5] of the remains of these three animals, so that there can be no reasonable doubt of his accuracy in this particular case. Modern ages afford no instance of like phenomena. From some cause or other, the temperature has increased on the banks of the Rhine; and in the fact that at the present moment the reindeer[6] cannot live south of the Baltic we may recognise a proof of a diminution of cold in that region since it was inhabited by those lovers of a severe climate. This change of temperature is very generally accounted for by the drainage of morasses and the cutting down of woods; but may it not with more probability be ascribed to a much deeper cause—to a secular change operating throughout Europe, which began in the Pleistocene, and was going on throughout the Prehistoric, and happened incidentally to be noticed in the Historical period? The presence of the reindeer in the Prehistoric deposits of England, Ireland, and Scotland, affords precisely the same evidence as those mentioned by Cæsar. At the time they lived in Britain and Ireland the climate must have been suited for them. On the theory of the gradual modification of climate through the Prehistoric and Historical periods, the fact of the manufactured ivory and the tusk preserved in the *cave-earth* of Paviland, cited above, being in precisely the same state of preservation, is alone explicable. There may have been oscillations of temperature, but the progress on the whole seems to us to have been gradual from the intense cold of the glacial period to the temperate "insular climate" obtaining in Britain at the present day.

§ 6. The term Pleistocene is used in the same sense as Professor Forbes and M.

1 Diodorus Siculus, i, 5, p. 340, edit. Wesselling. Herodian, i, 6, p. 221.

2 Gibbon's 'Decline and Fall,' chap. ix.

3 Ovid, 'Epist. ex Ponto,' Lib. 4, ep. 7, Lin. 9, 10. Virgil, 'Georgic,' Lib. 3, Lin. 355. Zenophon's 'Anabasis,' i, 7.

4 'De Bello Gallico,' vi, 23.

5 Professor Nilsson, "On Extinct and Existing Bovidæ of Scandinavia;" 'Ann. and Mag. Nat. Hist.,' 1849, p. 264.

6 See Zimmerman, Specimen Zool. Geograph., 4to, 1778, p. 285.

Gervais[1] have used it, as the exact equivalent of the Post-pliocene of Sir Charles Lyell, the Quaternary of the French geologists and Mr. Prestwich, and the Preglacial and Glacial divisions of Professor Phillips. It applies to all formations from the top of the Norwich Crag up to the Prehistoric deposits, comprising the Preglacial Forest-bed, the Glacial drift, the Post-glacial brickearths, loams, gravels, and the contents of the older ossiferous caverns. The discussion of the characteristic mammalia of each of these we must leave to a future day, when we hope to enter fully upon the distribution of the Pleistocene mammalia in Britain and Ireland. In the south of France the ossiferous caverns of Perigord connect it with the Prehistoric deposits, and mark an epoch when a people, probably closely allied to the Esquimaux, lived on the banks of the Dordogne.[2]

§ 7. *Pleistocene caverns and river-deposits.*—The writings of Sir Charles Lyell, Dr. Buckland, Professor Morris, Messrs. Godwin-Austen, Prestwich, Trimmer, MacEnery, Dr. Falconer, Boyd Dawkins, and many others, on the remains derived from Pleistocene caverns and river-deposits are so well known that to enter into details about them would be superfluous in this Introduction. Their concurrent testimony proves that, while the great majority of caverns owe their contents to the falling of animals into open fissures, and the transporting power of water, others have been inhabited for ages by hyænas and other animals, and filled with the remains of their prey, and that the gravels, loams, and brickearths, which are sometimes very high above the level of the nearest stream, were deposited by a river flowing at a far higher level than at present, that has cut down its bed to its present level, and that the remains from the caverns and the river-deposits are, geologically speaking, of the same date. A list of the mammalia of each will be given subsequently.

A short summary of the Pleistocene mammalia will not be out of place in this Introduction, though, no doubt, our views will be altered in many points as our investigations become more extended. The list of species will also probably be increased. Before, however, we enter upon this, we must define what we mean by the determination and identification of a fossil species.

§ 8. Till within the last few years the idea that the succession of life in the rocks is the result of a series of acts of creation and destruction, and that therefore the fauna of any given geological period is insulated from that which has gone before and that which comes after, has insensibly affected[3] most of the palæontologists who have investigated the Pleisto-

[1] Gervais, 'Paléontologie Française,' 4to, 1859.

[2] MM. Ed. Lartet et H. Christy, 'Revue Archéologique,' 1864.

[3] "On considère ordinairement le terrain diluvien comme séparé de l'époque moderne par les charactères aussi tranchés que ceux qui distinguent les trois étages de la période tertiaire . . . . c'est-à-dire qu'à la fin de cette période toutes les espèces ont été anéanties et qu'une nouvelle création a repeuplé la terre à l'origine de l'époque moderne." ('Paléontologie,' par M. Pictet, vol. i, p. 359, first edit.) Professor Pictet

cene fauna. It has led nearly all to give a far higher value in classification to points of difference than to those of agreement, and has left an indelible mark in the terminology of the species—as, for example, in the *Hyæna spelæa* of Goldfuss, and the *Equus fossilis* of Professor Owen, which have not yet been proved to differ specifically from the living spotted hyæna (*H. crocuta*) and the common horse (*Equus caballus*). The first law of the distribution of fossils given by Professor Pictet is—" Les espèces d'animaux d'une époque géologique n'ont vécu ni avant, ni après cette époque ; de sorte que chaque formation à ses fossiles spéciaux, et qu'aucune espèce ne peut être trouvée dans deux terrains d'âge différent" —a law that is capable of disproof by the examination of any series of fossils stratigraphically arranged, We find, on the contrary, that in proportion to the lapse of time between any two formations, so the difference increases between their respective suites of organic remains. If the interval between them be great, there may be no species and no genera in common ; if it be small, a greater or less number of species or genera will be common to both. In the case before us the interval between the Pleistocene times and our own is, geologically speaking, small, and therefore we expect to find a large number of species and genera in common.

In the determination of these we purpose to give the maximum value to variations within the limits of species that may be the result of difference of food, of climate, and the like. But it may be objected that identity of osseous framework does not imply identity of species where colour of the dermal covering is of weight—for example, that the identity of form of the skeleton of *Hyæna spelæa* with the *H. crocuta* does not imply that the former was spotted, or that close agreement between the Pleistocene and living *Ursus Arctos* does not prove that the former was brown or black. To this we say that colour is not, in our opinion, of specific value, changing even in the same individual according to climate, as in the case of the Arctic wolves and many of the Arctic birds. The differences in dermal covering, on the other hand, in all cases that have come before us, are correlated also with differences in the skeleton, as in the recent lion and tiger. If the thick woolly and hairy covering on the carcasses of the mammoth and tichorhine rhinoceros, imbedded in frozen gravel on the shores of Siberia, be contrary to our experience of living species, they were accompanied also by characters in the dentition and skeleton that prove the species to which they severally belong to be extinct. Any argument, therefore, from them to any other Pleistocene mammal, between which and the recent there is no difference in hard parts, as the lion, falls to the ground. The value, indeed, of comparative osteology depends upon the axiom, that *identity of osseous framework and especially of that most important part of the digestive apparatus, the teeth, implies also an identity of species.*

We have purposely omitted to burden this Introduction with references and notes, which will be found in their proper place in the body of the work.

himself disclaims these views of the Pleistocene fauna, and states, as his belief, "Je crois qu' entre le moment ou les ossements des ours ont été enfouis dans les cavernes et le temps actuel, il n'y a point en de création nouvelle, et point d'interruption dans la vie organique."—p. 360.

§ 9. *Pleistocene Mammalia.*—The remains from the British caverns and river-deposits of Pleistocene age, determined according to the principles given above, present us with at least fifty-three species of fossil mammals, of which some are now extinct, some banished to remote parts of the earth, while others still survive in our forests, rivers, and moorlands.

§ 9, A. BIMANA, *Homo.*—The presence of man among the Pleistocene fauna is now so universally recognised that there is no necessity for further evidence upon the point being adduced. From the river-gravels of Bedford, Hoxne, the Brick-earth of Fisherton, near Salisbury, and a large number of other places,[1] have been derived the rude flint implements which Messrs. Evans and Prestwich have no hesitation in considering of the same age as the gravels themselves, which frequently contain the remains of mammoth, bear, and other Pleistocene mammalia. The caverns of Brixham, Kent's Hole, Gower, and Tenby, have afforded the rude implements used by the Pleistocene savages in association with the remains of the great carnivora. In the cavern of Wookey Hole also his rude handiwork of flint, chert, and bone, and the ashes of his fires, occurred under circumstances that admit of no doubt upon the subject.

§ 9, B. CHEIROPTERA.—The remains of bats found in the ossiferous caverns, as Professor Owen[2] very justly remarks, cannot be differentiated from those of the species still inhabiting the districts in which they occur; and from the fact of the species often still inhabiting the caverns in which its remains are found, there is a possibility of the latter not being of the same date as those of the associated mammalia. The same objection applies equally to the remains of the badger and fox, which, beyond all doubt, have been proved to have been Pleistocene mammals. The balance of probability is, on the whole, in favour of the *Cheiroptera* having lived at the same time as the extinct Pleistocene mammalia; but there is no absolute proof. Professor Owen describes *Vespertilio noctula* as occurring in a fissure in a Mendip bone-cavern, and a lower jaw of the Greater Horse-shoe Bat (*Rhinolophus ferrum-equinum*) is figured by Scharf among the fossils from Kent's Hole.[3]

§ 9, C. CARNIVORA. Genus *Machairodus*, Kaup. Species *Machairodus latidens*, Owen. —The fact that, out of all the numerous places in which the remains of Pleistocene mammalia occur in Britain, but one, Kent's Hole Cavern, should have furnished traces of this most remarkable Pliocene carnivore, caused the late Dr. Falconer to consider it of a different date to the other fossil mammalia in the cavern. The condition, however, of the teeth in question, and their intimate association with the other remains,[4] the absence of all traces

[1] 'Quart. Journ. Geol. Soc.,' 1856—65.

[2] Tom. cit., p. 11 et seq.

[3] See the beautful folio plates published in 1859, Torquay.

[4] 'Cavern Researches,' by the late Rev. J. MacEnery, F.G.S.,' edited by E. Vivian, Esq., London, 1859, 8vo, pp. 32-3.—"To enumerate the amount of fossils collected from this spot would be to give the

of watery action on their fine serrate edges incline us to believe that Machairodus ranged down, like *Elephas meridionalis,* from the Pliocene into the Pleistocene period, and was a contemporary of the tichorhine rhinoceros and the spelæan hyæna.

Genus *Felis.* Species *Felis spelæa,* Goldfuss.—The opinion that we propose to advance with reference to this species differs considerably from that of all the authors who have preceded us in their inquiries. The reason for it will be specially detailed in the monograph upon the genus, the first part of which is contained in the present publication. We consider that, although differences may be found in all the parts of the skeleton of *F. spelæa,* which, at first sight, appear to separate it specifically from the lion, that they are not too great to be fairly ascribed to variation within the limits of the species. Remains which can in no way be distinguished from those of the lion occur both in the caverns and river-deposits; and although the larger feline bones show us, as we have said, considerable differences, the examination and comparison of a large series, proves that the characteristics of lions are invariably shown, and very generally in an exaggerated form. We feel obliged, therefore, to consider *Felis spelæa* as a large variety only of the *Felis leo,* that differs far more than the latter from the tiger (*Felis tigris*). The fact of the tiger now having an extended northern range round the sea of Aral, the district of the Altai, and in Northern Tartary, and of its living with some of the Pleistocene species that have survived in those areas has inclined some naturalists, among whom is the late Dr. Falconer and M. Lartet,[1] to consider it identical with *F. spelæa.* Up to the present time there is no evidence that the tiger has ever existed in Britain, or, indeed, in Europe, the fossil remains upon which the European range of the species in Pleistocene times is based bearing, without exception, leonine, and not tigrine characteristics.[2]

A convenient method of classing the remains of the fossil lion is to consider the larger

inventory of half my collection, comprising *all* the genera and their species, *including the Cultridens* (= *Machairodus latidens,* Owen); there were hoards, but I must specify jaws of the elephant, and tusks, with the teeth in the sockets, the bone of which was so bruised that it fell to powder in our endeavour to extract it, a rare instance of the teeth occurring in jaws or gums. The same may be observed of the jaws of the rhinoceros, one portion alone of which was saved, but the teeth of both were numerous and entire. The jaws of the elk (*Megaceros Hibernicus*), horse, and hyæna, were taken out whole. The teeth of the last two were gathered in thousands, and in the midst of all were myriads of rodentia. The earth, as may be expected, was saturated with animal matter; it was, to use the expressive words of my fellow-labourer Walsh, fat with the sinews and marrow of more wild beasts than would have peopled all the menageries in the world."

[1] 'Cavernes du Périgord,' p. 21. Dr. Falconer's opinion, that the tiger of Northern Asia had no community of origin with, or, in other words, differs specifically from, the tiger of Bengal, is by no means confirmed by the description of one killed on the shore of the Sea of Aral, by Commander Bukatoff ('Journ. Geograph. Soc.,' 23rd vol., p. 95).—"A real royal tiger of a beautiful orange colour, with broad black stripes, uncommonly fat, and six feet four inches long from the nose to the beginning of the tail."

[2] The naturalists who consider the lion of Barbary, Senegal, Persia, and India to belong to distinct species, will also consider *F. spelæa,* as specifically distinct from all the living species.

remains, which, besides their size, present also the characters of lion in an exaggerated form as belonging to variety α, *Felis spelæa,* while the smaller ones, that exhibit no differences as compared with those of the existing lion, constitute the second variety—var. β, *Felis leo.*

Species *Felis antiqua,*[1] Cuvier.—The remains of *Felis antiqua,* first discovered by Cuvier in the bone-breccia, at Nice, in association with remains of the horse and cave-lion have been determined by us[2] in two localities in the Mendip Hills. One canine tooth in the collection of the Earl of Enniskillen, F.R.S., came from Banwell, and two canines and molar teeth in the Taunton Museum were obtained by the late Rev. D. Williams from the cavern either of Sandford Hill or Hutton. We believe also, from drawings shown us by Colonel Wood, that its remains occur also in the cave of Spritsail Tor, in Gower. In Germany the species occurs in the great cave of Gailenreuth; in Belgium, in the caverns of Liège, so ably explored by Dr. Schmerling; and in France it appears to have been described under several names by various authors. In 1864 it was found at Gibraltar by Dr. Falconer and Mr. Busk, by the former of whom it has been identified with the panther, *Felis pardus* of Linnæus.

Species *Felis catus ferus,* Linn.—The remains from Kent's Hole and the Mendip caverns indicate a species slightly larger than the wild cat, that is becoming extinct so fast at the present moment in Britain. The brickearths of Ilford also have furnished a lower jaw, which is figured by Professor Owen, and is in the collection of Mr. Wickham Flower, to whose courtesy we are indebted for its examination.

Genus *Hyæna.* Species *H. spelæa,* Goldfuss.—The Spelæan hyæna, so abundant in the caverns of France and Germany, we consider to be a variety merely of the *H. crocuta* or spotted hyena of South Africa.[3] Full evidence for this view will be given in the monograph upon the genus. Its remains, as we would expect from its habits, are abundant in the caverns, and comparatively rare in the river-deposits. Maidstone, Grays Thurrock, Lawford, Walton, and Fisherton, may be cited as the places where it occurs in river deposits. It exhibits considerable variation in respect to the talon of the lower sectorial molar, which MM. Croizet and Jobert, M. de Serres, Dubrueil, and Jean-Jean consider of specific importance. The two marked varieties in Britain are var. α, *H. intermedia* of M. de Serres, and var. β, *H. Perrieri* of MM. Croizet and Jobert. They are, in our opinion, mere varieties, as in a large series that has passed through our hands a gradation is evident from the typical to the more unusual forms.

Genus *Canis.* Species *C. lupus,* Linn., *C. vulpes,* Linn.—The wolf (*C. lupus*) and the fox (*C. vulpes*) are indistinguishable from those that are now living in Europe. Their remains are found both in caverns and river-deposits.

Genus *Gulo.* Species *Gulo luscus,* Linn.—The wolverine or glutton (*Gulo luscus*),

[1] 'Oss. Foss.,' 4to, 1825, vol. iv, p. 188, pl. xv, fig. 12.
[2] See Ayshford Sanford, 'Brit. Assoc. Rep.,' 1864.
[3] See Boyd Dawkins "On the Dentition of *Hyæna spelæa,*" 'Nat. Hist. Rev.,' 1865.

the great pest of the fur-hunters of North America and Siberia, has left traces of its presence in Britain in Banwell and Bleadon caverns, and also in a cavern at Gower. It is very abundant in the Pleistocene caverns of Liège, and occurs also in the famous Bear's Den at Gailenreuth.

Genus *Mustela.* Species *Mustela erminea,* Linn.—The identification of the ermine or stoat as a British Pleistocene mammal we owe to our great palæontologist, Professor Owen.[1] It has been discovered by Mr. Bartlett in the cave at Berry Head, near Plymouth, and by Mr. MacEnery in Kent's Hole.

Species *Mustela putorius,* Linn.—The skull of the fossil polecat, obtained, like that of the preceding species, from Berry Head, and figured by Professor Owen,[2] is identical with that of the living *Mustela putorius.* Dr. Schmerling has proved the existence of this species in the caverns of Liège.

Species *Mustela martes,* Linn.—In the Williams' collection from the Mendip Caverns is a skull and lower jaw imbedded in breccia which we can by no means differentiate from the marten-cat that is now rapidly becoming extinct in Britain.

No species of this genus has up to this time been found in a river-deposit.

Genus *Lutra.* Species *Lutra vulgaris,* Erxl.—From the aquatic habits of the otter we should naturally expect to find few traces of its presence in the bone-caves, many in the river-deposits. Yet but three cases have come to our knowledge of its occurrence in association with the extinct mammalia—the one in Kent's Hole Cavern, and the second in the brick-earths of Grays Thurrock, in Essex, the third from Banwell, and is preserved in the Taunton Museum. The specimens figured and described by Professor Owen are derived from the Prehistoric marls that underlie the peat of Cambridgeshire.

Genus *Meles.* Species *Meles taxus,* Linn.—No trace of the badger (*Meles taxus*) has been afforded by Pleistocene river-deposits. The caverns of Banwell, Kent's Hole, Berry Head, and Wookey Hole, have furnished ample proof of its presence among the Pleistocene cave-fauna, where, however, it does not seem to have been abundant. In the caverns of Prehistoric age, on the other hand, the occurrence of its remains is the rule rather than the exception. It is indistinguishable in species from that which abounds at the present day in the limestone caves of Somersetshire.

Genus *Ursus.* Species *Ursus spelæus,* Goldfuss.—The remains of the fossil bears have been a fruitful source of dispute among naturalists since the days of Goldfuss. Their variations are so great and marked that to the person who has confined himself to the study of those derived from some one locality there is not the slightest difficulty in dividing them into species, while, on the other hand, those who have compared the French, German, and British specimens gradually realise the fact that the fossil remains of the bears form a graduated series in which all the variations that at first sight appear specific vanish away. In the very large number of bears' skulls from our own caves and those of France

[1] Op. cit. [2] Op. cit.

and Germany that we have examined there are hardly two that are alike. The frontal development, the muscular ridges, the zygomata, the size and even the form of the last upper true molar, present us with points of difference that, perhaps, may be the result of different food, locality, and sex. In the lower jaw, also, the relation of the angle to the coronoid process, the length of the diastema between the canine and premolar 3, the absence or presence of the small monofanged premolars 1, 2, or 3, afford materials for the manufacture of species or varieties according to the views of the naturalist as to their value in classification. Thus, the eminent French palæontologist, M. de Blainville, considers these differences of no specific value, and believes that the specific determination of *U. spelæus* from *U. ferox* and *U. Arctos* to be by no means clearly proved. Professor Owen, on the other hand, considers the spelæan bear to differ in species from both *Ursus ferox* and *U. Arctos*, and endorses the validity of Goldfuss's second species from Gailenreuth—*U. priscus*. Dr. Schmerling divides the remains of the bears he obtained from the caverns of Liège into five species—*U. giganteus* Schm. *U. Leodiensis*, Schm., *U. Arctoideus*, Gold., *U. priscus*, Gold.; *U. spelæus*, Gold. To this list of fossil species Marcel de Serres adds *U. Pitorii*, and Mr. Denny, of Leeds, *U. planifrons*. The whole of these, with the exception of *U. priscus*, are probably varieties of *U. spelæus*, dependent upon locality, food, and sex.

In the remains ascribed by Dr. Carte to the Polar bear (*U. maritimus*)[1] from Lough Gur, in Limerick, we can see nothing to differentiate the animal to which they belonged from the spelæan bear. The proportions of the long bones and the position of the third trochanter on the inner side of the femur are points of difference between these remains and the recent Polar bear.

The *Ursus planifrons*[2] of Mr. Denny, A.L.S., is probably a variety of *Ursus spelæus* with small frontal sinuses.

Species *Ursus Arctos*, Linn.—The second group of fossil remains may be considered to belong to *Ursus Arctos*, the living European bear. It is differentiated from the *U. spelæus* by the persistence of the small monofanged premolar one immediately behind the canine, and many other points to be discussed in the article on the Ursidæ. It occurs in Wookey Hole, Oreston, Durdham Down, Hutton, Llandebie, Kent's Hole, and several Welsh caverns, and in the deposits of the Thames Valley at Grays Thurrock, in Essex, and Crayford, in Kent.

The *Ursus priscus* of Dr. Goldfuss is probably a variety of this species.

In conclusion, we are obliged to acknowledge that the evidence afforded by the remains of the fossil bears is most conflicting, and that we consider it by no means impossible that at some future time the interval between the *U. spelæus* on the one hand and *U. Arctos* on the other may be bridged over, and both turn out to be, as M. de Blainville has suggested,

[1] 'Journal of Royal Dublin Society,' 1863.

[2] 'Geol. and Polytechnic Soc. of Yorkshire,' 1864.

the extremes of a series; but at present it is safer to consider them two closely allied species than as varieties of one and the same,

§ 9, D. INSECTIVORA. Genus *Talpa*. Species *Talpa vulgaris*.—The remains of the common mole have been discovered in a raised beach near Plymouth, together with the skull of a polecat, and in the fluviatile clay at Bacton, whence also those of *Hyæna spelæa*, *Ursus spelæus*, *Elephas primigenius*, *Hippopotamus major*, and *Rhinoceros leptorhinus*, have been obtained.[1]

Genus *Sorex*. Species *Sorex moschatus*, Pallas = *Myogalea moschata*, Fischer.—The fluviatile or lacustrine deposit at Ostend, near Bacton, in Norfolk, has afforded the only remains of this the most gigantic of the shrews. In the absence of the means of comparing it with the recent skeleton, Professor Owen named and described it as an extinct species under the name of *Palæospalax magnus*.[2] In 1863 M. Lartet determined its true affinities, and considers it identical in species with the animal described by the eminent Russian zoologist, Dr. Pallas, under the name of *Sorex moschatus*, from the water-shed between the rivers Volga and Don, in Southern Russia.[3]

Species *Sorex vulgaris*, Linn.—The common shrew has been found in Kent's Hole. Its apparent rareness in the caverns is probably the result of its small size. Other remains of shrews from Bacton and Ostend, in Norfolk, are perhaps referable to *Sorex remifer* and *Sorex fodiens*, but "the dentition of the jaws is not in such a complete state as to allow of an unequivocal determination."

§ 9, E. RUMINANTIA.—Genus *Bos*. Subgenus *Bison*. Species *Bison priscus*, Owen.—Just as at the present day the bison wanders in vast herds over the lower grounds of the North American Continent, from north latitude 33° to 65°, so did the *Bison priscus* or great fossil bison in Pleistocene Europe and Asia north of the Himalayas. Its remains are most abundant in both the river-deposits and in the caves. The gravels of the Thames furnish most unequivocal proof of its presence in the numerous skulls and horncores that have been obtained from Grays Thurrock, Clacton, Ilford, Crayford, and Dartford. In Yorkshire and Scotland also it has been recognised, and in Somersetshire we have detected it in five out of eight ossiferous caverns of the period. It formed the prey of the hyenas of Wookey Hole, and fell into the "swallow-holes and fissures" by which Banwell, Bleadon, Uphill, and Sandford Hill caves were supplied with bones. The horncores present considerable variations in size—one from Sandford Hill measuring 26 inches in length, with a basal circumference of 16 inches, while a second from Banwell measures but 13·5 in length, with a basal circumference of 12·5 inches. The examination of a very large number of horncores and skulls of the fossil bison leads us to endorse Baron

[1] Prof. Owen, op. cit. [2] Op. cit.
[3] 'Revue Archéologique,' 1863.

Cuvier's opinion that the living and the fossil belong to the same species.[1] The smaller varieties are those to which Professor Owen applies the name of *Bison minor*.

Genus *Bos*. Species *Bos primigenius*, Bojanus.—Numerous horncores and skulls and other remains in various parts of Britain attest the former existence of the great Urus (*Bos primigenius*) in Britain during the Pleistocene period. It has been found in Scotland near Edinburgh, and in the gravels of the Avon and Thames, and in a large number of other localities.

Species *Bos longifrons*.[2]—A second species of true ox, the small short-horned *Bos longifrons*, has been described by Professor Owen from the river-deposits of Clacton and Walton, and Kensington, associated with the mammoth (*Elephas primigenius*), and from Bricklingham, in the valley of the Avon, along with *Bison priscus* and *Bos primigenius*. On the other hand, all the smaller Bovine remains of Pleistocene age that we have examined, are proved by the associated horncores to belong to the bison, and not to *Bos longifrons*, many bones of which, from their strong resemblance to those of the former, have been a frequent cause of error in the absence of horncores. We have already spoken of *Bos longifrons* as being probably a variety of *Bos taurus*, of which also *Bos primigenius* is probably a second and extreme variety. Professor Nilsson, of Lund,[3] considers the latter as the ancestor of the large-horned Flemish oxen, and Professor Owen thinks that in all

[1] Op. cit., t. iv, p. 140.

[2] It is a remarkable fact that out of all the localities in Europe where Pleistocene mammals occur those given in the "British Fossil Mammals" should alone furnish proofs of the coexistence with the extinct mammalia of an ox that subsequently was brought under the rule of man, and kept in great herds in France, Britain, and Switzerland, in Prehistoric and Historic times. With respect to the remains of *Bos longifrons* washed up along with *Elephas antiquus* and rhinoceros on the coast at Walton and Clacton; a parallel case at Selsea, on the Sussex sea-board, inclines me to hesitate in inferring their contemporaneity from the fact of their having been washed up together. While engaged in the Geological Survey of the latter district in 1863, I found that there were two deposits of widely different age, lying side by side at the mouth of Pagham Harbour; the one Preglacial, underlying the Boulder-clay, containing *Elephas antiquus* and the mammoth, the other estuarine, of comparatively recent formation, and containing *Bos longifrons*, and red deer. The latter is deposited on the same Eocene plateau as the former, the ancient estuary having worn away the Preglacial forest-bed, the Boulder-clay, and the Preglacial river-deposits. The remains from both these deposits, washed out by the waves, were precisely in the same mineralogical condition, and both were stained of the same dark colour, and had I not been able to trace the remains of *Bos longifrons* to the estuarine mud, where one hind and one fore extremity of the animal remained in *situ*, with every bone in place, I should have been compelled to believe that the *Bos longifrons* of Pagham coexisted with the *Elephas antiquus* of the forest-bed. May not the similar association of the remains on the shores of Walton and Clacton be accounted for in some such manner? While paying all possible deference to the views of our most eminent comparative anatomist upon the contemporaneity of *Bos longifrons* with the Preglacial mammalia, the evidence seems to be of such a nature as to leave the question of the existence of the animal in Pleistocene times entirely open. With reference to the other localities, where this species is alleged to occur, Kensington and Bricklingham, satisfactory evidence of its association with Pleistocene mammals seems to me to be wanting.—W. B. D.

[3] Tom. cit. (1849).

probability the small Scottish and Welsh cattle are descendants of the former. If these views be correct, and we accept, as we are bound to do, interbreeding as a test of species, then both the urus and the short-horn belong to the same species, because their descendants breed freely together. Since, however, there is a great and persistent contrast between the size and form of the two in Pleistocene and Postpleistocene times, not only in England but throughout Germany, France, and Switzerland, we think that in classification they more conveniently fall under the head of closely allied species than of varieties. The views, moreover, of their being the ancestors of our present varieties of cattle may possibly turn out to be false in after years.

The evidence for the existence of *Bos longifrons* in Pleistocene times appears to us to be of such a nature as not to warrant the insertion of the animal in the list of species.

Genus *Ovibos.* Species *Ovibos moschatus,* Blainv.—One of the more curious of the North American herbivores is the *Ovibos moschatus,* or musk-sheep, generally from its size called the musk-ox.[1] Its affinities, as M. Lartet[2] and M. de Blainville[3] have shown, are all with the *Ovidæ* and *Capridæ.* Its former existence in the West of England is proved by portions of two skulls found in the gravels of the Avon, near the Somerset and Wilts border. Messrs, Lubbock and Kingsley have also found it in the river-deposit near Maidenhead, on the banks of the Thames.[4] A fragment of a cranium and a portion of a pelvis of this animal have also been found at Green Street Green, in Kent, and are preserved in the British Museum. It has not as yet been found in any of the British bone-caves.

Genus *Capra.* Species *Capra hircus,* Gmelin.—The discovery of the skull, figured by Professor Owen, and lower jaw of *Capra hircus* on the Walton shore, is by no means conclusive of the contemporaneity of the genus with the extinct mammalia, the remains of which are washed up on the same shore. The case indeed, cited by Professor Owen, stands alone, no instance being on record of the occurrence of the genus in any of the numerous Pleistocene deposits on the Continent. The remains found by Mr. Brown, of Stanway, on the Walton coast, may have been washed up from some other and later formation, as in the instance cited in the note upon *Bos longifrons* of the association of remains on the Selsea shore. Further evidence is still required to prove that any of the *Ovidæ* or *Capridæ* coexisted with the mammoth, rhinoceros, and other Pleistocene mammalia.

Genus *Alces.* Species *Alces malchis,* Gray.—We have already mentioned the characteristic broad palmated antler of the true elk of Norway, or moose-deer of the Canadians, found in the neighbourhood of Newcastle, in our list of Prehistoric mammalia; the proof that the same species inhabited South Wales in Pleistocene times is furnished by the lower

[1] *Bubalus moschatus,* Owen. 'Quart. Geol. Journ.,' 1856.

[2] 'Comptes Rendus,' lviii, 26.

[3] 'Bull. Soc. Philom.,' 1816, p. 81.

[4] 'Quart. Geol. Journ.,' 1856.

jaw detected by M. Lartet among the remains from the cave of Llandebie, in the Oxford Museum.[1] It was associated with remains of *Ursus arctos.*

Genus *Megaceros.* Species *Megaceros hibernicus,* Owen.—More closely allied to the preceding than to any of the existing mammalia is the great extinct Irish elk—the most gigantic of the deer tribe, generally found not only in the caverns and gravels of the Pleistocene, but also in the lacustrine marls of the Prehistoric period.

Genus *Cervus.* Species *Cervus tarandus,* Linn.—On the borders of "the Barren Grounds" in North America, Sir John Richardson tells us "there are two varieties of reindeer, the larger inhabiting the woods and living upon grass as well as lichens, the smaller living entirely on lichens, and ranging into the extreme northern latitudes." In our caverns and river-deposits there are traces of reindeer, also of two sizes. The hyænas of Wookey Hole and of Kirkdale preyed upon both the larger and the smaller deer. The fossil antlers, like the recent, vary to such a degree in size and form, and in the position of the brow-antler, that scarcely any two can be found alike. They may however, roughly, be divided into two classes by their size. On the larger series is based the variety *C. Bucklandi,* of Professor Owen; on the smaller *C. Guettardi,* of Baron Cuvier. The antlers from Banwell are all of the large variety. The remains of reindeer are so incredibly numerous in some caverns that Colonel Wood obtained upwards of 1000 antlers in one cave in Pembrokeshire.

Species *Cervus elaphus,* Linn.—Two varieties of red deer, a large and a small, are found both in the caverns and in the river-deposits. Professor Owen terms the larger—from the large size of its antlers—*Strongyloceros spelæus.* It is probably the Pleistocene representative of the large variety of red deer (*Waipiti*), now ranging on both sides of the Rocky Mountains, from the Columbia River at least as far north as the Saskatchewan, from North latitude 45° to 55°. It is a very curious fact that in tracing the red deer (*C. elaphus*) from the Pleistocene times down to the present in Western Europe, there is, from some unknown cause, a diminution of the size of the antlers. Thus, those of the variety *Strongyloceros spelæus,* are vastly larger than those of the Prehistoric period, while the latter greatly surpass in size the red deer now living on the Scotch moors. That the large Prehistoric variety lived on in Britain into the times of history, is proved by its discovery near Worcester, in 1844, in association with the remains of *Bos longifrons*[2]—"fragments of Roman urns and pans of red earth, and a piece of Samian ware." A coin of Marcus Aurelius was also found that would bring the date of the whole deposit to some time posterior to the year A.D. 161. The increase of population, and the encroachment of the cultivated lands on the lower grounds, more favorable in climate and food for the support of the deer, by forcing them to take refuge in higher and inhospitable districts where the herbage is scanty, were the probable causes of this diminution in size.

[1] 'Revue Archéologique,' 1864.

[2] Brit. Foss. Mam. p. 475.

Species *Cervus capreolus*, Linn.—The presence of a small deer, undistinguishable from the roe (*C. capreolus*), among the Pleistocene mammals, is proved by five jaws, numerous teeth, and some antlers associated with *Elephas antiquus*, reindeer, red deer, bisons, and others, derived from Bleadon Cave, its antlers from that of Brixham, and other remains from the lacustrine deposit of Ostend, accompanied by *Elephas antiquus*.

Species *Cervus dicranios*, Nesti.—The Rev. S. W. King has called our attention to the Cervine remains obtained in the forest-bed of Cromer, and preserved in his splendid collection of Mammalia. Of these, one portion of skull with bases of antlers attached proves that the *Cervus dicranios* of the Italian Pliocenes is to be ranked among the British Pre-glacial Mammalia.

§ 9, F. Artio-dactyla.—Genus *Sus*. Species *Sus scrofa ferus*.—The wild boar (*Sus scrofa ferus*) has left traces of its presence in the West of England, in the caverns of Bleadon, Uphill, and Hutton. One of its small incisors and a molar was obtained also from Wookey Hole Hyæna-den. It occurs also in the river-gravels of Ilminster, as well as those of the Thames Valley at Ilford and Brentford.

Genus *Hippopotamus*.—Species *Hippopotamus major*, Owen. The remains of the hippopotamus have only been found in four bone-caverns in this country—in that at Durdham Down near Bristol, by Mr. Stutchbury, in association with *Elephas antiquus* and *Rhinoceros leptorhinus* and other remains; and in that of Kirkdale, along with the same two species of mammalia; in Kent's Hole cavern; and in the Ravenscliff cave in Gower. In the river-deposits, also, it is, contrary to what one might expect from its habits, comparatively rare. Its remains are found at Grays and Ilford associated with the tichorhine, leptorhine, and megarhine rhinoceroses; at Walton and Folkestone with *Elephas antiquus*; at Peckham with *E. antiquus* and *E. primigenius*; at Bedford with *E. antiquus*, the tichorhine rhinoceros, and the reindeer, and at Bacton with the leptorhine rhinoceros; and the mammoth. Brentford, Cromer, Burfield, Overton, Alconbury, and Cropthorne, are the principal localities in Britain, which up to the present day have yielded the remains of this member of a tropical group of mammals. Its occurrence so far north in association with the reindeer, bison, and other members of a northern fauna, has led Sir Charles Lyell, Bart., Mr. Prestwich, and other eminent authorities, to infer that it was defended from the cold by long hair and fur, similar to that which the discoveries in Siberia have made known on the mammoth and tichorhine rhinoceros. And this inference is probably true, because in existing nature we know of no animal that is exposed to a severe or even temperate climate without some protection against the cold. The difference between the dentition of *H. major* as compared with the closely allied species *H. amphibius* (Linn.) is very small. The former, however, is characterised by its larger size, by the shortness of its cranium, the posterior position of its orbits, the great elevation of the sagittal and occipital crests, and especially of the upper margin of the orbits above the plane of the brow.[1]

§ 9, G. PERISSO-DACTYLA. Genus *Equus*. Species *Equus fossilis*, Von Meyer.—The prairies of Pleistocene Europe must have been as plentifully stocked with the wild horse as those of America by the half-wild horses introduced by the early settlers. Nearly every Pleistocene bone-cavern in England has yielded their remains, and in the river-deposits their presence is the rule rather than the exception. In the forest-bed at Cromer, it is found associated with the remains of mammoth, hippopotamus, rhinoceros, and trogontherium. In Wookey Hole Hyæna-den, in conjunction with the tichorhine rhinoceros it formed the chief food of the hyænas.

Professor Owen considers that the solidungulate remains indicate the coexistence of three distinct species in Pleistocene Britain;—*Equus fossilis*, a species distinct from the living *E. caballus*, *Equus plicidens*, based on molar teeth from Oreston, and *Asinus fossilis* from Chatham, Oreston, Thorpe, and Kessingland. These last two may turn out to be varieties of *Equus fossilis*, and that species we can determine by no special mark except by the smaller transverse measurement of the teeth, from the living *Equus caballus*. It is possible that the smaller remains ascribed to *Asinus fossilis* may have belonged to the ass, but at least it is equally possible that they may have belonged to a small variety of horse.[2]

Genus *Rhinoceros*. The remains of the fossil rhinoceros have perhaps a wider range than those of any other fossil quadruped except *Machairodus* and *Elephas*. From the shores of Siberia in latitude 72°, southwards as far as the Sivalik Hills they are found in greater or less abundance, from east to west the genus ranges from the banks of the Lena to the Straits of Gibraltar. Its range in time is as great as its range in space—from the Miocene as far down as the later division of the Pleistocene, when the 'low-level' gravels and brick-earths of Mr. Prestwich were being deposited. The British Pleistocene species are four in number.

Species *Rhinoceros tichorhinus*, Cuv.—The tichorhine is the most widely spread and the best known of the British species of rhinoceros. Its remains are found from the Pyrenees and Alps, throughout France, Germany, and Russia, as far north as the shores

[1] Dr. Falconer's letter in Dr. Morton's paper, "On a new living species of Hippopotamus," etc., 'Journ. Acad. Nat. Sci.,' Philadelphia, vol. i, 2nd series.

[2] Cuvier comes to the same conclusion, after a careful study of the remains of horses: "La même resemblance paroît avoir eu lieu de l'espèce fossile aux espèces vivantes. J'ai choisi des os de cheval fossiles bien entiers, et que je savois certainement avoir été trouvés pêle-mêle avec des os d'éléphans, rhinocéros, ou d'hippotames, qui devoient donc être provenus de chevaux de cette ancien monde, ayant vécu avec tous ces grands pachydermes et j'en ai fait une comparaison soignée avec mes squelettes. Par example, une fémur de cette caverne de Breugues ou il y avoit des os de rhinocéros etoit parfaitement semblable, à un fémur de cheval de taille moyenne," etc., etc. Op. cit., tom. ii, pp. 111, 112.

of the great Arctic Sea. Cuvier also mentions it as having been found in Italy;[1] but his determination is, in our opinion, open to considerable doubt. In Britain, Professor Owen[2] describes its remains as occurring in the forest-bed of Cromer; and in the caverns and river-deposits its bones and teeth are very generally found. In Ireland no remains of any of the four species have as yet been determined, nor could we detect any trace of them in the Museums, on a journey for that express purpose. The species is characterised by the possession of two horns; an osseous septum between its nares, that *completely* divides the one from the other; by the presence of the *anterior combing-plate* in the permanent upper molar series and of *two costæ* on the anterior area of the lower,[3] by the stoutness of its bones and a very great many other points to be found in the essays of Professors Brandt,[4] Owen,[5] Mr. Dawkins,[6] and M. de Christol.[7] Defended from the cold by hair, and with a hide entirely without those hideous wrinkles that disfigure the living species, this animal ranged throughout the regions of the great Pleistocene continent north of a line passing through the Pyrennees eastwards through Switzerland to the northern end of the Caspian, thence along the watershed of the River Irtish through Lake Baikal as far as the Jablonoi and Stanovoi Mountains, and most probably up to Behring's Straits.

Species *Rhinoceros leptorhinus*, Owen.[8]—The remains of the non-tichorhine species of rhinoceros remained in the greatest confusion up to the year 1835. Baron Cuvier, so far back as the year 1812, had divided the non-tichorhine rhinoceros into three species, *R. leptorhinus*, *R. minutus*, and *R. incisivus*. The *R. leptorhinus*, with which alone we have to do, he based upon a skull found in the Pliocene of the Val d'Arno, of which he had a drawing sent him by Professor Cortesi, which he gives in the first edition of the "Ossemens Fossiles." In this drawing, the osseous septum between the nares was absent, and from its absence,[9] coupled with the slenderness of certain long bones found in the same deposit, and with different proportions of the skull as compared with the tichorhine species, he inferred the existence of a second species, *R. leptorhinus* or "*rhinocéros à narines non-cloisonnées.*" This determination was accepted without question by the scientific world until the year 1835, when M. de Christol proved that the very skull described as *à narines non-cloisonnées*[10] possessed the osseous septum between the nares, and that therefore Baron

1 Op. cit., tom. ii, p. 73, pl. ix, fig. 10.

2 Op. cit., p. 347.

3 'Nat. Hist. Rev.,' (1863) xii, p. 552.

4 "De Rhinocerotis Antiquitatis seu Tichorhini seu Pallasii structurâ." 'Trans. de St.-Pétersburg, vol. vii, pt. 2. 4to, 1849.

5 Op. cit., p. 325.

6 'Nat. Hist. Rev.,' 1863.

7 'Ann. de Sci. Nat.,' 2e série, t. 4, 1835.

8 Op. cit., 356.

9 Op. cit., tom. ii, pp. 71-2, pl. ix, fig. 7.

10 It is indeed very hard to reconcile the figure given by M. de Christol (op. cit., pl. ii, fig. 4) with an incidental remark of Dr. Falconer. In his masterly "Treatise on the Mastodon and Elephant," ('Quart.

Cuvier's definition of the species was wrong. In the year 1846, Professor Owen, on the discovery of a non-tichorhine skull and lower jaws at Clacton in Essex, inferred from the correspondence of the latter with those from the Val d'Arno described by Cuvier, that the rhinoceros of Clacton and that of Italy belonged to one and the same species. And as the skull found at the former place presented traces of a partial septum between the nares he proposed that Cuvier's definition of "*R. à narines non-cloisonnées*" should be altered into "*R. à narines demi-cloisonnées.*" Whether the lower jaws from Italy, by which Professor Owen connects his species with that of the great anatomist, belong to the leptorhine as defined by the latter or not may be an open question; but as the assemblage of remains of rhinoceros from Clacton has been truly and accurately defined by Professor Owen as belonging to *R. leptorhinus,* under which name they have been in the catalogues of British Fossils for the last 18 years, the specific name as imposed by Professor Owen ought to be maintained. The *Rhinoceros leptorhinus* then, or *R. à narines demi-cloisonnées* of Professor Owen,[1] the equivalent of *R. hemitœchus* of Dr. Falconer is the second species of fossil rhinoceros found in Britain. Like the tichorhine species it was bicorn; but probably from the partial ossification of the anterior continuation of the vomer, the anterior horn was much smaller than in the latter. The head and the bones were much more slender, the *anterior combing-plate* is invariably absent from the upper permanent molar series, and a very large number of other differences are observable which it is superfluous to mention here without the aid of figures. It occurs in the brick-earths and gravel-pits of the "lower terrace" of the Thames Valley at Clacton, Ilford, Crayford, and Peckham. It is one of the species that fell a prey to the hyænas of Kirkdale and Wookey Hole, and its teeth and skulls have been found in the ossiferous caverns of Gower and of Durdham Down near Clifton. Both upper and lower jaws associated with the *Hippopotamus major* and *Elephas antiquus* have been obtained from the river deposits at Lexden near Colchester.

Species *Rhinoceros megarhinus,* De Christol.[2]—Out of the confusion which the non-tichorhine continental species were involved, M. de Christol determined in 1835, one valid species, *Rhinoceros megarhinus,* so called from the large size of its nasals. In the type

Geol. Journ.,' 1865, p. 285) he says of a skull of *Elephas meridionalis,* "It was found at no great distance from the classic cranium of Monte Zago, upon which Cuvier founded his *Rhinoceros leptorhinus,* as an extinct species devoid of any bony partition between the nostrils. Both specimens are now preserved in the Natural History Museum of Milan, and, by the permission of Dr. Emilio Cornalia, I had an opportunity of examining them minutely .... The skull of the rhinoceros is exactly as Cuvier in the first instance, and Dr. Cornalia subsequently, described it, *i. e.,* without a trace of an external nasal septum."

[1] It is probably the same species as that described by Aymard, as *R. mesotropus* (Pictêt, Paléontologie, 1856, t. 1, p. 298); *R. leptorhinus* du Puy., by Gervaise, (Zool. et Pal. Fran., 1st edit. t. 1, p. 48); and as *R. Aymardi,* by Pomel. ('Cat. Méthod.,' p. 78, 1854.) Gervaise describes this fossil species as being ona "dont les narines sont séparées par une demi-cloison osseuse."

[2] Op. cit.

specimen from Montpellier the septum between the nares is absent. It is closely allied to the *R. leptorhinus* of Professor Owen, but differs materially in its larger size, and in a great many other points. Its existence in Britain was first satisfactorily determined by Mr. Boyd Dawkins,[1] in the spring of 1865. The remains belonging to this species have been obtained from three localities in the valley of the Thames, at Grays Thurrock, Crayford, and Ilford, and are preserved for the most part in the British Museum. In the cabinets also of Dr. Spurrell and Mr. Grantham are some upper molars from the south bank of the Thames near Crayford, in Kent; while in the beautiful collection of mammalia from Ilford, in Essex, on the north bank, made by Dr. Cotton, F.G.S., are two molar teeth. A single worn and mutilated tooth, obtained by Mr. Prestwich from the railway-cutting near Bedford, may possible belong to this species; but its condition renders a precise determination impossible. The Rev. J. Gunn, F.G.S., has a fine upper premolar of this species in his collection from the forest-bed of Norfolk, where, as in Italy, it is associated with *Elephas antiquus, E. meridionalis,* and *E. priscus.*

The occurrence of these Pliocene species, the remains of which in the marine sands of Montpellier were found in association with *Mastodon brevirostris,* and *Halitherium Serresii,* in the lower part of the Thames Valley, is a very curious and interesting fact, especially as at Grays Thurrock it is associated with the *Elephas priscus,* Falc., of the Pliocenes of the Val d'Arno. It may perhaps attach a higher antiquity to the Pleistocene river-deposits in which it is found than those from which it is absent.

Species *Rhinoceros etruscus,* Falc.—In the collections of the Rev. J. Gunn, F.G.S., and of the Rev. S. W. King, F.G.S., Dr. Falconer, identified also the remains of a second species of Pliocene rhinoceros derived from the Preglacial deposits on the Norfolk shore. It is a species found very abundantly in the deposits of the Val d'Arno, near Florence. The upper true molars from the latter place differ from those of the tichorhine rhinoceros in all points of difference presented by the megarhine and leptorhine species. In size and general form they are more closely allied to the latter of these two species. From both they differ in their small size, coupled with the lowness of the crowns of the upper molars and basal excavation of the *external lamina.* A second upper true molar in the cabinet of the Rev. J. Gunn, F.G.S., presents also a cusp at the valley-entrance.

§ 9, II. Proboscidea.—Genus *Elephas.*—The proper classification of the genus *Elephas* we owe to the cosmopolitan researches of the late Dr. Falconer, brought before the Geological Society of London in 1857, and published in the 'Quarterly Journal' for 1865.[2] Beginning with the mastodons he traces, in a most masterly way, the gradual passage through the various existing and extinct species into the *Elephas Indicus* and the

[1] 'Nat. Hist. Rev.' (1865), No. xix, p. 99.

[2] This short abstract of Dr. Falconer's papers, we give, merely that our readers may be in possession of the facts.

mammoth (*E. primigenius*). His classification is based upon that most important part of the digestive series—the dentition.

A. *Stegodon.*—The remarkable deposits in the Sivalik hills yield the first indication of a passage from mastodon into elephas in the presence of three species—*Elephas* (*Stegodon*) *bombifrons*, *insignis*, and *ganesa*. *E.* (*Stegodon*) *Clifii*, Falc., found by Mr. Crawford in Ava, constitutes the nearest approach to Mastodon in the limited number of ridges (six) of which its intermediate[1] teeth are composed. *E. bombifrons* and *E. insignis* present the next stage in departing from the mastodontic type in the presence of seven, eight, or even nine ridges in their intermediate molars. The Stegodons are differentiated from the mastodons by the number of ridges on the crown; by the convex outline of each unworn ridge, by the absence of the longitudinal line of division along the middle of the crown; by the valleys being filled with cement; by "the pronounced arc of a circle described by the molars as we trace them forwards in the jaw;" and by the inner side of the upper teeth and the outer side of the lower being the higher, besides many other less obvious points. A longitudinal and vertical section of the stegodon tooth showing "a series of chevron-shaped ridges, of which the height does not much exceed the base, and assimilating closely to the true mastodons," differentiates this group from the succeeding ones.

This group is confined to tropical Asia, and is now extinct.

B. The next stage in departing from the mastodons is shown by the species of the group *Loxodon*, that comprises the extinct *Elephas planifrons*, Falc., of the Sivalik Hills; *Elephas priscus*, Falc., and *E. meridionalis*, Nesti, of Europe; and the living *Elephas Africanus*. Its essential character "is that the ridges while closely corresponding" with the former group, "in regard of number, are considerably more elevated and compressed," showing, in a longitudinal and vertical section a series of elongated wedge-shaped processes of enamel, intermediate in thickness between *Stegodon* and *Euelephas*.

C. The third and last group, the most aberrant from the mastodontic type, is the group of the *Euelephas*, comprising the living Indian elephant (*E. Indicus*), and the extinct *E. antiquus*, Falc., and mammoth (*E. primigenius*), Blum., and some other species. It is characterised by the number and thinness of the ridges or lamellæ forming the crown, and the flattened ellipse afforded by their sections on its worn surface, by the small quill-shaped digitations that they present in the unworn tooth, and by the thinness and the minute folds on the enamel.

[1] *i. e.* The last milk molar and ante-penultimate and penultimate true molars. See Falc., 'Quarterly Journ. Geological Society' (1857), No. 52, p. 315.

Such is a brief summary of the results of Dr. Falconer's classification. Previous to this the elephants were divided into three species—*E. Indicus*, *E. Africanus*, and, lastly, the fossil species *E. primigenius*. Under the head of the latter all the remains of the fossil elephants were described by Baron Cuvier, M. de Blainville,[1] and Professor Owen, and considered to be merely varieties by MM. Gervais, Pictet, and other palæontologists.

The species of elephant that lived in Britain during the Pleistocene period are four in number—*Elephas* (*Loxodon*) *priscus*, Goldfuss; *E.* (*Loxodon*) *meridionalis*, Nesti; *E.* (*Euelephas*) *antiquus*, Falc., and *E.* (*Euelephas*) *primigenius*, Blum.

1. Species *Elephas* (*Loxodon*) *priscus*, Goldfuss.—The sections of the ridges on the worn surface of the crown present a lozenge-shaped outline and a mesial expansion. Teeth bearing this characteristic have been identified by Dr. Falconer from the Pleistocene brick-earths of Grays Thurrock, in Essex, and from an uncertain locality in the Thames Valley, and from the Norfolk coast, between Cromer and Lowestoft, near Happisburgh.[2] The latter was probably derived from the horizon of the Forest Bed. The species occurs in Italy in the Pliocene strata of the Romagna, and possibly in central France.

2. Species *Elephas* (*Loxodon*) *meridionalis*, Nesti.—This species of elephant, first of all named by Nesti, from the rich deposit in the Val d'Arno, and accurately defined by Dr. Falconer in the essay above cited, is characterised by the possession of the following ridge formula, exclusive of talons:—

Milk Molars.	True Molars.
$\dfrac{3 + 6 + 8}{3 + 6 + 8}$	$\dfrac{8 + (8 - 9) + 13}{8 + (8 - 9) + 13 - 15}$

The enamel composing the ridges or lamellæ of the teeth is thick and plaited, and the ridges themselves are very thick as compared with those of the group Euelephas, and present a mesial angular expansion. The crown is very wide and belongs to the eury-coronine, just as the preceding *E. priscus* belongs to the steneo-coronine, or narrow-crowned species of the group Loxodon. The tusks are *simply* curved, and the skull presents a large number of characters, that it would be out of place to mention here. The remains of *Elephas meridionalis* have been found only in the horizon of the Forest Bed at Bacton, Mundesley, and Happisburgh, in deposits of Pleistocene age. They occur also in the Norwich Beds and the Red Crag below them. The species is essentially a Pliocene one, that lingered on into the early part of the Pleistocene, where its range in Britain is restricted to the area of Norfolk and Suffolk, which it inhabited also in the Pliocene times.

1 Ostéographie, Article 'Elephas.'

2 'Quart. Geol. Journ.' (1865), lxxxii, p. 269, et seq.

3. Species *Elephas* (*Euelephas*) *antiquus*, Falconer.—The *Elephas antiquus*, like the preceding species found in vast numbers in the Val d'Arno deposits is characterised by the possession of narrow-crowned (steneo-coronine) molars. The enamel is crimped, and the ridges in the worn crown surface present a certain amount of mesial rhomboidal expansion. The tusks are nearly straight. Its remains are found both in the bone-caverns and in river-deposits. In the West of England the caverns of Bleadon and Durdham Down have furnished unequivocal proofs of its coexistence in the one with the cave-bear, cave-lion, and mammoth, in the other with the hippopotamus and leptorhine rhinoceros. In South Wales those of Gower yielded it in association with the reindeer, and the hippopotamus, and the same species of rhinoceros; and in Yorkshire, that of Kirkdale, with the three last species and the cave-hyæna, and the bison. Along the coast of Norfolk, southwards round the coast of Kent and Sussex, the detached molars are frequently dredged up, and between high and low water-mark on the Selsea shore the greater part of a skeleton was found in association with the stumps of trees that constitute the Forest Bed of the south coast. The skull, ribs, teeth, tusks, and gigantic leg bones are preserved in the Chichester Museum. It is found abundantly in the low-level deposits of the Thames Valley, as at Ilford, Brentford, Grays Thurrock, and Crayford. Clacton, Walton, Lexden, Ostend, Happisburgh, and Thorpe, have also afforded its remains. In the Bedford Gravels it is found associated with the tichorhine rhinoceros, the hippopotamus, and reindeer, and in those of Folkestone with the Irish elk, the red deer, and the bison.

4. Species *E.* (*Euelephas*) *primigenius*, Blum.—The mammoth is differentiated from the other fossil species of the genus by the possession of the same ridge-formula as the Indian elephant—

Milk Molars.	True Molars.
$\frac{4 + 8 + 12}{4 + 8 + 12}$	$\frac{12 + 16 + 24}{12 + 16 + (24 - 27)}$

exhibiting a progression by successive increments of four ridges. The tusks are curved spirally, in which point they contrast greatly with those of the preceding species. The enamel is very thin and uncrimped—a point of difference between the mammoth and the *E. Indicus*—and the ridges are very much compressed. This species is most abundantly found in all the British Pleistocene deposits from the Forest Bed of Norfolk upwards. In Wookey Hole Cavern it was associated with the leptorhine and tichorhine rhinoceroses, and in the Thames Valley with *E. antiquus*, and *Rhinoceros megarhinus*. It is one of the few Pleistocene species that have been found in Ireland. The animal must have lived in Britain in vast numbers, and for a long time, as its remains are so universally found. Its range was greater than any other fossil mammal—throughout Europe, north and east of the Pyrenees, through France, Germany, Russia, and Siberia (where its frozen carcase was found), across Behrings Straits into Russian America, and down southwards as far as the river Ohio, where its remains occur associated with the mastodon at "Big-bone Lick." In the College of Surgeons there are some very characteristic remains from this latter locality.

§ 9, 1. Glires.—Genus *Castor.* Species *Castor trogontherium,* Cuvier.—Jaws and numerous isolated teeth from the Forest Bed of Bacton and Mundesley, and the blue clay of Cromer, prove the former existence of the great extinct species of beaver first found by M. Fischer on the sandy borders of the Sea of Azof, at the beginning of the present century.[1]

Species *Castor Europæus,* Owen.—The existence of a species of beaver that cannot be differentiated with that now living in the Rhone and Danube, with the great extinct C. trogontherium, is proved by the occurrence of its remains in the same series of deposits at Mundesley, Happisburgh, and Thorpe, on the Norfolk coast. A ramus from Grays Thurrock, preserved in the British Museum, and the entire lower jaw from Ilford, in the cabinet of Dr. Cotton, F.G.S., prove also that it was a contemporary of the leptorhine, megarhine, and tichorine rhinoceroses, of *Elephas primigenus, E. antiquus* and *E. priscus.* In size the remains coincide exactly both with the recent beaver, and with that that is found so abundantly in and under peat-bogs. It has not yet been found in any of the British Pleistocene caverns.

Genus *Arvicola.* Species *Arvicola amphibia,* Desm.—That the large water mole of our streams lived at the same time as the great extinct carnivora, and pachyderms in Britain is proved by the occurrence of their remains, both in caverns and river-deposits. In Banwell Cavern it was associated with the great cave-bear, the reindeer, and the panther; in Kent's Hole, with machairodus; in Kirkdale, with hyæna; and in the river-deposits at Ilford, Crayford, and Erith, with bison, lion, and the tichorhine, leptorhine, and megarhine rhinoceroses.

Species *Arvicola pratensis.* The Bank Vole has been found in Kent's Hole, in precisely the same condition as the other Pleistocene remains obtained from that famous cavern.

Species *Arvicola agrestis.*—The third species of *Arvicola,* the Field Vole, has also been obtained from Kent's Hole, by the late Mr. MacEnery, and from the Hyæna-den at Kirkdale, by Dr. Buckland.

Genus *Mus.* Species *Mus musculus,* Pall.—From Kirkdale Cavern has been obtained the only evidence for the existence of the common mouse in the Pleistocene period. The remains though, as Professor Owen remarks, slightly larger than the existing mouse, in no other respect differ from that species.

Genus *Lepus.* Species *Lepus timidus,* Erxl.—The remains of the common hare have been discovered in the Mendip bone-caves, by the late Rev. D. Williams; in Kent's Hole,

[1] ('Cuvier,' tom. cit., vol. v, pt. i, p. 59.) The large size of the anterior molar, as compared with the rest, and the absence of involutions of enamel on the outer side of the molars, with many other points, differentiate the teeth of this species from the living *Castor fiber* of Europe and North America. Its remains are confined to the localities mentioned above.

by the Mr. MacEnery; and in Kirkdale, by Dr. Buckland, in association with the extinct and living species of Pleistocene mammalia.

2. Species *Lepus cuniculus*, Pall.—The rabbit also has been found in Kent's Hole, Kirkdale, and the Mendip Caverns, and, on the authority of Professor Owen, also in the cave at Berry Head.

Genus *Lemmus*, Link. Species (?).—The remains of two or three individuals of the genus *Lemmus*, Lemming, obtained by Dr. Blackmore, from the low-level gravels of Fisherton, near Salisbury, in association with the remains of the reindeer, tichorhine rhinoceros, mammoth, and spermophilus, proves this northern genus to have been represented in Britain during the Pleistocene period. Whether or no it be identical in species with the Norwegian Lemming *Lemmus Norwegicus*, Desmarest, or that of Greenland, *Mus Greenlandicus*, Trail, *Arvicola Greenlandica*, Richardson, or that of Hudson's Bay, or any of those described by Richardson in his great work 'Fauna Boreali-Americana,' or of those described by Pallas, in Siberia and Lapland, is entirely an open question, requiring more time for its solution than this Introduction would allow. It will be fully discussed in the body of the work.

Genus *Lagomys*. Species *Lagomys spelæus*, Owen.—We owe to Professor Owen the determination and description of the tail-less hare, discovered by Mr. MacEnery, in Kent's Hole, and figured in the beautiful unpublished plates by Sçharf, for a second volume of the 'Reliquiæ Diluvianæ,' of which the death of Buckland deprived the scientific world. Baron Cuvier had determined, with his usual sagacity, the occurrence of this northern genus of Rodent, in the ossiferous Breccia of Cette in Corsica and in Gibraltar; and he considered it to be closely allied to the *Lagomys Alpinus*, or larger species of tail-less hare described by Pallas. Professor Owen considers also that the Kent's Hole fossil is closely allied to the same species, but that it is slightly larger; and a comparison of pl. lxxxiv of the 'British Fossil Mammals,' with the figures of *Lagomys alpinus*, and *L. pusillus*, given in tab. iv, A, in the beautifully illustrated treatise on 'Novæ Species e Glirium ordine' of Dr. Pallas (4to, Erlangæ, 1778), proves the truth of his remarks. The genus at the present day is confined to the Himalayas, Siberia, and the high latitudes of North America. Richardson describes it as living in the Rocky Mountains. No species of it is found at the present day in Europe. A second instance of the occurrence of this species in Britain is afforded by Mr. Busk, F.R.S., who has identified among the remains from the Brixham Cave, those that can in no way be differentiated from the species found in Kent's Hole. Whether *Lagomys spelæus* be an extinct species or not is by no means satisfactorily determined; but in the absence of absolute evidence upon this point, we think it highly probable that it may turn out to belong to some one of the many species that live in the cold regions of the northern hemisphere.

Genus *Spermophilus*. Species *Spermophilus erythrogenoides*, Falc.—The identification of two lower jaws in the collection of mammalia from the Mendip Caverns, made by the late Rev. D. Williams, and now in the Taunton Museum, we owe to Dr. Falconer, who applied the specific name from their close resemblance to the *Spermophilus erythrogenys*, Brandt,[1] of Siberia.

Species *Spermophilus citillus*, Pall.—A third jaw in the same collection differing from the preceding in its greater stoutness, and in the greater outward extension of the process between the angle and condyle, is most closely allied to the pouched marmot, *Spermophilus citillus* found near the snow-line on the high mountains of central and northern Europe.

Remains of several individuals of this genus have been discovered by Dr. Blackmore also in the low-level gravels of Fisherton, near Salisbury. Unfortunately, from the very large number of the living species that must necessarily be examined before an accurate determination can be made, we have been unable to determine these in time for the Introduction, which we publish now in an imperfect state rather than keep back till the end of the work.

§ 10. If we now pass on to consider the relation which exists between the British Pleistocene mammalia and those now living on the earth, we shall find that the former fall into five distinct groups: the first comprehending all the extinct species; the second, those confined at the present day to northern climates; the third, those confined to southern; the fourth, those common to northern and tropical climates; and lastly, those still inhabiting the temperate zones of Europe.

§ 10, A. *Extinct species.*—Out of the fifty-three species, omitting *Bos longifrons*, which has not yet been proved to have inhabited Pleistocene Britain, but fourteen are no longer to be found on the face of the earth:

Machairodus latidens.	Elephas meridionalis.
Ursus spelæus.	Hippopotamus major.
Megaceros Hibernicus.	Rhinoceros tichorinus.
Cervus dicranios.	,, megarhinus.
Elephas antiquus.	,, leptorhinus.
,, primigenius.	,, Etruscus.
,, priscus,	Castor trogontherium.

And it is a fact well deserving of note that of these more than half had already begun to live in the preceding period. Thus, the Pliocenes of the Val d'Arno, near Florence, are characterised by the occurrence of *Machairodus*, *Elephas antiquus*, *E. meridionalis*, *E. priscus*, *Rhinoceros Etruscus*, *Hippopotamus major*, and *Cervus dicranios*, while the Pliocene strata of Montpellier have yielded the megarhine rhinoceros, which probably occurs also in the former locality. The *Castor trogontherium* may perhaps turn out also to have existed in Pliocene times; but at present we know nothing of the age of the sandy deposit

[1] 'Deux nouvelles especes de Sonsliks de Russie' (Spermophilus Eversmanni et Erythrogenys), Bull. Scient. Acad., St. Petersb., t. ix (1842), p. 43.

on the shores of the Sea of Aral, in which its remains were found. In Britain it is confined to the Preglacial formation of the east coast.

The only Pleistocene formations in Britain that have yielded the five Pliocene species, *Elephas priscus*, *E. meridionalis*, *R. Etruscus*, *R. megarhinus*, and *Cervus dicranios*, are the Preglacial deposits on the Norfolk and Suffolk coasts, and the river-gravels, and brick-earths of the lower part of the valley of the Thames. The precise geological age of the latter, as they are deposited along a line that roughly marks the southern limit of the Glacial Sea, the extension of which is marked by the Boulder-clay, is at present undetermined; but the Fauna they contain more closely resembles that of the Preglacial Forest Bed, and that of the Pliocenes of the south of France and of Italy than that contained in any Pleistocene deposit in Britain of Postglacial age.

Of all the Pliocene mammalia that lived on into Pleistocene time *Elephas antiquus* had the most extended range in Britain. To pass over the deposits in the valley of the Thames, and the Preglacial beds on the Norfolk and Suffolk coasts, where its remains are very abundant, it is found in Kirkdale Hyæna-den associated with *Hippopotamus major* and the leptorhine rhinoceros of Professor Owen; at Selsea with the mammoth and horse; in the Gower Caverns with reindeer and leptorhine rhinoceros; in Bleadon Cavern with wild boar, cave-lion, cave-hyæna, wolverine, bison, and roebuck. A very large number of other localities might be cited in proof of its having coexisted with most of the mammalia found either in Pleistocene caverns or river-deposits. For these we must refer to the table of the range and association of the British Pleistocene mammalia that we have now in hand.

The leptorhine rhinoceros (Owen), is associated with the tichorine in Wookey Hole Hyæna-den, with the megarhine in the Thames Valley. Its presence in these localities, as also in the caverns in Gower,[1] at Kirkdale and Durdham Down prove that it also coexisted with the great majority of the Pleistocene mammalia. The characteristic fossil mammals of the British Pleistocene, omitting *Castor trogontherium* are *Rhinoceros leptorhinus*, Owen, *R. tichorhinus*, *Elephas primigenius*, and *Ursus spelæus*. *Megaceros Hibernicus* lived on into the Prehistoric period.

§ 10, B. *Species confined to northern climates.*—The second group of Pleistocene mammals now confined to the colder regions of the north, or to high altitudes in the northern hemisphere, where a low temperature obtains, consists of eight.

Gulo luscus.	Spermophilus citillus.
Cervus tarandus.	,, erythogenoides (Falc.).
Alces malchis.	Lagomys spelæus.
Ovibos moschatus.	Lemmus ?

The *Cervus Bucklandi* of Professor Owen, and the *C. Guettardi* of Baron Cuvier

[1] See 'Quart. Journal of Geol. Soc.,' vol. xvi, p. 487. 1860. 'Dr. Falconer's account of Col. Wood's collection.'

appear to be only varieties of *C. tarandus*, analogous to those now found in the high latitudes of Europe, Asia, and America. Previously[1] to the year 1671 it had disappeared from the south side of the Baltic, and now is rapidly retreating northwards along with the Fins at the approach of civilised man. In Asia, in Pennant's time (1780), on the authority of Dr. Pallas, it extended along the Urals to the foot of the Caucasus. In America its southern limit is the parallel of Quebec.

The musk-sheep, *Ovibos moschatus*, De Blainv., associated with the mammoth, tichorhine rhinoceros, horse and deer, in the gravels of the Avon, is now confined to the high northern latitudes of the American continent, where it ranges over the treeless barren grounds from the River Mackenzie, through 105 degrees of longitude, along with Esquimaux, reindeer, wolverines, bears, and various species of lemming, and spermophilus, and hare. Sir John Richardson places the Mackenzie River as its probable western limit, but Captain Beechey[2] found that the Esquimaux near Eschscholtz Bay knew the animal, so that in all probability it ranges through the district to the west of this. Its southern limit extends from the edge of the woods up to the highest northern latitudes, yet reached by our explorers, "from the entrance of the Welcome into Hudson's Bay, about the 60th parallel of latitude, in a westward and northward direction to the 66th parallel, at the north-east corner of Great Bear Lake, and from thence nearly in the same direction to Cape Bathurst in the 71st parallel."[3] Within the last century it had a further range to the south to latitude 59, the enterprising traveller Hearne having seen its tracks in the neighbourhood of Fort Churchill in the year 1770. As an associate of the mammoth it ranged over the "tundras" or treeless "barren grounds" of Asia, on the borders of the great Polar Sea. In tracing its remains from the locality in which it still lives, southwards and westwards, we find them in the frozen gravels and brick-earths of Eschscholtz Bay, along with mammoth, elk, reindeer, horse, and bison.[4] On crossing Behring's Straits into Asiatic Russia they are described by Ozeretzkousky as occurring at the mouth of the river Jana, between the rivers Lena and Indigirka, in longitude 135°, and latitude 65°; and by Pallas, as occurring still further to the west, in the great "tundra" or moss steppe between the Obi and the Lena. The discovery of the skull of *Ovibos moschatus* at the mouth of the river Obi, in longitude 70°, and within the Polar circle, brings the animal almost to the borders of Europe.[5] Then passing over the vast areas of Russia in Europe, and Germany, where there are no authentic accounts of

1 Zimmerman, 'Specimen Zoologiæ Geographiæ' (4to, Lugduni Batavorum, 1778, p. 285):—"Bartholino teste ('Acta Hasnens.,' 1671), Daniam *rangiferi* plene deseruerunt nec amplius ibidem ut olim proveniunt. Et Pontoppidanus ('Norweg.,' t. xi, p. 21), Reynardus que ('Œuvres de Reynard,' Paris, 1750, t. i), tentatas eorum educationes propagationesque secus ibi cecidisse omnesque periisse confirmant."

2 'Voyage to the Pacific' (4to, London, 1831), p. 324.

3 'Zool. of H.M.S. Herald,' 4to, 1854, p. 23.

4 See 'Zool. H.M.S. Herald,' and Appendix, by Dr. Buckland, in 'Beechey's Voyage to the Pacific.'

5 See Cuvier's 'Oss. Foss.,' vol. iv, p. 155, 1825.

its discovery, the next three localities in its southward and westward range, are Maidenhead, in Berkshire, whence Messrs. Lubbock and Kingsley obtained two heads, described by Professor Owen in 1856[1] under the name of *Bubalus moschatus*; the Avon, near Bath, whence Mr. Moore obtained also two skulls; and Green Street Green, in Kent. The discoveries of M. Lartet[2] extend its southward limit to the Department of Oise, the environs of Paris, and the banks of the Vezère. Thus, the range of the musk-sheep is as great, if not greater than that of the mammoth. The two running side by side throughout France, Germany, North Europe, and Asia, part company at Eschscholtz Bay; the former ranging eastward in a living state throughout the northern shores of the American continent; the latter being found in a fossil state through Oregon, as far south as the Zanesville, on the banks of the Ohio, and as far east as Rutland, in Vermont.[3]

The tail-less hare (*Lagomys spelæus*) of Kent's Hole and Brixham, found also by Baron Cuvier in a breccia at Gibraltar, is probably that described by Pallas as a living member of the Siberian Fauna, while the fossil lemming of Salisbury, and the elk or moose-deer of Llandebie are at present natives of the northern parts of Asia, America, and Europe, the province of the latter ending where that of the reindeer begins. The *Spermophilus*, or pouched marmot, of Salisbury and the Mendip Caves, is found throughout the high northern latitudes of Europe, Asia, and America; and it inhabits also the higher districts much to the south of these, where a low temperature prevails throughout the year, as the Alps, the Pyrennees, the Urals, and the Rocky Mountains. Pallas mentions[4] it also as inhabiting the water-shed of the Don and Volga, along with the *Sorex* (*Myogalea*) *moschatus*.

The glutton or wolverine (*Gulo luscus*), of Banwell, Bleadon, and Gower Caverns, ranges at the present day through the colder regions of North America, inhabiting alike the districts of the elk, the reindeer, and the musk-sheep, and extending as far north as Melville Island, in latitude 75°. According to Audubon[5] it occurs as far south as Jefferson County, in latitude 42°·46. It ranges also throughout the northern parts of Asia and Europe, living in the latter in northern Russia, Sweden, and Norway. Everywhere it is the great pest of the fur-hunters, destroying both their traps and their game, and tearing open their winter stores.

§ 10, c. *Species confined to southern climates.*—The third group of Pleistocene species now confined to hot climates, consists of two:

Felis spelæa, *var.* of F. leo.
Hyæna spelæa, *var.* of H. crocuta.

1 'Quart. Geol. Journ.,' 1856.

2 'Comptes Rendus,' lviii, 26.

3 Warren 'On the Mastodon,' p. 158, Boston, 1855.

4 Audubon, Richardson, Fischer, Brandt, Desmarest, Cuvier, and Pallas are the principal authorities upon which the geographical distribution of the northern group of mammalia is given.

5 'Quadrupeds of North America' (1847), 4to, p. 211.

The range of the first of these, *Felis leo*, has been considerably modified during the Historical Period. At the present day it is found, with but extremely slight variations, in the whole of Africa, with the exception of Egypt and the Cape Colony, from which areas it has probably been driven away by the hand of man. In Asia the maneless variety inhabits the valley of the Tigris and Euphrates, and the districts bordering on the Persian Gulph; and still lingers on in India, according to Mr. Blyth, in the Province of Kattywar, in Guzerat.[1] That, however, lions dwelt in Europe within the Historical times, is proved by the concurrent testimony of Herodotus,[2] Aristotle, Pausanias, and Ælian. The former mentions them as descending from the mountains in the night and attacking the baggage camels of Zerxes' army in their march through Pæonia; and he mentions that the mountainous district between the River Nessus, in Thrace, and the Achelöus, in Acarnania, was infested by a great number of lions. Aristotle confirms this statement of Herodotus, and adds that they were more numerous in Europe than in Asia or Africa, and also more powerful. In this latter respect the spelæan lion of Pleistocene Europe tallies exactly with his description of the lion of Thrace and Macedonia. Pausanias adds other details to the above account, and states that they were peculiarly abundant in the plains at the foot of Mount Olympus. There is, indeed, no geographical reason why, at a period still earlier than this, the species should not have inhabited Western Europe. On the whole, the sum of the evidence as to the relation between *F. spelæa* and the European lion of History, inclines us to believe that the latter was widely spread throughout France, Germany, and Britain in Pleistocene Europe, under the name of the former, and that probably it was gradually driven from Western into Southern Europe, and thence into Asia by the hand of man.[3] From the latter also it is gradually disappearing, having retreated from Asia Minor, Syria, and Palestine into Persia and India, which are the only countries in the Europæo-Asiatic continent where it is now found.

The remaining animal belonging to this section is the *Hyæna spelæa*, which a careful comparison leads us to consider as a variety of a living form—the spotted hyæna of South Africa. The present range of this animal presents a difficulty which is not felt in the case of the cave-lion, the latter being traceable in a living state into Europe, while the former is now confined to Southern Africa, and has never been found in the north of that vast continent. The *Hyæna spelæa*, on the other hand, of Pleistocene Europe, is very abundant in the caverns of France, Germany, and Britain. That, however, the spotted hyæna of the Cape is the living representative of the European Pleistocene species, which under

[1] 'Cat. Mam. Mus. Asiat. Soc., Beng.,' Calcutta, 1863.

[2] Herodotus 'Polymnia,' chap. cxxv, Ed. Wesseling; Aristotle 'Hist. Ann.,' chap. xxvii; Ælian 'Hist. Ann.,' lib. 17, chap. xxvi; Pausanias, on the authority of M. de Blainville.

[3] With reference to the lions of Greece, Zimmerman thinks this explanation improbable:—"Eos autem non auctis hominum catervis ad hauc discessionem perductos esse, ex eo patet, quod majori longe hominum multitudine Græcia Aristotelis ævo frequentata fuit quam quibus nunc temporibus ipsam sub Turcarum ditione immitique dominio cultam novimus."—'Specimen Zoologiæ Geographicæ,' 4to, p. 386.

conditions of existence, differing from those under which the former now lives, presents certain variations within the limits of the species, we hope satisfactorily to show in the Monograph upon Hyæna, to be published at a future day.

§ 10, D. *Species common to cold and tropical climates.*—One of the Pleistocene mammalia, the *Felis antiqua,* of Cuvier, or the fossil representative of the *F. pardus,* of Linnæus, has at the present day a most extended range throughout Africa, from Barbary to the Cape of Good Hope (Cuvier), and throughout Persia into Siberia. In this latter country M. Gotthelf Fischer[1] describes it as occurring in the Altai Mountains and in Soongoria, a tract of country also that is inhabited by tigers. The fox and the wolf are like instances of some of the living carnivora being able to endure almost every degree of temperature without being specifically modified by it.

§ 10, E. *Species still inhabiting the temperate zones of Europe.*—The fifth, and by far the largest, group of the Pleistocene mammalia embraces those still living in the temperate zones of Europe. It consists of twenty-eight species:

Homo.
Rhinolophus ferrum-equinum.
Vespertilio noctula.
Talpa vulgaris.
Felis catus ferus.
Canis lupus.
„ vulpes.
Mustela erminea.
„ putorius.
„ martes.
Lutra vulgaris.
Meles taxus.
Ursus Arctos.
Sorex vulgaris.
Sorex moschatus.
Bos primigenius (?).
Bison priscus.
Cervus elaphus.
„ capreolus.
Sus scrofa ferus.
Equus caballus.
Castor Europæus.
Arvicola amphibia.
„ agrestis.
„ pratensis.
Lepus timidus.
„ cuniculus.
Mus musculus.

The *Bison priscus,* or the aurochs of the Pleistocene, that spread over nearly the whole of the Pleistocene Europæo-Asiatic continent from the Pyrennees through France and Germany as far as Behrings Straits and Eschscholtz Bay on the American shore of the

[1] 'Zoognosia," iii, p. 221 (8vo, Mosquæ, 1814):—"Sic dictam unciam a Cl. Steven æstumatissimo nostri musei largitore accepi ex montibus Soongoricis et jugo Altaico, pantheram Africanam ex ditissima donatione Excell. Pauli de Demidoff obtinuimus. Hæc profundiore colore gaudebat, uncia vero albidiore, sed macularum nullam vidi differentiam. Individium vivum nunc apud Excell. Principem de Yussupoff conservatum ex Persia venit, etiam albidiore indutum est veste, et maculæ subannulares, in pedibus et cauda magis virgatæ sunt. Uncia itaque pelle albidiore, juniores pardos indicare videtur."—Cuvier (tom. cit., vol. iv, p. 428) endorses this determination.

Arctic Sea, now lingers in a Lithuanian Forest, protected by an imperial decree of the Czar of Russia. Its remains are found associated with those of the mammoth, in the frozen brick-earths and gravels of Eschscholtz Bay, throughout the Asiatic "tundras," the islands of New Siberia and the Lächow Group, and in the caverns and river-deposits of Northern and Western Europe. It is mentioned in a remarkable List of Graces[1] of the Abbey of St. Gall, written by Ekkehard the younger (who lived from A.D. 980 till 1036), as an article of food, together with the bear, the urus, the beaver (which they called a fish), the wild horse (*Equus feralis*), the marmot, and others. Mr. Wylie considers that the *Equus feralis* was the offspring of a domestic breed run wild like that of America; but when we consider the vast number of horses that have left their remains in association with those of bison in various Pleistocene deposits, and that at a far later date they formed the food of the tribes that lived in the pile-dwellings of the Swiss Lakes, and the hut-circles of Berkshire, the probability seems to us that reference is here made to a breed of horses as undoubtedly wild as the mouse-coloured wild horse of Central Asia.

The musk-shrew, *Sorex moschatus*,[2] of Pallas, described by Professor Owen from the Preglacial deposits of Bacton, under the name of *Palæospalax magnus*, is now found only in a

[1] The list of animals is so remarkable that we have subjoined the whole passage in which they are mentioned:

"Sit benedicta *fibri* caro *piscis* uoce salubri."—line 71

"Sub cruce diuina benedicta sit ista ferina.
Sub cruce diuina sapiat bene quæque ferina.
Et semel et rursus cruce sit medicabilis *ursus*.
Hunc medici sanum memorant nullique nocivum.
Dente timetur (petulcus) *aper*, cruce tactus sit minus asper.
Cerui (vel cerue) curracis caro sit benedictio pacis.
Hæc satan et Larvæ fugiant crustamina *ceruæ*.
Signet *uesontem* benedictio *cornipotentem*.
Dextra dei ueri (uel benedicat) comes assit carnibus *uri*.
Sit *bos siluanus* sub trino nomine (crucis hoc signamine) sanus.
Sit *feralis equi* caro dulcis in (sub) hac cruce Christi.
Imbellem *dammam* faciat benedictio summam.
Capreus ad saltum benedictus sit celer altum.
Sit cibus illæsus *capreæ*. Sit amabilis esus.
Capreoli (us) uescam dent (det) se comedentibus escam.
Carnes *uerbicum* nihil attulerint inimicum.
Pernix *cambissa*[3] (fera alpina) bona sit elixa vel assa.
Sub cruce diuina caro dulcis sit *leporina*
Alpinum *cassum*[4] faciat benedictio crassum.
Sit caro syluana crucis omnis robore sana."—'Benedict. ad Mensas' Ekkehardi Monachi Sangallensis (lines 117—136), 'Archæological Journal,' vol. xxi, pp. 355 and 358.

[2] Pallas, 'Zoographia,' vol. i, p. 128; 'Second Travels,' trans., vol. i, p. 48, London, 1802. Fischer ('Synopsis Mammalium,' 8vo, Stut., 1829, p. 250-1) gives the literature of the species.

[3] Chamois. [4] Marmot?

living state in Southern Russia, in the area between the Don and the Volga. An animal of aquatic habits, it is especially abundant on the banks of the Soura River, in latitude 55° north, and longitude 47° east, under a temperate continental climate, cold in winter but hot in summer. Dr. Pallas, in his 'Second Travels,' describes the country which it inhabits, after an unusually severe winter, as covered with tulips, saffron, and the Star of Bethlehem, and although *Spermophilus citillus*, the Alpine marmot, was in the neighbourhood, there were vineyards close by. The water-shrew of the Pyrennees, *Myogale Pyrennaica*, Geoffr., is a closely allied species, differing from the *Sorex moschatus* (*Myogale moschata*, Fischer), in its smaller size, and long and rounded tail.

An analysis, therefore, of the fifty-three Pleistocene species, those about which there is any doubt being omitted, gives

14	as extinct.
8	as confined to northern climates.
2	,, southern climates.
1	as common to temperate and hot climates.
28	as still inhabiting the temperate zones of Europe.
53	

§ 11. *Inferences as to Pleistocene climate.*—The proportion of fourteen extinct to thirty-nine living species proves that, in the geological sense, the present order of things is separated by a small interval from the Pleistocene; while, from the fact that twenty-eight species, or half, are still living in the same European area, we may infer that the conditions of existence, the climate and food, and the like were then very similar to those now obtaining in the area in which they live. That, however, some great physical change has taken place in Europe since the Pleistocene times, is proved by the presence of other groups of mammalia—those confined now to cold and to hot countries. They afford evidence that at first sight appears conflicting, but which upon analysis we shall find to be very conclusive, that the climate in Britain, in those days, was very much more severe than at present. From the conditions under which the surviving Pleistocene herbivores now live, we can infer those under which they lived in Britain in that early period. The northern group of Pleistocene mammalia, living only now in a severe continental climate, consists of species that have very different powers of resisting cold and heat. Thus, the musk-sheep is found now only under the lowest temperatures in the vast treeless "Barren Grounds" of North America, while the reindeer lives also in the forests, along with the elk, of the Europæo-Asiatic and North American continents. The red deer and the bison range up to the edge of the province inhabited by the latter animals. The lemmings live under a very severe climate, while the marmots are found in the higher and colder districts in Southern Europe and Central Asia. Each of these northern species is dependent upon the oscillation of the climate for its particular habitat in a given year, retreating northwards or southwards, according to the temperature that regulates the supply of food necessary for its existence. Thus, in North America, Sir John Franklin writes that the migrations of the animals afford a means of foretelling the severity of the season. If the reindeer retreat far south then a severe winter is to be apprehended; if, on the contrary, they remain very nearly in their usual winter haunts, the season invariably is a mild one. The reindeer of Northern Russia are equally dependent upon the season for their locality; and if an unusual season occurs, to put the animals off their accustomed route, the inhabitants of the district at the mouth of the Kolyma, living upon the chase, endure the severity of famine. M. Von Matiuskin, the Lieutenant of Admiral Von Wrangel, had the good fortune to see one of these migratory bodies of reindeer crossing a river, consisting of many thousands, divided into herds of two or three hundred each. By some such oscillation of temperature, which regulates the supply of food for the herbivores, the remains of the animals of two contiguous zoological provinces may be found together in one spot, as in the case of the northward retreat of the musk-sheep which, living in Hearne's time (A.D. 1770—72) near Fort Churchill, has left that district to be occupied now by the elk and the waipiti. In this manner the admixture of the remains of animals living at the present day, respectively, in a severe, and in a temperate continental climate, may be accounted for in the Pleistocene caverns and brick-earths. Of the district in America, where the animals inhabiting the high northern latitudes meet with those that live under a comparative temperate climate, Sir John Richardson writes:—"The subsoil north of latitude 50° is perpetually frozen, the thaw on the coast not penetrating above three feet, and at Great Bear Lake, in latitude 64°, not more than twenty inches. The frozen substratum does not of itself destroy vegetation, for forests flourish on the surface at a distance from the coast, and the brief, though warm summer, gives birth to a handsome flora, matures several pleasant fruits, and produces many carices and grasses."[1]

But in the vast plains of Siberia, extending from the Altai Mountains to the Arctic Sea, we find probably a nearer approach to the Pleistocene climate of Western Europe. Covered by impenetrable forests, for the most part of birch, poplar, larch, and pines, and low creeping dwarf cedars, they present every gradation in climate from the temperate to that in which the cold is too severe to admit of the growth of trees, which decrease in size as the traveller advances northwards, and are replaced by the grey mosses and lichens that cover the low marshy "tundras." The maximum winter cold, registered by Admiral Von Wrangel,[2] at Nishne Kolymsk, on the banks of the Kolyma, is $-65°$ in January. "Then breathing becomes difficult; the wild reindeer, that citizen of the Polar region, withdraws to the deepest thicket of the forest, and stands there motionless as if deprived of life;" and trees burst asunder from the intensity of the cold. Throughout this area roam elks, black bears, foxes, sables, and wolves, that afford subsistance to the Jakutian

[1] Back's 'Journey to the Arctic Sea,' 4to, 1836, appendix, p. 479.

[2] Op. cit.

and Tungusian fur-hunters. In the northern part countless herds of reindeer, elks, foxes, and wolverines make up for the poverty of vegetation by the rich abundance of animal life. "Enormous flights of swans, geese, and ducks arrive in the spring, and seek deserts where they may moult and build their nests in safety. Ptarmigan run in troops amongst the bushes; little snipes are busy along the brooks, and in the morasses; the social crows seek the neighbourhood of new habitations; and when the sun shines in spring one may even sometimes hear the cheerful note of the finch, and in autumn that of the thrush." Throughout this region of woods a hardy, middle-sized breed of horses lives under the mastership and care of man, and is eminently adapted to bear the severity of the climate. Like the other northern quadrupeds they change their coats *in the midst of summer*. "They perform most laborious journeys, often of three months' duration, with no other food than the half-withered grass, which they get at by scraping away the snow with their hoofs, and yet they are always in good condition." The only limit to their northern range is the difficulty of obtaining food. The severity of the winter, through the southern portion of this vast wooded area is almost compensated for by the summer heat and its marvellous effect on vegetation.

The hypothesis of a series of conditions obtaining in Pleistocene Western Europe similar to those now found in this portion of Northern Asia, will alone satisfy the evidence afforded by the fauna, and the deposits in which they are found. The contortion of the gravels, and the angular state of the pebbles of which they are often composed, are, as Mr. Prestwich infers, explicable only on the theory of ice having been formed in our rivers in far larger quantities than at the present day; the one being the result of the grounding of miniature bergs, the other of their melting away and depositing their burden of pebbles. The large plateaux of brick-earths are probably the deposit of the floods caused by the sudden melting of the winter snow, similar to that which Admiral Von Wrangel describes in Northern Siberia, and Sir John Franklin in the area north of the Canadian Lakes. The winter cold would be sufficiently intense to allow of the northern group of mammalia living in the winter, and even the musk-sheep (of which the remains are rare) might have been obliged to leave the Pleistocene "tundras," and take shelter in the zone of the elk and even the bison, in an unusually severe season. On the other hand, in the summer, the animals that are now found in the temperate zones of Europe might advance even into the country of the elk and the reindeer; and even carnivora now confined to hot climates find their way into the temperate zone of the day. Thus, the *Hyæna vulgaris*, or common living hyæna, is found fossil in the South of France, without penetrating as far north as Britain, France, or Germany.

In fine, the evidence afforded both by the fauna and deposits of the Pleistocene seems to us to prove that the climate in Pleistocene Britain was more severe than it is now; that at a time when Britain formed a portion of the Europæo-Asiatic continent, it more closely resembled that now obtaining in the fur-countries of Northern Asia than elsewhere; and lastly, that it was subject to oscillations by which the migrations of the herbivores were directed northward or southward, as the case may have been.

The remarkable evidence afforded by the thick woolly covering on the carcases of the mammoth and tichorhine rhinoceros of Siberia, as to the temperature of the countries in which they lived, makes it very probable that the *Hippopotamus major* was in like manner defended from the cold; but at the same time we must bear in mind that the aquatic habits of the genus are incompatible with the severity of a climate suited to the reindeer; that it has not been found in Russia, nor in any of the vast deposits in the high northern latitudes; and that therefore it is rather to be put into the same category with the bison of North America, rather than the reindeer, as an occasional visitant rather than a dweller throughout the year in England, France, and Germany. Its remains are very rare, as compared with the other herbivores, the fossil elephants, rhinoceroses, Irish elks, bisons, reindeer, and the like. Its head-quarters probably were on the shores of the Mediterranean, and the north of Africa, from which latter locality M. Gervaise[1] cites it as occurring in a fossil state near Constantine, in Algeria. In the caverns on the European shores its remains are extremely abundant, as also in the Italian Pliocenes.[2]

There is another interesting point connected with climate. How it may be asked, can you reconcile the presence of the spelæan hyæna and the lion with the climate which the reindeer and the musk-sheep required for their existence? Is not the very fact of their coexistence with the reindeer a proof of their specific distinctness from the African or Asiatic lion, or the hyæna of the Cape? If they are identical in species must not the Pleistocene climate have been similar to that of the countries in which they now live? An appeal to the zoological distribution of the carnivora over wide areas, proves that it is not so. While the herbivora are dependant upon the temperature for the vegetation on which

[1] Tom. cit., p. 363.

[2] The occurrence of hippopotamus may be accounted for in a somewhat different manner. While we may be almost certain that the general climate of Britain, during the Postglacial epoch, has been more severe or, properly speaking, more extreme or continental than at present, a period or periods of some length may have intervened, while England and Ireland formed a portion of the European continent, when the climate may have been less severe, and the rivers free from ice throughout the year. This view of the case is strengthened by the fact that the fossil hippopotamus is frequently, if not generally, accompanied by forms of elephant and rhinoceros *i. e. Elephas antiquus* and *Rhinoceros leptorhinus*, which appear both in this hemisphere, and as far as *E. antiquus* is concerned, in America also, to have had a southern, and even a tropical, rather than a northern range. Among other facts which must be accounted for is the existence of a Lusitanian flora on the west coast of Ireland. This flora, or some member of it at least, with difficulty maintain their ground at the sea-level, and must have been exterminated by the severity of the glacial epoch; and we cannot suppose but that their migration from a southern land has occurred since, and that along a coast-line. It is true that Professor Forbes assigned the Miocene period as that of this migration, but he appears to have overlooked the great severity of the intervening glacial climate.

On these points compare, Forbes's "Flora and fauna of the British Isles," 'Mem. Geol. Survey,' vol. i, p. 336 et seq.; Trimmer, 'Quart. Journ. of Geol. Soc.,' vol ix, p. 13, 1853; Lyell, 'Ant. of Man,' ed. 1863, pp. 273 et 320; Croll, 'Nat. Hist. Review,' No. xx, p. 594; and authors quoted by them.—W. A. S.

they feed, and are restricted in range to those districts where the food most fitted for them is to be found; the only limit of the range of the carnivora is to be found in that of the animals upon which they prey.[1] Thus, the tiger preys upon buffaloes, deer, and the herbivores peculiar to each district, throughout the length and breadth of India. On the shores of the Sea of Aral it is the scourge of the horses of the nomad Tartars, and in the district of the Altai it preys upon the wild boars, and further north upon the reindeer; and yet specifically it is the same, the markings on the skin of that of the Aral being of the same character as that of India.[2] The fox is another example of the same kind, ranging throughout the old and new worlds, and yet not divisible into species. The wolf, also, and the panther, already quoted, are instances of the same kind. The fact, therefore, of the spelæan lion and hyæna having lived in a climate in the Pleistocene far differing from that in which they now live cannot be quoted in favour of the recent and the fossil belonging to distinct species. The remains of *Hyæna spelæa* are found in vast numbers in Britain, France, and Germany; those of *F. spelæa* being more sparingly found; and those of wolverine being abundant in the caverns of Liège and Gailenreuth, and absent from France, and met with but in three caves in Britain. Neither of the two former species have, as yet, been discovered in Russia or in the high northern latitudes of Europe and Asia, where there are such vast stores of fossil remains.

§ 12. *Relation of Pleistocene to Prehistoric mammals, and those now living in Britain.*—The following table of British genera and species of land mammalia, from the Pleistocene downwards to the present day, shows at a glance the close relation existing between them; and it shows, moreover, by the gradual elimination of the Arctic group of mammalia, that the increase in temperature from the Pleistocene to the present day has been gradual:

Genera.	Pleistocene species.	Prehistoric species.	Species now living in Britain.
Castor, *Lin.*	fiber, *Lin.* trogontherium, *Fisch.*	fiber, *Lin.*	
Mus, *Lin.*	musculus, *Lin.*	musculus, *Lin.*	musculus, *Lin.* messorius, *Sh.* sylvaticus, *Lin.* rattus, *Lin.* decumanus, *Pall.*
Arvicola, *Lac.* = Hypudæus, *Ill.*	amphibia, *Desm.* agrestis, *Flem.* pratensis, *Bell.*	amphibia, *Desm.* agrestis, *Flem.* pratensis, *Bell.*	amphibia, *Desm.* agrestis, *Flem.* pratensis, *Bell.*
Spermophilus, *Fred. Cuv.*	citillus, *Pall.* erythrogenoides, *Falc.*		
Sciurus, *Lin.*			vulgaris, *Lin.*
Myoxus, *Zimm.*			avellanarius, *Desm.*

[1] See M. de Serres, "Sur l'Origine des Animaux et des Végétaux," 'Revue du Midi,' tom. ix, v livraison.

[2] See preceding note on *Felis spelæa*.

Genera.	Pleistocene species.	Prehistoric species.	Species now living in Britain.
Lagomys, *Geoffr.*	spelæus, *Owen.*		
Lepus, *Lin.*	timidus, *Erxl.*	timidus, *Erxl.*	timidus, *Erxl.*
	cuniculus, *Pall.*	cuniculus, *Pall.*	cuniculus, *Pall.*
			variabilis, *Pall.*
Lemmus, *Link.*	lemmus, *Link.*		
Elephas, *Lin.*	primigenius, *Blum.*		
	antiquus, *Falc.*		
	priscus, *Gold.*		
	meridionalis, *Nesti.*		
Rhinoceros, *Lin.*	tichorhinus, *Cuv.*		
	leptorhinus, *Owen.*		
	megarhinus, *Chris.*		
	Etruscus, *Falc.*		
Equus, *Lin.*	fossilis, *Owen.*	caballus, *Lin.*	= caballus, *Lin.*
Sus, *Lin.*	scrofa, *Lin.*	scrofa, *Lin.*	scrofa, *Lin.*
Hippopotamus, *Lin.*	major, *Desm.*		
Bison, *Gesn.*	priscus, *Owen.*	?	
Bos, *Lin.*	primigenius, *Boj.*	= Urus, *Cæs.*	= ? taurus, *Lin.*
		longifrons, *Owen.*	= ? taurus, *Lin.*
Ovibos, *Blain.*	moschatus, *Desm.*		
Capra, *Lin.*		hircus, *Gm.*	hircus, *Gm.*
		ægagrus, *Gm.*	ægagrus, *Gm.*
Ovis, *Lin.*		aries, *Lin.*	aries, *Lin.*
Cervus, *Lin.*	elaphus, *Lin.*	elaphus, *Lin.*	elaphus, *Lin.*
	capreolus, *Lin.*	capreolus, *Lin.*	capreolus, *Lin.*
	tarandus, *Lin.*	tarandus, *Lin.*	
	dicranios, *Nesti.*		
			dama, *Lin.*
Alces, (*Cæs.*), *Lin.*	malchis, *Gray.*	malchis, *Gray.*	
Megaceros, *Hart.*	Hibernicus, *Owen.*	Hibernicus, *Owen.*	
Machairodus, *Kaup.*	latidens, *Owen.*		
Felis, *Lin.*	spelæa, *Gold.*		
	antiqua, *Cuv.*		
	catus, *Lin.*	catus, *Lin.*	catus, *Lin.*
Hyæna, *Briss.*	spelæa *Gold.*		
Canis, *Lin.*	lupus, *Lin.*	lupus, *Lin.*	
	vulpes, *Lin.*	vulpes, *Lin.*	vulpes, *Lin.*
		familiaris, *Lin.*	familiaris, *Lin.*
Lutra, *Erxl.*	vulgaris *Erxl.*	vulgaris, *Erxl.*	vulgaris, *Erxl.*
Mustela, *Lin.*	martes, *Lin.*	martes, *Lin.*	martes, *Lin.*
	putorius, *Lin.*	putorius, *Lin.*	putorius, *Lin.*
	erminea, *Lin.*	erminea, *Lin.*	erminea, *Lin.*
			vulgaris, *Lin.*
Meles, *Lin.*	taxus, *Lin.*	taxus, *Lin.*	taxus, *Lin.*
Gulo, *Storr.*	luscus, *Sabine.*		
Ursus, *Lin.*	spelæus, *Gold.*		
	Arctos, *Lin.*	Arctos, *Lin.*	
Talpa, *Lin.*	Europæa, *Lin.*	Europæa, *Lin.*	Europæa, *Lin.*
Sorex, *Lin.*	vulgaris, *Lin.*	vulgaris, *Lin.*	vulgaris, *Lin.*
	moschatus, *Pall.*		
	? ?		fodiens, *Pall.*
	? ?		remifer, *Geoff.*
Vespertilio, *Lin.*			mystacinus, *Leisl.*
			Daubentonii, *Leisl.*

MONOGRAPH

ON

THE BRITISH MAMMALIA

OF THE

PLEISTOCENE PERIOD.

Order—CARNIVORA.

FAMILY—FELIDÆ.

Genus—FELIS.

Species—*Felis spelæa*, Goldfuss.

CHAPTER I.

Felis spelæa—Lower jaw, Pl. I, figs. 1, 2, 3; Pl. VI,[1] 1, 2.

A COMPARISON of the jaws of large Feles from the caves and river-deposits, one with the other, and with those of the existing species nearest them in size, shows us most distinctly that, while there are some fossil jaws which, in form and size, are absolutely indistinguishable from those of the lion, others, which are generally considerably superior to them in some of their dimensions, offer characteristics which appear to prove that they are so closely allied to those of that animal that the differences between them probably do not amount to more than extreme variety, while they essentially depart by the same characters from those of the tiger.

If a large series of lower jaws of recent lions and tigers be compared together we find that, while the individual differences are great, resulting possibly from difference of sex, food, climate, and the like, there is one test of specific value by which the one can be distinguished from the other. In the lion the inferior border of the ramus bears a slight

[1] Unfortunately we have been unable, from want of time, to publish the Plates and descriptions of the bones of *Felis spelæa* in the order that they should naturally appear. We trust that this may be rectified in future monographs.

process immediately beneath the last molar, which is developed to a different degree in different individuals; in some it causes the outline of the inferior border of the lower jaw to present a regular rounded, convex outline, nearly straight from symphysis to angle, while in others it reaches a maximum of development, so that the jaw approaches the doubly arched appearance so manifest in the figures Pl. I, figs. 1, 2. In the tiger, on the other hand, the inferior border of the lower ramus is straight, or rather concave in outline, from the symphysis backwards, the only exception out of the large number of tigrine skulls in the museums of Oxford and London being that afforded by one in the Hunterian collection, killed in India, and presented by General Hardwicke, in which there is the faintest possible approximation to the leonine contour.

In this point the rami of *Felis spelæa* agree most remarkably with those of *Felis leo*, and, as far as the larger specimens are concerned, present us with the maximum development of this "*ramal*" process, as it may be called (A of figs. 1, 2, Pl. I). In these large specimens it is far more strongly marked than in any recent varieties of *Felis leo;* but, as the latter present great variations in this respect, we cannot consider the stout proportions which the former exhibit a proof of specific difference.

The smaller jaws above referred to (figs. 1, 2, Pl. VI) do not present a greater development of the "*ramal*" process than ordinary specimens of the lion; being in this respect, as in all others, indistinguishable from that animal. In the leopard, both of Africa and of India, the inferior outline of the lower jaws resembles that of the lion; but that of the jaguar (*Felis onca*) is straight or slightly concave, like the tiger.

In both the large and small varieties the height of the condyle above the angle coincides remarkably with that of the lion, but differs in the tiger; this dimension being in the latter greater, both proportionally and absolutely. The proportion of length to maximum depth of the condyle varies in different individuals; but in the few instances we have seen, both large and small varieties have this part proportionally somewhat stouter than in the recent species (Pl. I, figs. 1, 2, 3, B; Pl. VI, figs. 1, 2, B).

Baron Cuvier considers that the gradual ascent of the coronoid process from the alveolar border of *Felis spelæa* is one point of difference between that animal and the living lion. We cannot see that in this point any difference exists between the fossil and recent species. The coronoid process rises more gently from the alveolar border in the lions that we have examined than in the tigers, but the difference is very slight.

The apparently sharper angle at which this process rises from the alveolar border in the lion we find to be caused by the form of the anterior portion of the ramus in that animal, which tapers slightly forwards through the length of the molar series, while in *Felis spelæa* the alveolar and lower borders are nearly parallel (Pl. I, figs. 1, 2, C D, A E). The angle in both forms, *F. spelæa* and *F. leo*, is in reality as near as possible identical, when measured with the alveolar border C D produced backwards, *i. e.* about 30° in each case. But when the angle is measured from the lower border of the ramus A B, it is about 40° in the lion and 30° in *Felis spelæa*. This angle, however, is variable, and therefore not to be trusted to as a specific character. Another point appears to deserve more attention; it is that in *Felis spelæa* the coronoid process projects backwards far more beyond the neck of the condyle (Pl. I, fig. 1, F) than in the lion or tiger; in the former animal this excess of projection amounting to nearly an inch, while in the tiger it is barely perceptible; and, as far as we have measured, it does not exceed half an inch in the lion. The different appearance this gives to the bone is very remarkable. The superior border of the coronoid process is a strong, smooth, externally rounded ridge, somewhat stronger than that of the lion or tiger, but almost totally destitute of the strongly marked ridges which are on this part of the bone in those animals.

The angle in the larger jaw resembles that of the lion, except that in the lateral aspect it forms one end of an arch (Pl. I, figs. 1, 2, G), of which the *ramal* process (*a*) forms the other, whereas in the lion and in the small variety this aspect presents a slightly concave line (Pl. VI, figs. 1, 2, G, A). In the adult tiger the angle descends far lower, and the arch above mentioned extends without interruption to the symphysis.

The masseteroid ridge is perhaps proportionally somewhat thicker and stronger in the large jaws, and the upper external border of this portion is massive and rounded (Pl. I, fig. 1, H), instead of ending in a sharp and knotted ridge, as in the lion and tiger and smaller cave variety (Pl. VI, fig. 1, H). The contour of the lower border of the anterior half of the ramus is precisely the same in the smaller cave jaws and the lion, as well as in the large fossil jaws; but it is more concave in the tiger.

The contour at the symphysis differs in the large form of *Felis spelæa* from that of either of the others. The angle formed by the front edge of the symphysis and the produced plane of the lower border is much larger in *Felis spelæa* than in either *Felis leo* or the small cave specimens (Pl. I, figs. 1, 2, K, E, *a*). This angle amounts to 70° in *Felis spelæa*, while it is 45° in the smaller fossil forms, and 40° only in the lion; in the tiger it is 55°. This difference, though very striking to the eye, appears to be variable; it is probably of little, if any, specific value.

The alveolar border is straight in all the forms (Pls. I, VI, figs. 1, 2, C, D).

The mentary foramina are very variable in form and position (Pls. I, VI, fig. 1, I). In some of the fossil jaws they appear to be each divided so as to form four on each side; we have seen an approach to this variation in recent specimens of both lion and tiger.

We may observe here that the silky smooth surface, which is remarkable on the other more robust feline bones of the caves, is also observable on the larger jaws, while the smaller resemble in this respect those of the recent large Feles.

The jaws we have principally used in our descriptions are from Bleadon and Sandford Hill. Of these, nearly perfect specimens of both varieties exist in the Taunton Museum, being a portion of the collection of Mr. Beard. There are also in the same collection many large fragments which confirm the description taken from the more perfect specimens.

The fragments of lower jaw, showing the angle, condyle, and coronoid process (Pl. I, fig. 3), which enables us to complete the illustration of the part missing from the Bleadon jaw was obtained from the brick-earth of Crayford, in the Thames Valley, and is now in the possession of Dr. Spurrell, to whose kindness we are much indebted for the loan of the specimen. It was found in association with the tichorhine, leptorhine (Owen), and megarhine Rhinoceros, *Elephas antiquus* and *E. primigenius,* horse, red deer, bison, &c. It probably belongs to the smaller variety.

A reference to the table of dimensions will show that the measurement of this bone are not greater than those of the lion and tiger.

A second specimen from the same locality gives the extent of the alveolar border occupied by the teeth at 3·20 inches, while $\overline{PM3} = 0{\cdot}73 \times 0{\cdot}41 \times 0{\cdot}39$, $\overline{PM4} = 1{\cdot}12 \times 0{\cdot}56 \times 0{\cdot}66$, and $\overline{M1} = 1{\cdot}15 \times 0{\cdot}51$.

A third mutilated ramus from the brick-earth at Ilford, in the possession of Mr. Brady, has a circumference anterior to premolar three of 4·90 inches.

A jaw of the large form was found at Fisherton by Dr. Blackmore, and others exist in different parts of the country.

Messrs. Schmerling, Marcel de Serres, Dubrueil, and Jean-Jean describe under the name of *Felis leo,* and Messrs. Croizet and Jobert under the name of *F. antiqua,* various bones of large Feles found in the caves of Belgium and France, and in the Pleistocene deposits of the latter country, and consider them as distinct from *Felis spelæa.*

We have no doubt as to the correctness of the four first-named authors in their determination of these bones as those of *Felis leo,* confirmed as it is by the remains of that animal in the Taunton Museum, from Sandford Hill and Bleadon. We have endeavoured to show, by our analysis of the jaws of *Felis spelæa,* that, as far as indications afforded by this part of the animal are concerned, the latter is simply an extreme variation of the former, and that the differences between it and the lion are not specific, or, in other words, greater than those that occur in recent varieties of the existing lion.

Measurements of Lower Jaw. (In Inches.)	*Felis spelæa.* Taunton Museum.							*Felis spelæa.* Dr. Spurrell's Collection.		*Felis spelæa.*								
	Figured specimen, Pl. I, figs. 1, 2., Bleadon Cavern. Bl. B. 1.	The same, left ramus.	Figured specimen, Pl. VI, Sandford Hill. S. H. B. 1.	The same, left ramus.	Sandford Hill Cave. S. H. B. 2.	Bleadon Cavern. B. L, B. 2.	Mendip. Williams' Collection. Wms.	Figured specimen. Pl. I, fig. 3. Crayford Brick-earth.	Crayford Brick-earth.	Ilford Brick-earth. Mr. Brady's Collection.	*Felis leo*, Gambia. Br. Mus.	*Felis leo*, Barbary. Br. Mus.	*Felis leo*, Coll. Surgeons, Asia, 4489.	*Felis leo*, W. A. S.	*Felis tigris*, Br. Mus.	*Felis tigris*, Br. Mus.	*Felis tigris*, Taunton. Captain Speke.	*Felis tigris*, W. A. S.
1. Symphysis to condyle	9·90	9·90	9·00	9·00	...	...	...	...	...	...	9·50	9·90	8·20	9·60	8·00	9·90	9·10	9·10
2. Circumference anterior to $\overline{PM3}$	5·40	5·21	4·08	4·05	...	...	...	...	...	4·09	4·36	4·70	3·50	4·30	3·50	4·30	4·10	4·10
3. Ditto posterior to $\overline{M1}$	5·50	5·29	4·70	4·71	...	...	...	...	...	...	4·90	5·00	4·30	5·00	4·00	4·60	4·40	4·60
4. Length of the inferior border from symphysis to angle	8·10	8·00	8·00	8·00	...	...	...	...	...	...	7·80	7·80	6·80	7·50	6·40	7·80	7·50	7·20
5. Length of exterior border of symphysis	3·60	3·60	3·00	3·00	...	...	...	...	...	...	3·20	3·30	2·50	3·60	2·70	2·80	3·10	3·50
6. Height of coronoid process from angle	5·00	...	...	...	...	...	...	4·80	...	...	4·80	4·50	3·60	4·50	4·00	5·10	5·30	4·90
7. Transverse measurement of condyle	...	...	...	...	...	...	...	2·17	...	...	2·60	2·60	1·95	2·30	1·80	...	2·50	2·60
8. Vertical ditto ditto	...	...	*0·80	*1·15	...	...	...	1·40	...	...	1·40	...	...	†0·80	0·70	1·10	†0·80	†0·65
9. Canine to $\overline{M1}$ inclusive	5·00	5·10	4·50	4·55	...	...	...	...	...	...	...	...	...	5·10	...	...	4·80	4·80
10. Canine to $\overline{PM3}$ exclusive	0·90	0·85	1·35	1·25	...	...	...	...	...	...	...	...	...	1·35	...	...	1·20	1·15
11. Molar series, length of	3·20	3·80	2·60	2·55	3·10	3·25	2·90	...	3·10	...	3·00	3·00	2·45	2·80	2·50	2·70	2·50	2·60
12. Depth of jaw anterior to $\overline{PM3}$	2·40	2·12	1·70	1·70	...	2·86	...	...	...	...	...	...	...	1·75	...	...	1·70	1·72
13. Ditto posterior to $\overline{M1}$	2·50	2·30	2·00	1·90	2·00	2·80	...	...	...	...	...	...	...	1·90	...	...	1·70	1·90
Extreme length from symphysis to end of coronoid process	10·10	...	...	...	...	...	...	...	...	...	...	...	...	9·20	...	...	9·20	9·10

* In columns 4 and 5, measurement 8 is the same in both specimens; that in column 4, is taken with calipers; that in column 5, is taken with the tape.

† In columns 15, 18, 19, the vertical measurements of the condyle (measure 8); *F. leo*, W. A. S.; *F. tigris*, Captain Speke; and *F. tigris*, W. A. S., are taken with callipers; taken with a tape they are respectively, 1·10″, 1·00″, and 0·97.″

CHAPTER II.

Felis spelæa—Fore-arm, Pl. II.

1. Ulna, figs. 5, 6, 7, 8, 9.

We have unfortunately been unable to procure the distal end of this bone.

The smaller specimens correspond so exactly with those of the lion that we are unable to perceive any difference, save a very slight diminution in size of the recent specimens, which, we believe, have been all, or nearly all prepared from animals which have lived most of their lives in cages.

The larger, however, present some differences, which, we think, necessary to describe.

The line drawn from the proximal end of the humeral articulation to the summit of the olecranon forms a more acute angle with the axis of the bone in *F. spelæa* than in *F. leo* (figs. 5, 6, 7, 8, 9, *a*, *b*).

The large humeral articulation (figs. 5, 6, 7, 8, 9, *a*, *a'*) is precisely alike in both.

The proximal radial articulation (*c*, *c'*, figs. 5, 6, 8, 9) is more nearly at a right angle with the axis of the bone in *F. spelæa* than in *F. leo*, though it still forms an angle of 60°, that in *F. leo* being 50°. In *F. spelæa* the articulation is shallowest posteriorly, in *F. leo* anteriorly.

The coronoid process *c* is strongly developed, but not more so proportionally than in the lion.

The shaft of the bone appears, from the largest fragments we have met with, to have been straighter and deeper, in proportion to the thickness in the larger, than the smaller form.

But the most marked difference to the eye is shown by the comparison of figs. 6 and 9, which show the extremes of the variation (fig. 8 being a somewhat intermediate form). It will be seen that in fig. 6 a strong ridge runs parallel to the back of the bone on the outer or radial surface (figs. 6, 8, 9, *d*, *d'*), forming a broad shallow groove which extends downwards as far as the specimens we have seen allow us to observe. It will be seen that this ridge terminates or dies away in fig. 9 a little below the radial articulation (fig. 9, *d*); in the recent specimens of the lion it is still less visible.

As, however, the length and prominence of the ridge appears to vary precisely as the size of the specimens, and we have examined above twenty, we cannot look upon it as a characteristic difference. Generally speaking, the surface of the bone in the larger specimens appear to present well-defined ridges with rounded contours, and smooth shallow grooves between; while the smaller and more strictly leonine forms present more angular and less defined ridges, and the grooves between appear to be more cut up by small irregular supplementary ridges.

Fragments of this bone are very numerous in collections of Somerset bones from the caves of Hutton, Bleadon, Sandford Hill, and Wookey Hyæna-den, specimens of both varieties having occurred in all. The largest number we know of together is in the Taunton Museum, from the collections of Messrs. Williams and Beard.

The only bone of the Pleistocene deposits that is likely to be mistaken for this is the same bone of the bear. The latter is, however, much straighter, and never has the broad external groove of the shaft described above. But the most marked distinction is in the proximal radial articulation, which in *F. spelæa,* as in all the Feles, invariably forms an acute angle with the axis of the bone, while in the bears it is at right angles. The form of the olecranon is also somewhat different, but its irregular form can be more easily recognised by a comparison of the plates of the bones than from the most elaborate description.

There is a figure of this bone belonging to the smaller variety in Schmerling's 'Oss. foss. de Liége,' vol. 2, pl. xix, fig. 1, and a very characteristic one figured by Marcel de Serres, &c. 'Oss. foss. de Lunel-Viel.,' pl. viii, fig. 3.

Measurements of Ulna. (In Inches.)	*Felis spelæa.*					*Felis leo.*		*Felis tigris.*
	Bleadon.			Sandford Hill.	Wookey Hyæna-den, Mr. Dawkins's figured specimen.	W. A. S.	Oxford Museum.*	Oxford Museum.*
	1. Figured specimen.	2. Apparently the pair of 1.	3.	1. Figured specimen.				
Length, extreme	...	...	...	...	...	14·75	12·62	14·0
Depth just below radial articulation, proximal	2·68	2·69	2·25	2·66	1·5	1·74	1·62	1·87
Thickness (transverse) at same point	1·05	1·00	1·17	...	1·1	0·86	0·87	0·75
Circumference at same point	6·00	6·00	5·12	6·10	6·5	4·39	3·24	4·0
Minimum circumference	...	...	...	...		2·40	2·0	2·25
Humeral articulation, vertical (linear)	...	3·00	3·40	...	2·0	2·80	1·37	1·75
Transverse humeral articulation	...	2·10	2·10	...	1·7	1·50	1·62	1·87
Radial articulation proximal, vertical: anterior	...	0·70	0·70	...	0·57	0·50	0·5	0·62
Radial articulation proximal, vertical: posterior	...	...	...	...	...	0·60		
Ditto ditto ditto, transverse	...	2·00	1·70	...	1·6	1·63	1·5	1·37
Ditto distal articulation, vertical	...	...	...	...	...	0·60	0·5	0·5
Ditto ditto ditto, transverse	...	...	...	...	...	0·60	0·6	0·62
Carpal articulation, vertical	...	...	...	...	...	0·75	0·62	1·0
Ditto ditto, transverse	...	...	...	...	...	0·48	0·37	0·5
From radial to carpal articulation, both inclusive	...	...	...	...	...	1·65	1·25	2·0

* For these measurements we are indebted to Mr. Charles Robertson, the able Demonstrator of Anatomy at Oxford.

2. Radius, Pl. II, figs. 1, 2, 3, 4.

The general form of this bone is like that of many other carnivora; the lower half is straight, while the upper is bent gently backwards in a slight curve; immediately below the proximal epiphysis it is bent sharply forwards, so that the humeral articulation which terminates the bone is set at an angle of about 70° to the axis of the bone (figs. 1, 2, 4, *a*).

The section of the bone at the distal epiphysis is nearly triangular, with the outer surface convex, while the inner is nearly flat or slightly concave, and the posterior deeply so. This section gradually passes into one which is a flat oval, rather wider on the after edge. The tuberosities (figs. 1, 4, *c*) give the bone, where they occur, a triangular section, the oval recurring just below the proximal epiphysis.

The humeral articulation is roughly oval (figs. 1, 2, 4, *a*), being produced into a blunt point on the anterior edge (figs. 1, 2, *e*). It is concave with the exception of the anterior edge, where it is vertically convex. There is a slight eminence on the external edge (figs. 1, 2, 4, *f*) which falls gradually away into the concavity of the articulation.

The proximal ulnar articulation commences just under this eminence (figs. 1, 2, 4, *f*), and is continued posteriorly round three fourths of the head of the bone to the anterior point (figs. 1, 2, 4, *e*), where it is deepest.

The distal ulnar articulation extends nearly the whole width of the bone, and forms a slightly concave oval, wider transversely than vertically, on the upper posterior edge of the distal epiphysis (fig. 3, *g*, where the edge alone is shown). This is set at an angle of 45° to the axis of the bone.

The carpal articulation (fig. 3) is roughly trapezoidal in form. The inner or ulnar edge of the articulation is bounded by a semicircular arc, and the surface is concave, the outer boundary is convex, and the inner is straight when viewed from below, while on the lateral aspect it is boldly curved vertically. The anterior edge of the styloid process is nearly semicircular; the surface of this part of the articulation is concave vertically, following the under surface of the styloid process, while it is convex transversely.

The styloid process (*i*, *i*, figs. 1, 3) is set slightly and obliquely inwards, while the process on the upper anterior edge of the epiphysis is set nearly in the plane of the greatest depth of the bone.

Some of these bones from the Somerset caves are, as far as considerable fragments allow us to judge, indistinguishable from those of the lion (fig. 4). Others, of which we figure one perfect specimen, are, as Cuvier remarks, generally far stouter in proportion to their length (figs. 1, 2, 3).

The only differences in form which we can discover in this or in numerous fragments that we have examined appear to be due to this excess in stoutness alone, and can hardly be regarded as of specific importance.

All the specimens that we have seen are from the caves of Bleadon, Sandford Hill, and Hutton, and are in the Taunton Museum.

This bone may be distinguished from that of the bear by the greater prominence of the eminence of the humeral articulation in the latter animal (figs. 1, 2, 4, *f*). This articulation is more circular in Felis than in Ursus. In the bear the ulnar proximal articulation is less pronounced and more rounded vertically; the tuberosities below this articulation are far smaller, and the bone is altogether more angular in section, more slender and flatter; the distal ulnar articulation is set nearly parallel to the axis of the bone on a small process. In the carpal articulation the strong upward curve on the internal edge altogether disappears, and the articulation is much less concave.

Schmerling, in his 'Oss. foss. de Liége,' gives good rough figures of this bone, both of the large variety (vol. ii, pl. xv, fig. 3) and of the smaller with the ulna (pl. xix, fig. 1).

Measurements of Radius. (In Inches.)	*Felis spelæa.*								*Felis leo.*		*Felis tigris.*
	Sandford Hill.		Bleadon.						W. A. S.	Oxford Museum.	Oxford Museum.
	Figured specimen.	Pair to ditto.	Large form.				Small form.				
			1.	4.	5.	6.	2.	3.			
Extreme length	12·75	...	...	...	...	...	...	...	12·40	10·37	11·0
Minimum circumference	3·50	3·50	3·85	3·60	...	...	3·10	3·10	2·66	2·5	2·75
Transverse proximal humeral articulation	1·42	1·45	1·50	1·30	...	...	1·00	...	1·09	1·12	1·12
Vertical proximal humeral articulation	2·05	2·00	...	1·95	...	...	1·50	...	1·42	1·5	1·62
Vertical proximal ulnar articulation	0·55	0·54	0·80	...	...	...	0·42	...	0·48	0·5	0·5
Transverse distal ulnar articulation	1·18	1·16	...	...	...	1·00	...	...	0·95	0·37	0·75
Vertical distal ulnar articulation	0·60	0·67	...	...	...	0·60		...	0·70	...	...
Transverse carpal articulation	1·40	1·36	...	...	...	1·40	...	...	1·05	1·0	1·12
Vertical carpal articulation	2·48	2·40	...	...	2·75	...	...	...	1·81	1·62	1·87
From proximal articulation to tuberosity, both inclusive	2·30	2·35	2·60	...	...	...	1·90	1·92	2·10	...	...

CHAPTER III.

Felis spelæa—Os innominatum, Pl. III, fig. 1.

We have met with but four specimens of this bone from the British Pleistocene deposits, all more or less imperfect. Of these, three were obtained by Messrs. Williams and Beard out of the bone-caverns of the Mendip Hills, and are preserved in the Taunton Museum, while the fourth and largest, which we figure, is derived from the brick-earth on the south side of the Thames Valley, at Slade Green, near Erith, in Kent, and is in the national collection. It consists of the ilium and ischium, tolerably perfect, and a portion of the os pubis of the left side.

The ilium may be described as resembling the blade of an oar in form, slightly concave on the external, and nearly flat on the internal or sacral surface ; the parts answering to the crest (fig. 1, *a*, *a′*) and spinous processes (*b*, *b′*, *b″*) forming the strong rounded and raised border of the blade. The external surface is traversed by a longitudinal ridge (*c*, *c′*) that strengthens the attachments of the glutei muscles. This ridge is very slightly developed in the specimens from the Mendip caverns, while in that figured it reaches a maximum development. The symphysis of the sacrum extends slightly along the upper edge of the shaft or body, and takes the form of a small spine or process at *b*. This shaft or body (*c*, *d*) is massive, and of great strength, flattened internally and rounded externally, and ending inferiorily in a sharp free edge (*d*). The anterior inferior spinous process (*e*) varies in form and size in the different individuals, but bears a general resemblance to that of the lion.

The portion (*f*) of the os innominatum that composes the apex of the sacro-ischiatic arch immediately above the acetabulum is convex and rounded, and without any ridge. It forms the connection between the shafts of the ilium and ischium. That of the latter (*g*, *h*) is prismatic in form, tapering posteriorly and expanding downwards and transversely into a broad triangular blade, the anterior edge of which forms the posterior boundary (*i*) of the pubic arch. The ischial spine (*k*) is a small pyramidal process immediately above the posterior edge of the acetabulum.

The shaft of the pubis (*l, m*) is convex externally and flat internally, and in some of the fossil specimens is proportionally more massive than in those of the lion and tiger, with which they have been compared. The acetabulum is proportionally larger, and the cotyloid notch (*n*) shorter in the spelæan than in the recent lion.

With these two exceptions, a close comparison of the spelæan ossa innominata with those of the recent large carnivora proves that the only difference between the pelvis of *F. spelæa* and *F. leo* and *F. tigris* is one of merely size. We are unable to detect any specific differences between the pelves of the two latter animals.

We have given a figure (fig. 2) of the pelvis of *F. tigris* in the British Museum, three fourths of the natural size, to show the far greater size of that of the *Felis spelæa*.

Measurements of Os Innominatum. (In Inches.)	*Felis spelæa.* Thames Valley, Slade Green. Br. Mus.	*Felis spelæa.* Sandford Hill, Taunton Mus.	*Felis leo.* 112 L. Brit. Mus.	*Felis leo.* W. A. S.	*Felis tigris.* 114 L. Brit. Mus.	*Felis onca.* Brit. Mus.	*Felis leopardus.* Brit. Mus.	*Felis concolor.* Brit. Mus.
Total length	14·50	13·25	11·75	11·50	12·2	9·00	7·70	7·51
Vertical height of ilium	3·50 ?	3·25	2·48	2·92	3·80	2·00	1·64	1·45
Minimum height of ischium	2·00	1·75	1·40	1·45	1·60	1·40	1·03	0·75
Maximum thickness of ischium	0·95	0·98	0·47	0·77	0·80	0·55	0·50	0·36
Transverse diameter of acetabulum	2·25	2·25	1·54	1·75	1·75	1·23	1·15	0·97
Longitudinal diameter of acetabulum	2·20 } 7·30	2·25 } 6·75	1·52 } 5·66	1·75 } 5·50	1·60 } 5·95	1·25 } 4·30	1·15 } 3·90	0·99 } 3·89
Acetabulum to end of ischium	5·10 }	4·50 }	4·14 }	3·75 }	4·35 }	3·05 }	2·75 }	2·90 }
Acetabulum to end of ilium	7·42*	6·75*	5·90	6·00	6·00	4·75	4·02	3·70
Minimum circumference of ischium	5·40	4·72	3·35	3·60	4·05	2·77	2·44	2·35
Minimum circumference of ilium	7·10	5·90	4·10	4·92	5·25	3·60	3·25	2·95
Depth of ischium	...	...	2·0	3·40	2·40	1·50	1·05	0·95
Semidiameter of ischium	...	...	2·37	2·85	2·75	2·30	1·92	1·37
Pelvic height	...	...	2·70	3·90	2·90	2·25	1·90	1·75
Semipubic diameter	...	...	1·33	1·80	1·50	1·00	1·25	1·05
Semi-iliac diameter	...	...	2·30	3·00	3·00	1·38	2·05	1·55

* These ilia are both imperfect. This proportion would be generally the same as in the lion.

CHAPTER IV.

Felis spelæa—Tarsus, Pl. IV.

Astragalus, fig. 1.

The astragalus of *Felis spelæa* is precisely like that of the lion and tiger in form, but, with the exceptions of certain specimens which we shall notice, is much superior in size to those of either of the latter two animals we have met with.

The tibial or proximal articulation (fig. 1, *a*, *a′*) is of the usual pulley-like form; it is inclined to the antero-posterior diameter, at an angle of about 30°; at the back of this are set the two articulations for the calcaneum, the outer being concave and somewhat broader at the top than the bottom, and this matches the great sigmoid articulation; the other is subtriangular and matches the small lateral circular articulation (*e′* of fig. 2) of the calcaneum. These three articulations are the surfaces of the head or proximal portion of the bone.

This is connected with the navicular or distal articulation (fig. 1, *b*), by a short shaft or neck, as in all the other digitate carnivora.

This articulation is suboval in form, and bent vertically and diagonally, so that it is highly convex, and matches well the deep concave articulation of the navicular bone.

The only cave fossil that is likely to be taken for this bone is that of the bear. But the latter is easily distinguished by the extreme shortness of the neck or shaft joining the proximal and distal portions of the bone. The pulley-groove of the tibial articulation is also flatter in the bear, and on the inner posterior edge this articulation is terminated by a sort of spur rising at right angles to the surface, which does not exist in the Feles.

Among the many specimens of this bone that have occurred to us there are some in the Taunton collection which are much smaller than the rest, and very little exceed those of a large lion in size. They do not, however, offer any other difference.

MEASUREMENTS.[1]

No.	*Felis spelæa.* Bleadon. L. 1.	1 R.	2 R.	1 L.	2 L.	Sandford Hill.	Lion W. A. S.	Lion 112 L. Br. Mus.	Tiger 114 L. Br. Mus.
1	3·20	3·17	3·00	2·80	2·70	3·20	2·35	2·25	2·51
2	4·20	4·25	3·62	3·14	2·25	3·75	3·10	3·05	3·40
3	1·86	1·82	1·61	1·49	1·42	1·62	1·09	1·01	1·22
4	3·33	3·33	3·68	2·79	2·45	3·15	2·30	2·09	2·22
5	1·70	1·68	1·46	1·31	1·31	1·40	1·50	1·40	0·94
6	1·30	1·28	1·26	1·00	1·02	2·00	0·90	1·10	1·27

The 4th and 5th specimens in the above list are of the small variety above mentioned.

The specimen figured is the first in the above list of measurements. It is with many others in the Taunton collection, from Bleadon cavern. Others have occurred to us from Sandford Hill and Oreston.

Calcaneum, fig. 2.

The general form of the calcaneum of *Felis spelæa*, like that of all the Feles, and of most, if not all, the digitate carnivora, is nearly straight from the bulb which forms the attachment of the tendo Achillis (fig. 2, *a*) to the cuboidal articulation (fig. 2, *b*). From this bulb the bone slightly increases in size to the upper part of the outer astragaline articulation, at which point is the maximum vertical measurement (fig. 2 *c'*).

The posterior boundary is generally a gentle convex sweep through the whole length of the bone; in some specimens this becomes nearly straight or even very slightly concave as it approaches the bulb for the tendo Achillis. The outer astragaline articulation (fig. 2, *c, c'*) is a broad sigmoidal surface, bent backwards vertically on itself. Near the level of the middle of this surface a stout process rises laterally, at right angles to the body of the bone (fig. 2, *d, e*), and supports at an angle of about 30° to the axis, a nearly circular surface, which is the inner astragaline articulation (fig. 2, *e*). In the form of this articulation it resembles the lion, that of the tiger being transversely oval. The mass of bone which connects these with the cuboidal articulation is nearly cubical in form, and has on the external surface the prolongation of the cuboidal groove for the tendon of the *peroneus*

[1] In this, as in all cases throughout these monographs, when the numbers alone are given, the measurements are—1, extreme length; 2, minimum circumference; 3, virtual measurement at the proximal articulation; 4, transverse ditto ditto; 5, vertical measurement of distal articulation; 6, transverse ditto ditto.

longus (fig. 2, *f*). The cuboidal articulation (fig. 2, *b*) terminating the bone distally at right angles to the axis forms a nearly circular surface, a portion of the circle being cut off by a chord, which forms the inner posterior boundary of the articulation. If this cord were slightly bent, it then would approximate very closely to the recent leonine form, which is nearly an oval.

The attachment of the tendo Achillis is formed by the process rising on the inner edge of the bone at right angles to the rounded terminal surface (fig. 2, *g*). In this it appears to differ slightly from that of the lion, for in that animal the groove formed by the two surfaces is replaced by a nearly flat or slightly rounded surface at an angle of about 45° to the axis.

The only differences which we can observe between the corresponding bones of this animal and the tiger are that mentioned above, and the rounded or oval form of the cuboidal articulation in the former, while in the latter it forms a quarter circle.

Among the large number of calcanea we have examined, we find three or four which do not appear to differ in any respect from those of lion, with the exception of being very slightly larger, the difference of size in general being very great. That figured probably belonged to an aged animal, the outer portion of the bone being roughened by exostosis.

Measurements of Calcaneum. (In Inches.)	*Felis spelæa.*							Lion.		Tiger.
	Bleadon.				Sandford Hill.	Bleadon.		W.A.S.	Br. Mus. 112 L.	Br. Mus. 114 L.
	1*	2	9	11	19	12	13			
1. Total length	5·60	5·24	5·34	5·00	5·01	4·52	4·48	3·90	4·00	4·30
2. Minimum circumference	4·73	4·24	4·30	4·40	4·30	3·90	3·70	3·30	3·15	3·45
3. Maximum vertical measurement	2·36	2·10	2·08	2·27	1·82	1·87	1·80	1·59	1·60	1·77
4. Maximum transverse ditto	2·38	2·06	2·10	1·97	2·03	1·80	1·70	1·67	1·45	1·64
5. From inner articulation to the outer end of the bone, articulation included	3·95	3·70	3·90	3·68	3·77	3·36	3·45	3·13	2·90	2·74
6. Sigmoidal articulation, transverse measurement	0·92	0·82	0·82	0·85	0·75	0·74	0·72	0·60	0·55	0·64
7. Cuboidal articulation, transverse measurement	1·32	1·30	1·45	1·38	1·30	1·10	1·25	0·90	1·02	0·92
8. Ditto ditto, vertical	1·17	1·13	1·26	1·15	1·17	0·95	0·93	1·02	0·82	0·85
9. Inner astragaline articulation transverse	0·81	0·80	0·84	0·88	0·79	0·68	0·68	0·71	0·70	0·73
10. Inner astragaline articulation, vertical	0·74	0·70	0·72	0·74	0·55	0·70	0·57	0·67	0·69	0·55

The specimen figured is from Bleadon, and evidently belongs to the same individuals

* Specimen figured.

as the cuboid, astragalus, &c., which we have figured; it is at Taunton, with many others, from the collection of Mr. Beard. The adult bones are from Bleadon and Sandford Hill, and the same bone of young animals from Bleadon and Hutton.

Naviculare, fig. 3.

This bone, as its name denotes, is somewhat boat-shaped, the upper concave and nearly circular surface forming the articulation for the astragalus (fig. 3, *a*), and the two flat inferior surfaces, slightly inclined to each other (fig. 3, *b*, *c*), forming those for the ecto- and meso-cuneiforms (figs. 5, 6), while a slightly rounded surface on the inner side forms the proximal attachment for the endocuneiform (fig. 3, *d*).

The hinder portion of the astragaline articulation is curved sharply upwards, and this portion is supported by a process (forming, as far as this bone is concerned, the upper border of the great tarsal groove for the *peroneus longus*), which is generally much slighter in *Felis spelæa* than in lion or tiger, it being proportionately the largest in the latter of these three animals. This forms the only appreciable difference observable in this bone except size between them.

It is distinguished from the corresponding bone of the bear by the somewhat greater thickness and by the greater development of the upward prolongation of the astragaline articulation, and also by the more decidedly circular form, as contrasted with the oblong and somewhat angular plan of that of the latter animal.

Measurements.

	Felis spelæa.			Lion, W. A. S.	Lion, Br. Mus. 112 L.	Lioness, Col. Surg.	Tiger, Br. Mus. 114 L.	Tiger, Col. Surg.
	Bleadon.							
1	0·75	0·66	0·66	0·65	0·63	0·59	0·55	0·56
2	5·45	5·00	4·77	4·03	4·20	3·98	4·90	4·35
3	1·24	1·20	1·15	0·98	0·91	0·90	0·91	0·97
4	1·79	1·54	1·50	1·38	1·17	1·10	1·25	1·20
5	1·33	1·27	1·26	1·02	1·02	1·00	1·06	1·00
6	1·94	1·66	1·51	1·00	1·10	0·91	1·00	0·83

The bone figured is from Bleadon, and is at Taunton; it probably belongs to the same animal as the astragalus, calcaneum, &c.; but it is from the right paw, and for the sake of uniformity is reversed in the plate. Schmerling gives two good figures of this bone, showing the proximal and internal surfaces ('Oss. foss. de Liége,' t. ii, pl. xvii, fig. 4).

Cuboid, figs. 4, 4′, 4″.

The general form of this bone is well expressed by the name, the bounding surfaces being roughly at right angles to each other; the distal surface, however, being larger than the proximal.

The outer and posterior or lower surfaces are traversed, diagonally and downwards, by a deep groove for the tendon of the *peroneus longus* (figs. 4, 4′, 4″, *b, b*); a continuation of the groove being formed on the outer and distal surface of the calcaneum in an upward direction, and by the hook of the ectocuneiform and the process on the hinder part of the naviculare in the opposite and transverse direction.

The proximal or calcaneal articulation (fig. 4, 4′, *c*) is nearly flat and subcircular. The distal or metatarsal articulation (fig. 4, 4″, *d*) is concave, and may be described as an oval, the outer side being bent inwards so as slightly to resemble a B in outline, while that of the ectocuneiform is trapezoidal and nearly flat (fig. 4, 4′, *a*).

The difference in size is the only difference we can remark between this bone and that of the recent lions and tigers. In some specimens of tigers we have observed a disposition in the tarsal articulations generally to separate up into small surfaces, whereas in the lion and *Felis spelæa* they appear to coalesce to a greater extent, and this is especially the case in the cuboid.

Measurements.

	Felis spelæa, Bleadon, Taunton.	Lion W. A. S.	Lion, Br. Museum, 112 L.	Lion, Col. Surg.	Tiger, Br. Mus., 114 L.
1	1·39	1·04	1·00	1·05	1·10
2	4·22	3·00	3·25	3·80	3·27
3	1·36	0·70	0·86	0·90	0·90
4	1·36	1·00	0·61	0·68	0·78
5	1·20	1·00	0·81	0·82	0·76
6	1·24	0·98	0·86	0·82	0·94

The only specimen we know of is from Bleadon. It evidently belongs to the same individual as the calcaneum and several other bones of the tarsus, which we have figured.

Schmerling gives rough figures of this bone, apparently taken from an imperfect specimen. They appear to be the external and posterior views, but one of them is reversed in position ('Oss. foss. de Liége,' t. ii, pl. xvii, fig. 5).

Ectocuneiform, figs. 5, 5′.

This bone has a wedge-shaped body, the superior surface (fig. 5) forming the head of the wedge, and the inferior or plantar the vertical edge. The flat navicular proximal (figs. 5, 5′, *a*) and slightly concave distal metatarsal (figs. 5, 5′, *b*) articulations are both nearly isosceles triangles. From the inferior surface of the bone a very stout hook-shaped process is developed (fig. 5′ *c*), that advances forwards to terminate in a rounded boss. This *hamular* process affords attachment to the plantar ligaments that extend to the cuboid and meso- and ectocuneiform, and to the *tibialis posticus* and *flexor pollicis* muscles. In all the British specimens of the bone that we have seen, the hamular process advances forward within a short distance, from 0·10 to 0·20 inch of the plane of the distal surface, and in no instance as far as the distal plane. This also is borne out by the examples from the cave of Gailenreuth, in the collection of the Earl of Enniskillen, F.R.S., to whose courtesy we are indebted for the examination of his museum.

A large series of ectocuneiforms belonging to lions and tigers, in the museums of London and Oxford, shows, as one might naturally expect, considerable variations in the development of the hamular process; and while we find many ectocuneiforms of lion that cannot, in this or any other respect, be differentiated from those of tiger, yet, on the whole, it has a smaller distal extension in the former than in the latter (fig. 5′′, *c*). The maximum distal extension is seen in the specimen of tiger in the British Museum figured fig. 5′′′, *c*, in which it extends as far down as the plane of the distal articulation. We must admit, therefore, that while the development of the hamular process in the ectocuneiform of *Felis spelæa* is no absolute test of leonine or tigrine affinities, yet that it points rather in the direction of the former than the latter.

MEASUREMENTS.

	Felis spelæa.			Lion.			Tiger.	
	Bleadon.		Sandford Hill.	Col. Surg.	Br. Mus. 112 L.	W. A. S.	Br. Mus. 114 L.	Col. Surg.
1	0·83	0·81	0·96	0·64	0·70	0·70	0·80	0·74
2	3·95	3·52	4·00	2·77	2·90	3·10	3·25	3·05
3	1·05	0·87	1·00	0·82	0·62	0·90	0·70	0·80
4	1·05	1·02	1·04	0·98	0·95	0·93	0·94	1·12
5	1·08	0·98	1·04	0·85	0·80	0·93	0·90	0·80
6	1·36	1·19	1·45	1·00	1·03	1·11	1·15	1·14

The specimen figured is the first in the list of measurements, reversed in order to get the most perfect representation on the same side as the rest of the tarsus.

The three specimens measured formed part of the collection of Mr. Beard, and are now at Taunton. There is a good rough figure of the distal articulation of this bone in Schmerling ('Oss. foss. de Liége,' t. ii, pl. xvii, fig. 6).

Mesocuneiform, fig. 6.

This small bone has the proximal and distal articulations slightly inclined to each other, and wider apart internally than externally. The proximal or navicular articulation is roughly oval, but slightly pointed anteriorly, and is slightly concave transversely and convex vertically, while the metatarsal or distal is wider anteriorly than posteriorly, and is very slightly concave vertically.

The inclination of the articulations one to the other, and other minute points in the form of the bone, appear to differ in different individuals of lion and tiger; consequently the slight difference we observe between the only specimen we know of this bone in *Felis spelæa* and the above two animals is probably not of specific value. Generally speaking, however, it appears to be a shorter and thicker bone altogether in the fossil than in either of the recent large species.

It may be easily distinguished from the corresponding bone in the bear by the greater squareness and angularity of the anterior or upper face of the bone in that animal, as contrasted with the rounded and oval form in *Felis spelæa*.

Both distal and proximal articulations in the bear are also much more concave, and the articulation for the endocuneiform is well developed, whereas scarcely a trace of it exists in *Felis spelæa*.

Measurements.

	Felis spelæa, Bleadon, Taunton Col.	Lion.		Tiger.	
		Br. Mus. 112 L.	Col. Surg.	Br. Mus. 114 L.	Col. Surg.
1	0·55	0·39	0·35	0·61	0·51
2	2·90	2·10	1·89	2·00	2·40
3	0·54	0·40	0·35	0·43	0·42
4	0·91	0·66	0·70	0·68	0·68
5	0·50	0·46	0·42	0·54	0·52
6	1·02	0·72	0·65	0·69	0·79

The specimen figured is from Bleadon, and probably belonged to the same individual as the astragalus, calcaneum, naviculare, and cuboid, which we have figured. It is at Taunton. We know of no other figure of this bone.

Endocuneiform, fig. 7.

It is with considerable hesitation that we give a figure of this bone. The general form and surface resemble the same bone in the lion and tiger, but there are differences which make us doubtful whether we have assigned the bone its right place. It has lost the proximal epiphysis. If this is restored as a feline endocuneiform (fig. 7, *a*), it would then be very similar to the same bone in lion and tiger; but the anterior portion of the distal articulation points downwards in an acute angle, whereas in lion it points nearly directly forwards in a right angle.

The articulation also is slightly convex in our bone, whereas it is slightly concave in that of the lion. Unfortunately, the corresponding articulation of metatarsal 1 is broken in the only specimen we know of, so that we cannot say whether this bone showed a corresponding variation in form. We think, however, that attention should be drawn to the bone, in the hope that some one, more fortunate than ourselves, may discover a perfect specimen, and decide whether we are right or wrong in our determination.

The only specimen we have being imperfect, we give no measurements. It is from Bleadon, and is in the Taunton Museum.

We know of no other figure of this bone.

CHAPTER V.

Hind Paw, Pl. V.

The metatarsals of the carnivora are so well known, and so much resemble each other in the digitate forms, that comparative anatomists are generally content to refer to the figures of those bones rather than to attempt to discriminate them by descriptions, which must all very closely resemble each other. If we attempt the course which, in nearly all other portions of the skeleton, is held to be absolutely requisite, it is with the view of doing what we can to render the descriptive portion of our work as perfect as we can, rather than to trust to bare figures.

Metatarsal 1, fig. 1.

It is well known that the first metatarsal of the genus Felis is rudimentary. In fact, it would be difficult for one not acquainted with the bone in question to recognise it as a metatarsal at all.

In *Felis spelæa* it is a small wedge-shaped bone, the wedge thinning off anteriorly to an edge, and distally to a blunt point. The internal surface is slightly rounded; but the external is flat, and the posterior is irregular. The articulation for the endocuneiform is slightly concave transversely and convex vertically; and, as we suppose, from the corresponding bone in the lion, it would be furnished with a small hook-shaped process on the external[1] and posterior edge. This part is mutilated in our only specimen (fig. 1, *a*). In other respects it does not differ appreciably from that of the lion, except that in that animal the articulation is flatter.

The specimen figured is from Bleadon, and is in the Taunton collection, and is reversed from the left paw.

We have to repeat what we have written respecting other specimens of various

[1] Internal and external, in these descriptions, are invariably used in reference to the position of the whole limb in the skeleton, and not to the position of the bone as to the joint.

parts of large Feles from the Somerset caves, that there occur metatarsals which, both in size and form, so exactly resemble those of the recent lion, that they cannot be distinguished from them. (We have observed, however, a tendency in those of the tiger to a greater proportional development in the antero-posterior direction of the proximal articulation, which appears generally to distinguish the metatarsals of that animal from the other two large feline animals.) But in all the Pleistocene deposits there occur, but not numerously, except in the Somerset caves, bones of larger size. The set which we have figured evidently belonged to the same animal, though metatarsal 3 is reversed from the left paw. They were found by Mr. Beard, with many other parts of the same skeleton, in Sandford Hill Cave, in the Mendip, and are now in the Taunton collection. Some larger specimens from Crayford, in the valley of the Thames, are figured in Pl. VIII. They belong to Dr. Spurrel, and are nearly, if not quite, equal to the largest German specimens. They differ from those we have figured in Pl. V by having the distal articulations comparatively much smaller, as well as by their tapering more and being more bent. We have observed similar variations in some of the cave specimens, as well as in the metatarsals of recent lions and tigers.

Metatarsal 2, fig. 2.

The shaft of the second metatarsal is somewhat triangular in section, the sides being flatter towards the proximal and becoming more convex towards the distal articulation, so that the bone then becomes almost cylindrical. The shaft is slightly curved backwards, the outer boundary, or that facing metatarsal 3, being nearly straight, and the inner, or that facing metatarsal 1, being curved slightly inwards, so that the bone appears to bend slightly in that direction.

The proximal articulation for the mesocuneiform (fig. 2, *a*, *b*) is nearly at right angles to the axis of the bone. It forms a roughly triangular surface, of slightly double curvature from front to back, where it ends in a small spur, curving sharply upwards (*b*, fig. 2). The surface is concave, in a transverse direction.

The point of contact with metatarsal 1 can hardly be called an articulation; it is slightly smoothed, and is supported by a small process (*c*, fig. 2), a short distance below the proximal articulation, on the inner front edge of the bone.

The ectocuneiform articulations, together with those for the third metatarsal, form two very slightly concave oval surfaces at right angles to the proximal articulation, and continuous in direction with the outer surface of the bone. Each of these surfaces is divided by an horizontal ridge, very slightly marked; the upper part of each belongs to the ectocuneiform, the lower to the third metatarsal. The anterior edge of the anterior of these is bent outwards, so that the front of the bone presents the angular projection (fig. 2, *d*, *e*), and when the metatarsals are applied to each other the point *d* rests on the point *a* (fig. 3).

The distal or phalangeal articulation is, unfortunately, mutilated in all the specimens of this bone that we have seen; but it probably resembles that of the lion, excepting that the lateral development of the internal process (*g*, fig. 3) appears to be much less in the large cave form than in the recent. It probably, like that of the lion, had the outer surface of the bulb much flatter and more deeply indented than in the other metatarsals.

Metatarsal 3, fig. 3; and Pl. VIII.

The shaft of this bone is cylindrical, slightly flattened on the front surface; it is very slightly bent backwards, and expands slightly laterally at the distal epiphysis. The proximal or ectocuneiform articulation is very flat (fig. 8, *a*, *b*), and inclined at an angle of about 60° to the axis of the bone downwards and inwardly, being at right angles to the front surface. It is bounded anteriorly by the curved front edge of the bone, inwardly by a waved line, posteriorly by a very small spur, rising from the surface (fig. 8, *c*), and externally by a waved line like the internal boundary, but set at a right angle to the front, while the internal is at an acute angle with the same. The articulations for metatarsal 2 are the small polished heads of two small eminences, corresponding with the summit of the internal waves above mentioned; while those for metatarsal 4 are two larger oval surfaces, on the opposite side of the bone, the anterior lining the surface of a hollow facing diagonally backwards and downwards, the anterior edge of which forms the boundary of the front external expansion of the proximal extremity of the bone (fig. 3, *b*, *d*), while the posterior articulation is a flat surface, facing directly outwards and upwards. This, with the posterior articulation for metatarsal 2, and the posterior portion of the proximal articulation, are supported by a large process, the lower part of which gradually slopes into the body of the bone.

The bulb-shaped phalangeal or distal articulation is proportionally wider than that of the recent lion, but is in other respects precisely similar.

Metatarsal 4, fig. 4.

This bone is somewhat more bent than metatarsal 3, and the section is somewhat more angular, giving a square section just below the proximal epiphysis. It is rather more bent backwards than metatarsal 3, and in the slightest degree outwards. The proximal or cuboidal articulation (fig. 4, *a*) is rhomboidal and convex, both in transverse and vertical directions, and is bounded posteriorly by a shallow groove and small spur.

Of the internal articulations for metatarsal 3, the anterior (fig. 4, *b*) is a convex surface passing into a concave towards the ridge which separates it from the cuboidal articulation; it rests posteriorly on a slight process, and faces inwards, upwards, and towards the front. The posterior of these articulations (*c*) is slightly convex and oval in form, and faces backwards, inwards, and downwards, and is, like the corresponding articulation on metatarsal 3, supported on a massive posterior process.

The articulations for metatarsal 5 much resemble those corresponding with them on metatarsal 3, but they are more concave; and the posterior, instead of facing slightly upwards, faces directly outwards, or rather a little downwards. The distal articulation corresponds with that of the lion, except that it is slightly wider in proportion to the depth.

Metatarsal 5, fig. 5.

This bone is cylindrical, passing upwards into a triangular section, and downwards into an oval, wider transversely than in a vertical direction. The cuboidal or proximal articulation is a small oval surface, inclined to the axis of the bone (*a*, *b*, fig. 5), and slightly concave transversely, and convex in an antero-posterior direction. It is bounded, externally, by a high, strong ridge or crest, which passes from the front, round the outside to the back of the bone, where it terminates just above the posterior articulation for metatarsal 4 (*c*, *f*).

The anterior articulation for metatarsal 4 (fig. 5, *c*) much resembles the corresponding articulation already described in that bone; but the posterior (fig. 5, *d*) is a small, irregularly formed surface, the facing of which is generally backwards, inwards, and upwards. The form of the distal articulation corresponds exactly with that of the lion, being flattened internally, and extended laterally in an outward direction, but it shows the same slight difference in the greater transverse diameter.

This bone in the specimens we have examined is more bent outwards and backwards than in the recent lion and tiger.

In general, these bones may be easily distinguished, when perfect, from those of the bear, by the smaller proportional length, as well as by the far greater proportional size of the proximal end of the bone in *Ursus*. This gives these bones in the bear a taper shape, quite different to the solid, strong-looking bones of *Felis spelæa*. For the details of difference we refer to our descriptions, measurements, and figures—

Measurements.

Metatarsal 1 being mutilated, we cannot give measurements.

	Specimen figured. S. H. B. Taunton.	Bl. B. Taunton.		*Felis tigris*, Brit. Mus. 114 L.	*Felis tigris*, College of Surgeons.	*Felis leo*, College of Surgeons.	*Felis leo*, W. A. S.
Metatarsal 2.							
	Inch.	Inch.		Inch.	Inch.	Inch.	Inch.
1	4·92	...	...	4·04	4·25	4·08	4·66
2	2·18	2·36	...	1·75	1·60	1·45	1·72
3	0·91	0·70	...	0·60	0·59	0·56	0·63
4	1·30	1·50	...	1·15	0·98	0·78	1·00
5	...	...	...	0·84	0·71	0·65	0·85
6	1·80	...	...	1·60	1·45	1·37	1·60
Metatarsal 3.		4 Bl. B. Taunton.	5 Bl. B. Taunton.				
1	5·50	5·40	5·94[1]	4·97	4·88	4·53	5·20
2	2·40	2·20	2·55	1·98	1·78	1·60	1·83
3	1·10	1·05	1 27	0·98	0·98	0·83	0·94
4	1·50	1·37	...	1·32	1·32	1·17	1·24
5	1·00	0·90	0·86	0·84	0·78	0·70	0·80
6	2·20	1·80	1·80	1·60	1·15	1·40	1·70
Metatarsal 4.							
1	5·60	...	...	4·95	4·55	4·54	5·30
2	2·30	...	...	1·80	1 58	1·51	1·65
3	0·84	...	...	0·62	0·68	0·67	0·70
4	1·60	...	...	1·23	1·20	0·94	1·30
5	1·98	...	...	1·78	0·61	0·65	0·78
6	2·00	...	...	1·55	1·50	1·50	1·75
Metatarsal 5.		2 Bl. B. Taunton.					
1	5·20	...	...	4·33	4·05	4·20	4·60
2	1·87	1·26	...	1·37	1·53	1·40	1·37
3	1·00[2]	1·30	...	0·72	0·83	0·57	0.75
4	0·90[3]	1·10	...	0·74	0·90	0·83	0·82
5	0·80	...	...	0·64	0·72	0·63	0·63
6	1·80	...	...	1·38	1·53	1·26	1·50

Phalanges, Pl. V., figs. 6 to 14.

We have had in the Taunton Museum, and in other places, abundant means of examining the phalanges of *Felis spelæa.* The well-known difficulties of assigning to each

[1] The largest Somerset specimen.

[2] Both 4th metatarsal articulations inclusive.

[3] Across cuboidal and metatarsal articulations.

first phalange the correct digit have been felt by us; and, though we give figures of specimens in the order in which we believe them to occur, we are by no means confident that we are right in all, particularly as the great variation in size has added to our difficulty in that respect.

Generally speaking, the first phalanges of *Felis spelæa* present the usual characteristics of the genus. The deeply concave proximal articulation, the border of which is broken by a deep depression posteriorly (figs. 6, 7, 8, 9, *a*, *b*), the pulley-like distal articulation, and the strongly marked muscular attachment on the lower surface, are common alike to the Felidæ and to the other carnivora; whereas, the less taper form of the shaft, swelling out laterally and frontally on the anterior surface towards the distal epiphysis (figs. 6, 7, 8, 9, *c*, *d*), the deeper proximal articulation, and the less strongly marked muscular attachments below, distinguish the feline phalanges from those of the bear's, which are, as far as this species is concerned, the only phalanges that are likely to be confounded with them.

As we state above, the great variety in size added much to the difficulty of determining the proper place of each phalange, but we came to the determination to trust to form alone, and to figure the largest of each form which we found most to resemble the corresponding bone in the lion.

Most of the phalanges we have seen are from that great depository of feline remains, Bleadon Cavern, in the Mendip, though we have good specimens from Sandford Hill, Oreston, Caldy, and other places.

The phalanges of the hind paw may easily be distinguished from those of the front by the superior stoutness in proportion to their length; the flexure also is not so great. There is but little difference, except in size, between those of digits 3 and 4; but we have always found that of digit 2 curved at least slightly, but sometimes considerably, outwards towards the centre of the paw, and to have the distal articulation set at an inward angle of about 60° to the shaft of the bone (fig. 6, *e*). This angle is sometimes, but not always, followed in the corresponding phalange of digit 3 (fig. 7, *e*); that of digit 4 being always at right angles (fig. 8, *e*), and that of digit 5 being set inwardly also at an angle of about 60° (fig. 9, *e*). This last digit is always strongly curved inwards. The outer may be distinguished from the inner side, in all the digits, by comparing the form of the sides of the posterior depression in the border of the proximal articulation. The angle at the summit of the outer side is nearly a right angle (figs. 6, 7, 8, 9, *a*); the inner side is more or less sloped, so that this angle at the summit is obtuse (figs. 6, 7, 8, 9, *b*).

All those we figure are from Bleadon, and are nearly, if not quite, equal in size to the largest we have seen elsewhere, and are vastly superior in size to those of any living *Feles*; but there are many fossil specimens of phalanges which do not differ in size or proportion from those of the existing lion and tiger.

Second Phalanges, Pl. XI, figs. 10 to 13.

The second row of phalanges of *Felis* may, as is well-known, be easily distinguished from those of other carnivora, by the peculiar outward turn of the distal articulation, which is so formed that the last or ungual phalange may fall back on the outside of the second so as to allow the claw to point upwards and protect its point from injury when retracted.

We are unable to give any rule for placing the phalanges of each digit in order, except that the distal articulation of digit 2, and sometimes also that of digit 3, is not at right angles to the axis of the bone, but at an angle of from 15° to 30°, as represented in fig. 10 *a*. That of digit 5 is generally shorter and stouter, in proportion, than the others. We have figured the largest of each form that we have met with. They are all from Bleadon; they occur also from the Sandford Hill Cave, and from Oreston, Caldy, Ilford, and a great many other localities.

The bone may be represented as triangular in section, from the distal to the proximal epiphysis, gradually expanding from the former to the latter. The proximal articulation is triangular in form, the inner and outer sides being convex, and the posterior deeply concave, having a deep pit within the concavity. It is divided by a ridge into two lateral concave portions, corresponding with the convexities of the distal articulation of the first phalange, and ends anteriorly in a truncated spur, pointing forwards and upwards.

The distal articulation is, as is well known, a cylindrical roll, set transversely on the end of the bone, narrower in front than posteriorly, so that one end projects outwards considerably, and at a varying angle to the axis.

The same rule may be given for the determination of those of the hind paws, by their superior stoutness, in proportion to their length, as we have given for the first phalanges.

Third Phalanges, Pl. XI, fig. 14.

The third or terminal phalange is a bone of rare occurrence. Five examples have occurred to us from English deposits; they are all from Bleadon. But one of them is in a sufficiently perfect state to figure and describe. It is probably that of the smaller hind toe. The lateral aspect may be gathered from the fig. 14, *a* being the articulation, the point of attachment of the tendons of the flexor, and *c* that for those of the extensor or retractile muscles. The large triangular portion which extended beyond these points is a hollow sheath, which contains within it at *d* a strong core, upon which the claw is fixed, so that it is kept firm in its place by the sheath. The form of the whole of these phalanges is alike, and we can find no difference between those of either the fore or hind paw, except size, that of the thumb of the fore paw being enormous. One of these from Gailenreuth is in the possession of Sir P. De Grey Malpas Egerton, Bart., M.P., F.R.S., and measures 2·5 inches in antero-posterior length, and 0·8 inch in width.

Measurements.

1st Phalanges:

Digit 1.	Figured specimens. 44. Bl. B., Taunton.	Smallest Set. At Taunton. 51. Bl. B.	*Felis tigris*, Brit. Mus. 114 L.	*Felis leo*, W. A. S.
	Inch.	Inch.	Inch.	Inch.
1	1·86	1·70	1·80	1·70
2	2·20	1·80	1·60	1·71
3	0·97	0·80	0·80	0·80
4	0·67	0·48	0·54	0·52
5	0·73	0·67	0·63	0·58
6	1·25	0·70	0·84	0·80
Digit 2.	(1). Bl. B., Taunton.	23. Bl. B.		
1	2·36	1·90	2·15	1·90
2	2·36	1·80	1·70	1·74
3	1·10	0·82	0·86	0·80
4	1·65	0·50	0·59	0·50
5	0·90	0·67	0·67	0·65
6	1·45	0·72	0·52	0·61
Digit 3.	32. Bl. B., Taunton.	24. Bl. B.		
1	2·01	1·85	1·99	1·80
2	2·34	1·78	1·61	1·51
3	1·02	0·78	0·80	0·78
4	0·65	0·50	0·49	0·48
5	0·83	0·59	0·62	0·60
6	1·13	0·70	0·51	0·80
Digit 4.	48. Bl. B., Taunton.	26. Bl. B.		
1	1·51	1·40	1·64	1·60
2	1·97	1·83	1·42	1·46
3	0·83	0·74	0·68	0·72
4	0·62	0·55	0·52	0·48
5	0·68	0·60	0·51	0·60
6	1·10	0·94	0·49	0·75

PLATE I.

Felis spelæa, Goldfuss.

(Natural size.)

Fig.

1. Lower jaw, external aspect. } These are from Bleadon Cavern, and form part of the
2. Lower jaw, internal aspect. } Collection of Mr. Beard in the Taunton Museum.
3. Lower jaw, posterior aspect, showing condyle, coronoid process, and angle. From the Brickearth of Crayford. In the possession of Dr. Spurrell.

W.A.S. del. J. Dinkel lith.

Lower Jaw.

W West imp.

PLATE II.

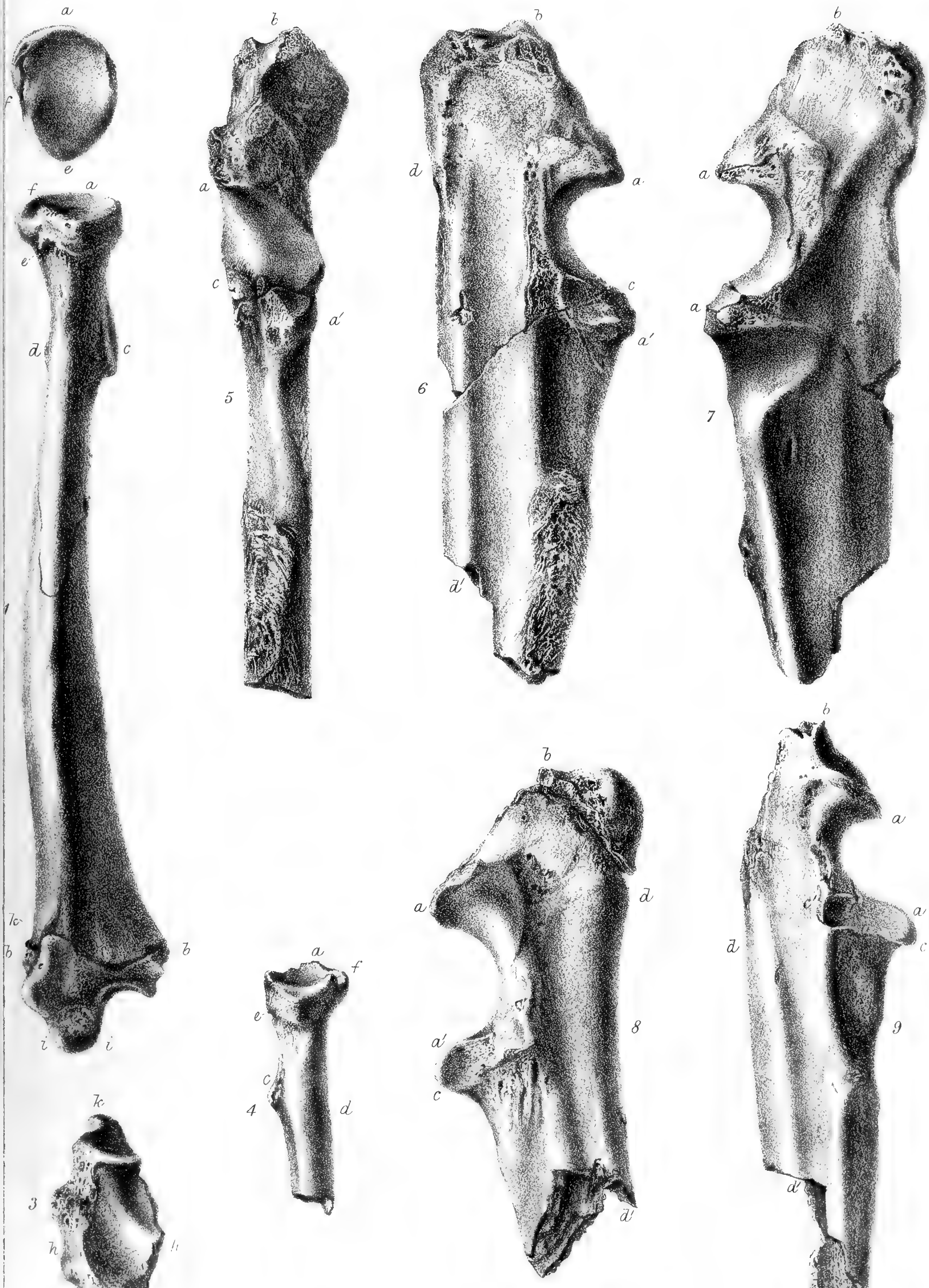
Felis spelæa.

FOREARM.

(Half natural size.)

Fig.

1. Radius. Sandford Hill Cavern. Mr. Beard's Collection in Taunton Museum. FS. S. H. B. 1.
2. Radius, proximal articulation of fig. 1.
3. Radius, distal articulation of fig. 1.
4. Radius, small form. Bleadon Cavern. Mr. Beard's Collection at Taunton. Bl. B. FS(L). 1.
5. Ulna, largest specimen known to authors (proximal half). Bleadon Cavern. Mr. Beard's Collection at Taunton. Bl. B. U. FS. 1.
6. Ulna, external view of fig. 5.
7. Ulna, internal view of fig. 5.
8. Ulna, proximal end. Sandford Hill. Belongs to same individual as the radius, fig. 1. FS. U. 1. S.H.B. Taunton. Mr. Beard's Collection.
9. Ulna, small form, external view. From Wokey Hyæna-Den. Mr. Boyd Dawkins's Collection.



½ nat. size.

W. Bidgood del. J. Dinkel lith.

W. West imp.

PLATE III.

Felis spelæa.

OS INNOMINATUM.

(Two thirds of natural size.)

FIG.

1. Os innominatum of *Felis spelæa*. Brick-earth, Slades Green, Crayford. British Museum.

2. Os innominatum of *Felis tigris*. India. In British Museum.

J. Dinkel del et lith

W. West imp.

PLATE IV.

Felis spelæa.

LEFT TARSUS.

(Natural size.)

Fig.

1. Astragalus.
2. Calcaneum.
3. Naviculare, reversed from right paw.
4. Cuboid.

4′. Cuboid, internal aspect.

4″. Cuboid, distal or metatarsal aspect.

5. Ecto-cuneiform, reversed from right paw.

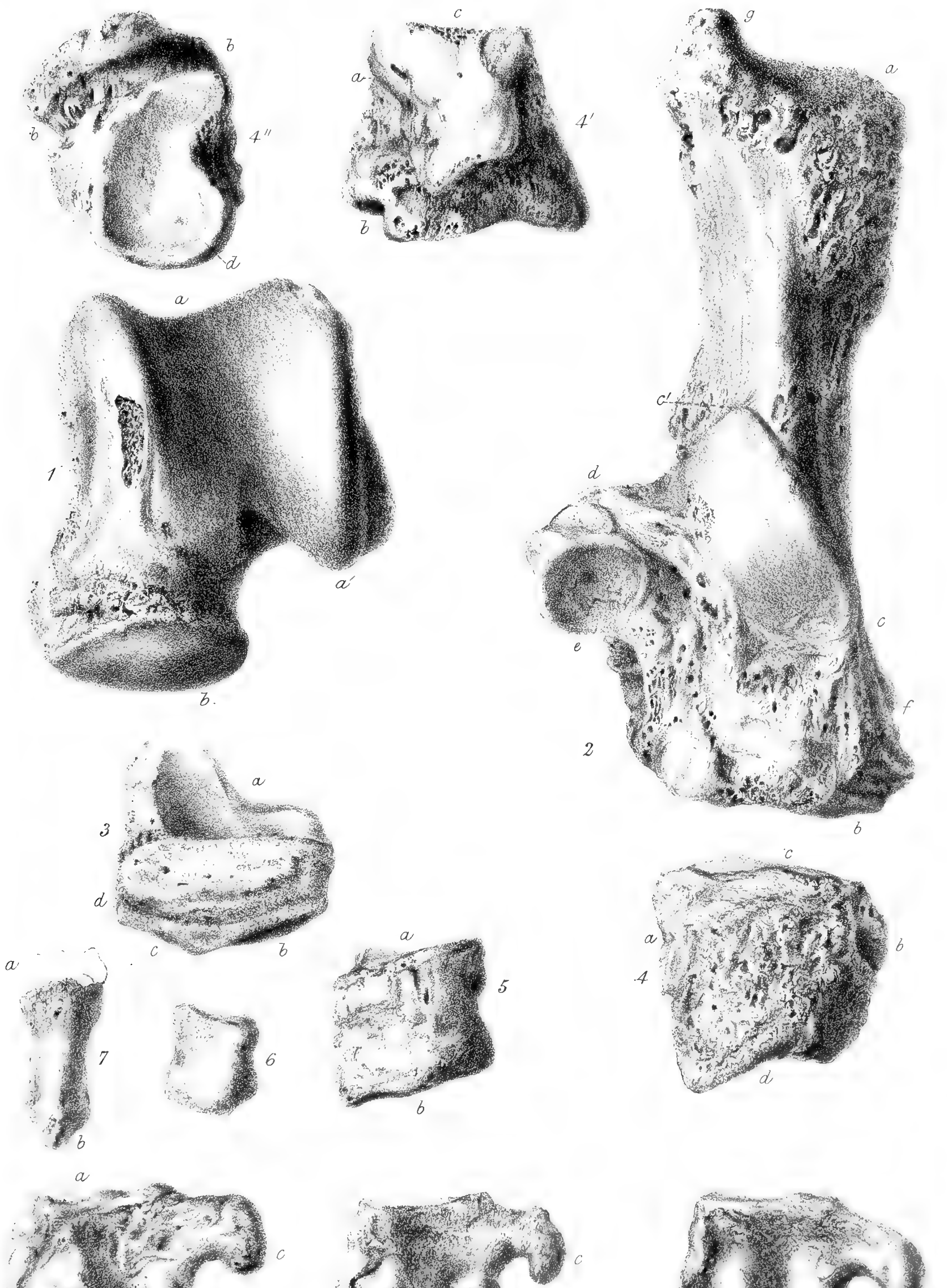
5′. Ecto-cuneiform, internal aspect, right paw.

5″. Ecto-cuneiform, internal aspect. Lion.

5‴. Ecto-cuneiform, internal aspect. Tiger.

6. Meso-cuneiform.
7. Endo-cuneiform.

Figs. 1, 2, 3, 4, 5, 6, 7, show the front or superior aspect of these bones; all those of *Felis spelæa* are from Bleadon Cavern, and formed part of the Collection of Mr. Beard, now in the Taunton Museum.



W.A.S. del. J. Dinkel lith.

PLATE V.

Felis spelæa.

RIGHT HIND PAW.

(Natural size.)

FIG.

1. Metatarsal 1. Bleadon Cavern.
2. Metatarsal 2.
3. Metatarsal 3.
4. Metatarsal 4.
5. Metatarsal 5.

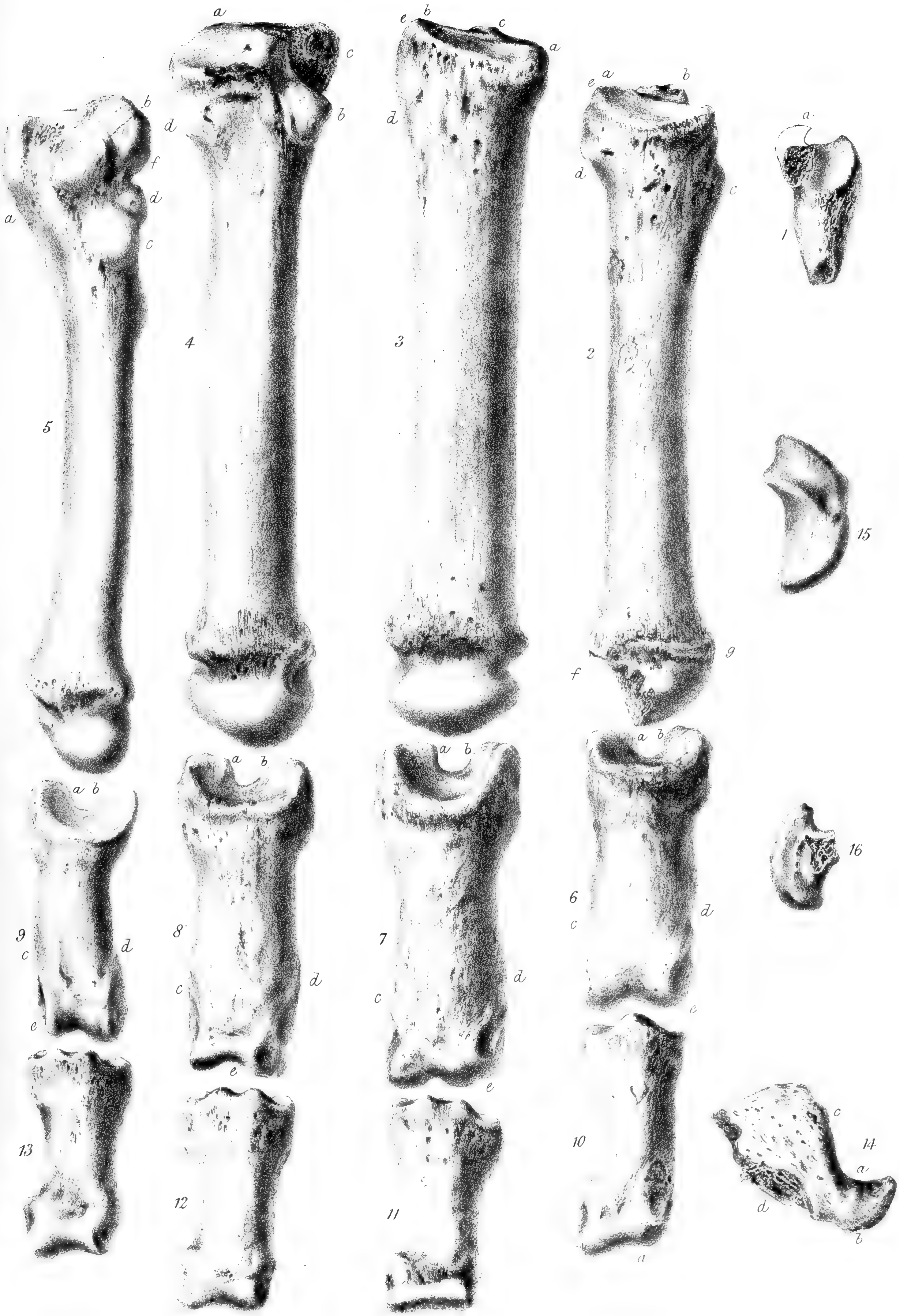
(Figs. 2–5) From Sandford Hill Cavern. These have the appearance of having all belonged to the same individual. Metatarsal 3 is reversed from a left paw.

6., 7., 8., 9. First phalanges. From Bleadon Cavern.

10., 11., 12., 13. Second phalanges. From Bleadon Cavern.

14. Third phalange, probably of the fifth toe. From Bleadon Cavern.

15., 16. Sesamoids. From Bleadon Cavern.



W A S del. J Dinkel lith
W West imp

TITLE-PAGES, INDEX, &c.,

TO THE

MONOGRAPH ON THE REPTILIA OF THE LONDON CLAY,

AND OF THE

BRACKLESHAM AND OTHER TERTIARY BEDS.

Directions to the Binder.

The Monograph on the Reptilia of the London Clay, and of the Bracklesham and other Tertiary Beds, will be found in the publications of the Palæontographical Society issued for the years 1848, 1849, and 1856.

Let the title-page and table of contents found in the volume for 1848 be cancelled. Substitute those now provided, and let the order of binding be, general title-page; table of contents; index of species; title-page to Part I, pages 1—76, plates I—XXVIII, VIIIA, XA, XIIIA, XVIA, XVIIIA, XIX*, XIXB, XIXC, and XIXD (1848 volume); Part I, Supplement No. 1, pages 77—79, plates XXVIIIA, XXVIIIB (1856 volume); Part II, Supplement No. 1, pages 1—4, plate XXIX (1849 volume); Part II, pages 5—50, plates I—XII, and IIA; Part III, pages 51—68, plates XIII—XVI (1849 volume).

MONOGRAPH

ON THE

FOSSIL REPTILIA

OF

THE LONDON CLAY,

AND OF THE

BRACKLESHAM AND OTHER TERTIARY BEDS.

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

AND

PROFESSOR BELL, F.R.S., F.L.S., F.G.S., &c.

LONDON:

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Part I, Supplement I, pages 77—79, plates XXVIIIa, XXVIIIb, April, 1858.

Part II, Supplement I, pages 1—4, plate XXIX, August, 1850.

Part II, pages 5—50, plates I—XII, and IIa, August, 1850.

Part III, pages 51—68, plates XIII—XVI, August, 1850.

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Family—FLUVIALIA.

Family—Paludinosa.

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ON THE

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THE FOSSIL REPTILIA

OF THE

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CHELONIA (CHELONE, &c.).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

AND

PROFESSOR BELL, F.R.S., F.L.S., F.G.S., &c.

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ON

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CHELONIA (EMYS).

BY

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CHELONIA (PLATEMYS).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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1850.

MONOGRAPH

ON

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OF THE

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PART II.

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CROCODILIA (CROCODILUS, &c.).

BY

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MONOGRAPH

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BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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1850.

TITLE-PAGES, INDEX, &c.,

TO THE

MONOGRAPH ON THE REPTILIA OF THE CRETACEOUS FORMATIONS.

Directions to the Binder.

The Monograph on the Reptilia of the Cretaceous Formations will be found in the publications of the Palæontographical Society for the years 1851, 1857, 1858, and 1862.

Let all the title-pages, together with page 19 in 1857 volume, pages 27—30 in 1858 volume, and page 1 in 1862 volume, be cancelled, and substitute those now supplied. Let the order of binding be, general title-page; table of contents; index of species; title-page to Part I, pages 1—118, plates I—XXXVII, with VIIA and IXA (1851 volume); title-page to Supplement No. 1, pages 1—19, plates I—IV (1857 volume); title-page to Supplement No. 2, pages 27—30, plate VII (1858 volume); title-page to Supplement No. 3, pages 1—25, plates I—VI (1858 volume); and title-page to Supplement No. 4, pages 1—18, plates I—IX (1862 volume).

A MONOGRAPH

ON THE

FOSSIL REPTILIA

OF

THE CRETACEOUS FORMATIONS.

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

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Supplement I, pages 1—19; plates I—IV, November, 1859.

Supplement II, pages 27—30; plate VII, March, 1861.

Supplement III, pages 1—25; plates I—VI, March, 1861.

Supplement IV, pages 1—18; plates I—IX, August, 1864.

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OF THE

MONOGRAPH ON THE REPTILIA OF THE CRETACEOUS FORMATIONS.

* The *Enaliosauria* of Conybeare were divided into two orders, 'Sauropterygia' and 'Ichthyopterygia,' in a "Memoir on the Classification of Recent and Fossil Reptilia," in the 'Reports of the British Association,' 1859, on the grounds therein assigned, pp. 159, 160.

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REPTILIA OF THE CRETACEOUS FORMATIONS.

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* For additional remarks on the Iguanodon, see 'Monograph on the Wealden Reptilia.'

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

CRETACEOUS FORMATIONS.

PART I.

PAGES 1—118; PLATES I—XXXVII, with VIIA and IXA.

CHELONIA (LACERTILIA, &c.).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

Issued in the Volume for the Year 1851.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1851.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

CRETACEOUS FORMATIONS.

SUPPLEMENT No. I.

PAGES 1—19; PLATES I—IV.

PTEROSAURIA (PTERODACTYLUS).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

Issued in the Volume for the Year 1857.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1859.

4to, 1851, *e.g.*, is 2 inches 2 lines; that of the wing-bone, figured in Tab. IV, figs. 1—3 of the present Monograph, is 3 inches. The transverse diameter of the distal end of the humerus of *Pterodactylus grandis*, Cuv., the largest species hitherto obtained from the Lithographic Slates of Germany, is 1 inch 3 lines; neither the radius, ulna, nor metacarpal of the wing-bone of the same species presents a diameter of its largest end equalling 1 inch.*

The articular end of the long wing-bone (Tab. IV, figs. 1—3), being most probably that of an antibrachial bone, and the total length of the bone, whether radius or ulna, being, according to proportions of either of these bones in *Pterodactylus suevicus*, 16 inches, the following would be the length of the other long bones of the wing in the large Pterodactyle to which the above-cited specimen belonged, according to the proportions which those bones bear to the radius or ulna in *Pterodactylus suevicus*:

	Ft.	In.	Lines.
Humerus	1	0	0
Radius	1	4	0
Metacarpus of wing-finger	1	8	0
First phalanx of do.	2	3	0
Second do. do.	1	9	0
Third do. do.	1	5	0
Fourth do. do.	1	1	0
Total length of long-bones of one wing	10	6	0

Supposing the breadth of the Pterodactyle between the two shoulder-joints to be 8 inches, and allowing 2 inches for the carpus and the cartilages of the joints of the different bones, in each wing, we may then calculate that a large *Pterodactylus Sedgwickii* would be upborne on an expanse of wings of not less than 22 feet from tip to tip.

I look forward with confidence to future acquisitions of remains of the truly gigantic Pterodactyles of the cretaceous periods, more especially from the Greensand locality, near Cambridge, as a means of throwing more light on the peculiar osteology of the extinct flying reptiles.

For the opportunities at present afforded me, I have to express most grateful acknowledgments to my old and much esteemed friend the Rev. Professor Sedgwick, F.R.S.; to the acute and active curator of the Woodwardian Museum, Mr. Lucas Barrett, F.G.S.; to James Carter, Esq., M.R.C.S., Cambridge; to T. W. Beddome, Esq., of Trinity College, Cambridge; and to the Rev. G. D. Liveing, M.A., of St. John's College, Cambridge, to whom I am indebted for the lower jaw of *Pterodactylus Sedgwickii* (Tab. I, figs. 2, *a, b, c, d*).

* These admeasurements are derived from the excellent figures of a recently acquired specimen, well described by Professor Andreas Wagner of Munich, in the "Abhandlungen der Kais. Bayer. Akademie der Wissenschaft," Band iii, p. 663, taf. xix.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

CRETACEOUS FORMATIONS.

SUPPLEMENT No. II.

PAGES 27—30; PLATE VII.

DINOSAURIA (IGUANODON).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

Issued in the Volume for the Year 1858.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1861.

SUPPLEMENT (No. II)*

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE CRETACEOUS FORMATIONS.

ORDER—DINOSAURIA, *Owen.*

Genus—IGUANODON, *Mantell.*

Dentition of the Upper and Lower Jaws (Tab. VII).

IN the year 1858 a considerable part of the skeleton of an Iguanodon was discovered in the Lower Greensand formation at Black Gang Chine, Isle of Wight.

The workmen disposed of various parts of it, as opportunities offered; and before steps could be taken to secure the whole for the British Museum, portions of jaws and teeth had passed into the hands of private collectors. From the best account of the discovery that I could collect, it appeared that the entire cranium, somewhat dislocated, had been brought to light by the quarrymen; but the bones were in a peculiarly fragile, crumbly state, and only the firmer parts of the jaws, lodging the teeth, were secured, and these portions in fragments. Some of them, of both upper and lower jaws, are now in the British Museum; and learning that other portions had been acquired by George Robbins, Esq., F.G.S., of Castle, near Bath, I addressed a letter to that gentleman, who very kindly brought his specimens to London, and liberally placed them in my hands for description. The largest fragment fitted on to another portion of the jaw in the British Museum, adding to its value as an illustration of the most interesting of the hard parts of the Iguanodon. It consisted of a fragment of the left upper jaw, with three teeth; there were also three fragments of the left ramus of the lower jaw, with one or more teeth in each.

The germs of the new teeth are developed, in all Saurians, as is well known, on the inner or mesial side of the base of the old teeth.† One of the teeth in the

* This Memoir was given as "Supplement (No. II) to the Monograph on the Iguanodon," in the 1858 volume.

† Of this character Professor Melville ably availed himself in determining the upper and lower teeth of the Iguanodon, in the joint memoir, by Dr. Mantell and himself, in the 'Philos. Trans.' for 1818.

portion of the upper jaw (Tab. VII, figs. 1, 2, and 3, *m*) has its summit obliquely worn from above downward and outward to the enamelled trenchant border ; the contiguous tooth, *n*, the summit of which has not suffered abrasion, is pressing upon the smooth, concave side of the older tooth ; a third tooth, *o*, the crown of which is still buried in the alveolus, has the same relation to the more advanced tooth, *n*. The smooth, concave sides of these teeth, shown in fig. 1, are, therefore, the inner or mesial ones, and the flat surface of bone extending from the alveolar border is the inner or palatal alveolar wall of the maxillary bone.

The crown of each tooth shows that more definite and prominent primary ridge on their outer side (*a*, figs. 2, 3, and 4) which is characteristic of the teeth of the upper jaw of the Iguanodon.

In figs. 5 and 6, three of the teeth (*m*, *n*, *o*) show precisely the same stages of growth as the foregoing one; one (*m*) has the summit abraded from the enamelled trenchant border downward and outward; in a second (*n*) the crown is extricated, but not worn; in a third (*o*) the major part of the crown is still in the formative cell. The relative position of these three teeth to each other is, in one respect, the reverse of those in fig. 1. The convex ridge side of the crown of the second tooth (fig. 5, *n*) partly overlaps (instead of being overlapped by) that of the first (*m*), and it is similarly overlapped by the germ of the third (*o*). The side of the jaw to which the newer teeth (*a r*, fig. 5) are nearest is the inner one ; the smooth, longitudinally concave, side of the tooth is next the outer side of the jaw (fig. 6) ; they belong to the lower jaw, and they show the formal characters of mandibular teeth ; the primary ridge, *a*, is less produced.

The upper teeth (figs. 1—4) are narrower, in the direction of the length of the jaw, or from *c* to *d*, and are less curved than the lower ; the fang and base of the crown are thicker, transversely to the jaw or from *a* to *g* (fig. 4). The primary ridge, *a*, is more prominent; the secondary ridges, *b*, are less constant and less marked than in the lower teeth. Both fore (*c*) and hind (*d*) borders at the base of the crown are entire, and are bent or produced slightly outward, bounding the transversely concave areæ between them and the primary ridge; they slightly diverge as the crown expands; along its apical half both borders are serrate or serro-lamellate, converge, and, with a slight difference of contour, meet at the apex of the unworn crown formed by the termination of the primary ridge (*n o*, fig. 2). This ridge, *a*, commencing in a tooth 3½ inches long about 1 inch 8 lines from the base, becomes thinner and sharper as it projects, which is to the greatest degree before it reaches the middle of the crown, whence it gradually subsides to the apex ; its longitudinal profile is a slight curve convex outward : this ridge divides the outer side of the crown unequally, the front area, *a*, *c*, being broader, sometimes nearly twice the extent of the hind one, *a*, *d*. The dentated margin of the crown to which the primary ridge is the nearest is the posterior one, and is the shortest and straightest (fig. 2, *d*). A few, irregular, linear, minute, ridges mark the enamel in both areæ; being more numerous, from three to five, in the wider one, and not more than one or two of these extend from the base to the apex of the crown; at the base they converge and sometimes unite as they descend.

The fore part of the tooth is slightly hollowed at the basal half of the crown (fig. 4, *e*); the fossa, which is elongated and concave transversely, gradually filling up towards the apex; below the middle of the crown, at the apical half, the fore part of the crown (fig 1, *e*) is convex transversely. The hind part of the tooth (fig. 4, *f*) is impressed by a longer, wider, and shallower depression, beyond which it shows an oblique, rather flattened than convex, surface. The inner part of the tooth, which is narrow in the fang (fig. 4, *g*), gradually expands upon the crown to near the apex, where it again grows narrower; at its broadest part it is flattened or even a little concave transversely, but rounds off convexly into the fore and hind parts of the crown (fig. 1, *m*).

The abraded surface of the crown is remarkably smooth and level; it inclines from before downward and backward, and more so from within downward and outward in the upper jaw.

The longitudinally convex and ridged part of the crown being external in the upper teeth, and the position of the primary ridge determining the fore and hind borders of the crown, a detached tooth may be at once referred to the right or left maxillary bone. The germ of the successional tooth causes an excavation on the inner, and generally towards the hinder, part of the base of the one in use.

In a left upper tooth, with one fourth of the crown abraded, and projecting 1 inch 9 lines from the alveolar border, the crown of the successional tooth had its apex on a level with that border, and on the inner and back part of this crown was the thin shell of the apex of a third tooth in the successive series.

The outer alveolar wall of the upper jaw is very thin at the outlet of the sockets, and is a little produced at the intervals of the teeth; it rapidly increases in thickness towards the base of the sockets.

The inner or palatal wall also thins off to a crenate edge; so much as is preserved in the specimens examined was flat and smooth, as in fig. 1. The grinding surface of the tooth (*m*), of which one third of the apex had been worn away by mastication, projected only about half an inch from the inner alveolar margin.

The lower or mandibular teeth of Iguanodon have a broader crown, and a fang less thick transversely to the jaw than the upper teeth; they are more curved lengthwise, the curvature being concave outward, contrary to that of the upper teeth. The outer side of the tooth (fig. 6, *m*, and fig. 11, *o*) is smooth and convex from the fore (*c*) to the hind (*d*) border, its greatest breadth being opposite the middle of the crown. The primary ridge, commencing at the enamelled base of the inner and flatter part of the crown (fig. 5, *m*, *a*, and fig. 11, *a*), slowly rises, and is most marked along the apical half, but is here much less prominent than in the upper teeth; it divides the crown into two unequal areæ, the front one (fig. 5, *m, a, c*) being at its broadest part nearly twice the breadth of the back one (ib., *a, d*). The front area is pretty equally subdivided by a low, secondary, longitudinal ridge, *b*, each division being feebly concave across. The angle between the entire (fig. 11, *i*) and serrated (fig. 11 *c*,) parts of the borders of the crown is more marked than in the upper teeth; the basal part of the posterior border (fig. 11, *d*) seems as if it were pushed inward and forward by the crown of the succeeding and less developed tooth. The anterior serrated border (fig. 5, *n, c*) is at first straight, then describes a bold, convex curve as it approaches the apex. The posterior border (ib., *d*) passes almost to that apex in a straight line before it is rounded off to the obtuse summit, where the primary ridge terminates. At the fore part of the tooth (fig. 9) the fang is convex, and the basal half of the crown shows a lanceolate depression, slightly concave across. The back part of the tooth (fig. 8) shows a longer, shallow depression, *s*, extending over the upper half of the fang and lower third of the crown. The inner or longitudinally convex side of the narrow fang, in worn teeth, is sharply excavated, even to expose the pulp-cavity, by the crown of the successional tooth (figs. 13 and 14, *p*).

The apex of the crown of a young successional tooth is shown at *r*, on the inner side of the tooth *p* in fig. 5. The remnant of the fang and alveolar depressions of the old and shed teeth are shown at *t, t*, on the outer side of the succeeding teeth, in fig. 7. Both are from the lower jaw.

The upper part of the outer alveolar wall of the mandible bends out, so as to be concave vertically; its border is more deeply crenate than in the upper jaw. A vascular canal runs about an inch and a half beneath it, from the oblique orifices open upon the outer surface of the mandible.

Figs. 10—14, in Tab. VII, from the dental series of the same individual, discovered in the Greensand of Black Gang Chine, exemplify different degrees of destruction of the tooth by abrasion and absorption. Fig. 10 is an unworn tooth from the fore part of the lower jaw. Figs. 11—14 show the size of the majority of the teeth. In figs. 13, 14 the letter *p* marks the cavity caused by pressure of the new or successional tooth; in fig. 14 it has laid open the pulp-cavity of the old tooth.

Fig. 15 shows the inner side, and fig. 16 the fore part, of a mandibular tooth of a young Iguanodon, from the Upper Greensand near Cambridge. The inner side of the fang shows the excavation due to the pressure of the successional tooth (*p*, fig. 15). Fig 17 shows the outer and inner sides of a smaller tooth of an Iguanodon, from the same formation and locality. All the evidences of Iguanodon which have yet reached me therefrom indicate a small size; but whether this may relate to the immaturity of the individual, or to a small variety, I am uncertain.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

CRETACEOUS FORMATIONS.

SUPPLEMENT No. III.

Pages 1—25; Plates I—VI.

PTEROSAURIA (Pterodactylus)

AND

SAUROPTERYGIA (Polyptychodon).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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1861.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

CRETACEOUS FORMATIONS.

SUPPLEMENT No. IV.

Pages 1—18; Plates I—IX.

SAUROPTERYGIA (Plesiosaurus).

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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SUPPLEMENT (No. IV)*

TO THE

MONOGRAPH

OF

THE FOSSIL REPTILIA

OF THE

CRETACEOUS FORMATIONS.

ORDER—SAUROPTERYGIA, *Owen.*

Genus—PLESIOSAURUS, *Conybeare.*

IN former Monographs and works are given descriptions of the following species of ***Plesiosaurus*** from Cretaceous deposits:

PLESIOSAURUS CONSTRICTUS, *Owen*. 'Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' 4to, 1850, p. 398, pl. xxxvii, figs. 6 and 7. From Steyning Chalk-pit, Sussex.

PLESIOSAURUS BERNARDI, *Owen*. Op. cit., p. 396, pl. xxxvii, figs. 8, 9. From the Upper Chalk, Houghton Pit, near Arundel, Sussex.

PLESIOSAURUS PACHYOMUS, *Owen*. Monograph, Palæontographical Society, 4to, 1851, p. 64, tabs. xx, xxi. From the Upper Greensand at Reach, near Cambridge.

PLESIOSAURUS LATISPINUS, *Owen*. 'Descriptive Catalogue of the Fossil Remains of ***Reptilia*** and ***Pisces*** in the Museum of the Royal College of Surgeons of England,' 4to, 1854, p. 63, No. 251.

* This Memoir was given as 'Supplement No. II,' in the volume for 1862.

PLESIOSAURUS NEOCOMIENSIS, *Cpche.* 'Description des Fossiles du Terrain Cretacé des Environs de Sainte-Croix,' 4to, 1858—1860, par N. J. Pictet and G. Campiche, p. 12, pl. vi.

The following are descriptions of other species of Cretaceous *Plesiosauri*, with additional illustrations of already indicated species:

PLESIOSAURUS PLANUS, *Owen*. *Vertebral Centrums,* Tab. I, II, and III.

The cervical centrum selected for the figures 1—4, Tab. I, gives the characters afforded by this instructive part of the vertebral column of a *Plesiosaurus*. The flatness, both of the under (fig. 4) and of the terminal articular surfaces (fig. 2), suggested the name distinguishing the species, or at least the vertebræ by which alone this cretaceous Plesiosaur has hitherto been exemplified. The costal surfaces (Tab. I, figs. 1, 2, and 4, *pl*) are of a narrow, oblong figure, formed, as it were, by truncation of the lower angles of the triangular centrum, of which the apex has been more broadly removed by the sections, leaving the neural (ib., *n*) and neurapophysial (*np*) surfaces above. If the borders of the costal surface have projected with a sharper definition, they have been abraded, as, indeed, is most probable; almost all the bones derived from the stratum of Cambridgeshire phosphatic Greensand being more or less rubbed or worn, either in the original imbedding, or subsequently by the mechanical appliances by which the phosphatic nodules are extracted. I have selected the centrum which has been least subject to this attrition, from a large series of the present species. Subsequent observers, who may have been favoured with entire and unworn fossil vertebræ with the main features and proportions of the *Plesiosaurus planus*, will make allowance for the circumstances in which the materials for reconstructing that species first came to hand.

What may be more certainly predicated of the costal surface is the absence of depth and of linear horizontal bisection, both which characters are present in the cervicals of some other *Plesiosauri*. The distance between the costal and neurapophysial surfaces is nearly three times that of the vertical diameter of the former, and the intervening non-articular surface is smooth, and also plane or flat, sloping upward towards the neurapophysial border, and showing no sinking or concavity in the longitudinal direction. The neural surface, $2\frac{1}{2}$ lines in breadth at the narrowest part, slightly expands towards the posterior surface of the centrum. The neurapophysial surfaces are coextensive with the long or fore-and-aft diameter of the centrum, and of nearly equal breadth anteriorly; they are smooth and very shallow, with a slightly defined, thin border, which is undulated outwardly, descend-

TITLE-PAGES, INDEX, &c.,

TO THE

MONOGRAPH ON THE REPTILIA OF THE WEALDEN AND PURBECK FORMATIONS.

Directions to the Binder.

The Monograph on the Wealden and Purbeck Reptilia will be found in the publications of the Palæontographical Society for the years 1853, 1854, 1855, 1856, 1857, 1858, and 1862.

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MONOGRAPH

ON THE

FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

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Supplement III, pages 19—21; plate X, August, 1864.

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OF THE

MONOGRAPH ON THE REPTILIA OF THE WEALDEN AND PURBECK FORMATIONS.

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ON THE

REPTILIA OF THE WEALDEN AND PURBECK FORMATIONS.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

PART I.

PAGES 1—12; PLATES I—IX.

CHELONIA (PLEUROSTERNON, &c.)

[PURBECK.]

BY

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

PART II.

Pages 1—54; Plates I—XIX and XVIa.

DINOSAURIA (Iguanodon).

[WEALDEN.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

PART III.

PAGES 1—26; PLATES I—XII.

DINOSAURIA (MEGALOSAURUS).

[WEALDEN.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

PART IV.

PAGES 8—26; PLATES IV—XI.

DINOSAURIA (HYLÆOSAURUS).

[WEALDEN.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE WEALDEN FORMATIONS.

ORDER—*DINOSAURIA.*

Genus—HYLÆOSAURUS,* *Mantell.*

THE third well-marked genus of Dinosaurian Reptiles, referred to in a former Monograph,† is founded upon a large portion of the skeleton of one and the same individual (T. IV), to which the name at the head of this section has been applied by its discoverer, Dr. Mantell.

In assigning to this genus a place in the Dinosaurian order, I have been guided by the structure of the vertebral column, especially the sacrum (T. V and VI); and, in placing it after the Megalosaurus, by the following considerations. The distinct alveoli in the jaws of the Megalosaurus, and the resemblance of its teeth to those of two extinct Crocodilians, viz., the Argenton species and the Suchosaurus, seemed to claim for that great carnivorous Dinosaur a position higher, or nearer to the Crocodilian order. In the present genus, which there is good reason for believing to have resembled the Lizards more than the Crocodiles in its dental characters, an affinity to the *Crocodilia* is, however, manifested not only by the structure of the vertebræ and ribs common to it with other Dinosaurs, but likewise by the presence of dermal bones, or scutes, with which the external surface was studded.

The Hylæosaurus has not been made known, like the Megalosaurus, from detached parts of the skeleton successively discovered and analogically recomposed, but was

* ὑλαῖος, *sylvestris,* belonging to a wood, σαῦρος, lizard.

† Part iii, p. 1, Palæontographical Publications for 1856.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

PART V.

PAGES 31—39; PLATE VIII.

LACERTILIA (NUTHETES, &c.)

[PURBECK.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

Issued in the Volume for the Year 1858.

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

ORDER—*LACERTILIA*.

Genus—NUTHETES,* *Owen*.

NUTHETES DESTRUCTOR, *Owen*.

FOR a knowledge of the fossil remains on which the present genus and species were founded,† I am indebted to Charles Wilcox, Esq., M.R.C.S., of Swanage, Dorsetshire, by whom the specimens submitted to me, including a portion of jaw with teeth, were discovered in the Purbeck formation, from the bed marked *k* 93 in Mr. Austen's 'Guide.'‡

The teeth are attached by partial anchylosis to depressions on the inner side of an alveolar wall, or according to the "pleurodont type." Their enamelled crowns are moderately long, compressed, pointed, slightly recurved, with a well-marked but finely serrated margin before and behind; the thickest part of the crown is not at the middle, but nearer the anterior border, as in the great Varanus (*Var. crocodilinus*) and in *Megalosaurus;* and they clearly resemble, in

* Abbreviated from νουθέτητης, *Monitor;* in reference to the resemblance of the teeth of the fossil to those of the modern Varanian Monitors.

† 'Quarterly Journal of the Geological Society,' 1854, p. 120.

‡ 'Guide to the Geology of the Isle of Purbeck,' by the Rev. J. Austen, M.A., Blandford, 1852.

miniature, the teeth of that great carnivorous reptile. To the question whether these Purbeck fossils might not be of a fœtus or young of Megalosaurus, the answer is, that the lower jaw of the Nuthetes differs from that of Megalosaurus in not having the inner alveolar wall developed in the same degree, and in not exhibiting any rudiments of alveolar divisions.* The inner wall is not produced in a greater degree than in the modern *Varani*. The largest teeth measure two lines in diameter at the base of the crown, which is more or less excavated on the inner side by the pressure of the matrix of a successional tooth.

The length of the largest fragment of the mandible was one inch and a half; the depth of the outer wall was six lines, that of the inner wall was from three to four lines. The exterior surface of the bone is smooth and polished, but shows under the pocket-lens very fine longitudinal linear markings; it is perforated by a series of nervo-vascular foramina along the alveolar wall, and is traversed near the lower margin by a line answering to the suture dividing the dentary from the angular piece in the jaw of *Varanus*.

The fossils give evidence of a carnivorous or insectivorous lizard of the size of *Varanus crocodilinus*, or great land-monitor of India. The specific name relates to the adaptations of the teeth for piercing, cutting, and lacerating the prey.

Of the vertebral characters I have not, as yet, received satisfactory evidence. *Nuthetes destructor* is referred solely on mandibular and dental characters to the "pleurodont section" of the order LACERTILIA. But, in the same division of the Purbeck strata, viz., from the "Feather Quarry," containing *Cyclas* and ***Planorbis***, have been found long bones of a small Saurian and dermal scutes, agreeing, in regard to proportional size, with the jaw and teeth of *Nuthetes*. The bones present the characters of tibia and fibula, and are longer in proportion to their breadth than in any known recent form of Crocodilian; they are associated in the same slab with the scutes, which are subquadrate in form, about eight lines in one diameter and six lines in the opposite; smooth on the inside, impressed by minute, circular pits on the outside, and presenting more the character of the bony, dermal scutes of *Crocodilia* than of those of any known species of *Lacertilia* so defended. Additional evidence is needed to determine the relations of these small, pitted, dermal scutes to the bones and teeth of *Nuthetes*.

* 'Monograph on Megalosaurus,' vol. for 1856, p. 21.

Genus—Saurillus,* *Owen.*

Saurillus obtusus, *Owen.*

The fossils upon which the above genus and species were founded† were transmitted for my determination, in 1854, by Mr. W. R. Brodie, of Swanage, and were discovered by that persevering explorer of the Purbeck beds, in the "Dirt-bed," No. 93, of Mr. Austen's 'Stratigraphical List' above cited.

The most instructive specimen consisted of the right dentary element of the lower jaw, containing thirteen teeth. These are moderately long, conical, and obtuse; but are neither so long nor so recurved as in *Nuthetes*, nor are the crowns compressed, as in that genus. On the outer side of the dentary bone, not far below the alveolar border, are six nervo-vascular foramina in a longitudinal row, relatively as numerous and large as in Iguanodon, and indicating, as in that and other Saurian reptiles, the scaly covering of the jaws and the equally reptilian simple and subdivided condition of the salivary apparatus in *Saurillus*. The teeth are implanted according to the pleurodont type.

Supposing the fossil to have come from a mature individual, the size of the animal must have been nearly that of the common European lizard, *Lacerta agilis*. It was most probably insectivorous. The specific name, "*obtusus*," refers to the obtuse termination of the muzzle, as indicated by the form of the fore part of the jaw, and also to the blunt apices of the conical teeth.

Genus—Macellodon,‡ *Owen.*

Macellodon Brodiei, *Owen.* Tab. VIII, fig. 10.

In the slab of the fresh-water Purbeck stone containing the portions of upper and lower jaw, with teeth, on which the above genus and species were founded,§ there were also specimens of small, subquadrate, pitted, dermal scutes, and of a vertebral neural arch, corresponding proportionally in size with the teeth.

One specimen consists of the right superior maxillary bone, containing eight nearly entire teeth, and showing the places of attachment of thirteen or fourteen

* Abbreviation of σαυρος, *saurus*, a lizard.

† 'Quarterly Journal of the Geological Society,' No. 40, pp. 423 and 482.

‡ Μακελλα, *a spade*, ὀδους, a tooth.

§ 'Quarterly Journal of the Geological Society,' 1854, p. 422.

such teeth, the mode of attachment being by partial anchylosis to the bottom of an alveolar groove and to the side of an outer alveolar wall.

The crown of the teeth is broad, compressed, with sharp, subcrenate margins at the apical half, curving in most to a low point at the summit, and having a semicircular contour when this is worn away, as at *c*, fig. 10. A few of the anterior teeth are narrower, and the crenate margins converge, almost straight, to a sharper point, as in *a*, fig. 10. The older teeth have the crown reduced by attrition to the shape of a spade (*b*, fig. 10), suggesting the name of the genus. The enamel is marked by very fine, longitudinal ridges, the terminations of which give the crenate character to the unworn margins of the crown; a larger longitudinal rising marks the middle of the flattened surface, and is more conspicuous on the outer than the inner side of the crown in the lower jaw; it commences at a short distance from the base of the enamelled crown, and terminates at the apex. From this middle, thickest part of the crown the tooth narrows to the lateral margins, its transverse section across the middle of the crown resembling that of the upper part of the crown of the tooth of *Echinodon* (fig. 6, *b*).

In a portion of the upper maxillary bone of ***Macellodon Brodiei,*** the low palatal alveolar plate terminates internally in a smooth border, which had formed the outer boundary of an extended palatal vacuity, as in most lizards; this structure, with the unequal development, the succession, and pleurodont mode of implantation of the teeth, indicates the Lacertian affinities of *Macellodon.*

In a small slab from the lower part of the Purbeck stratum, called "dirt-bed, containing shells," Mr. Brodie discovered the dentary element of the lower jaw of *Macellodon,* containing thirteen teeth, and alveolar depressions for twenty; with this were associated the neural arch of a vertebra, portions of ribs, and some dermal, bony scutes. The teeth in place were anchylosed to depressions in an outer alveolar wall; a few at the fore part of the jaw were less expanded relatively to their length than the rest, which presented the Macellodont type of crown. They are separated by slight intervals, and the teeth are much smaller in proportion to the jaw than in *Nuthetes.* The dentary bone, figured of the natural size at Tab. VIII, fig. 10, presented the posterior notch for articulation with the angular and surangular elements; its outer surface is convex, and perforated at its anterior half by a linear series of nervo-vascular canals.

The neural arch associated with the above portion of lower jaw bears a greater proportional size thereto than in most lizards; it exhibits long diapophyses, as in the lumbar and anterior caudal Saurian vertebræ, supports a moderately long spine, and shows a small, circular, neural canal; the zygapophyses have been broken away from the exposed surface; and the centrum has been, apparently, detached from a sutural connexion with the arch, which would be rather a Crocodilian than a Lacertian character.

The dermal scutes agree in proportional size with the vertebra; they are subquadrate, smooth, and slightly concave on the inner surface; they are impressed with small, round pits on the outer surface; of two scutes in apparently natural juxtaposition, one slightly overlapped the other.

The length of the dentary bone of *Macellodon*, above described, is 9 lines, or 17 millimètres; the breadth of the neural arch across, and including the diapophyses, is 10 lines; the long diameter of a scute is 9 lines; its short diameter 6 lines. On the supposition, raised by the collocation in the same slab of these remains, that they may have been parts of the same animal, we should reconstruct, in idea, a Lacertian with a proportionally small and short-jawed head, and with a skin defended by crocodilian scutes; but I have seen similar scutes accidentally associated, in another block of Purbeck clay, with mammalian jaws and teeth, and they may have no closer relation to *Macellodon*.

The remains of small, lizard-like reptiles, with teeth more or less fitted for piercing, cutting, or crushing the chitinous coverings of *Articulata*, are such as might be expected in the marly shell-beds of the Purbeck series, which have afforded such abundant evidence of insect life;* and with them are associated remains of small, insectivorous mammals.† The numerous remains of plants in the same formation, some referable to *Cycas*, others to *Zamia*, illustrate also the interdependency between the insect class and the vegetable kingdom. Amongst the numerous and various Entomophaga organized to pursue and secure the countless and diversified members of *Insecta*, in the air, in the waters, on the earth, and beneath its surface, bats, lizards, shrews, and moles now carry on simultaneously their petty warfare, and in warmer climates in the same localities. In like manner, we now have evidence that lizards and mammals co-operated in the same locality, at the same task of restraining the undue increase of insect life during the deposition of the Lower Purbeck beds.

Genus—Echinodon,‡ *Owen.*

Echinodon Becklesii, *Owen.* Tab. VIII, figs. 1—9.

The specimens figured in the above-cited plate were discovered by S. H. Beckles, Esq., F.R.S., in the thin, fresh-water stratum, containing shells§ and

* See the paper by Mr. Westwood, in the 'Quarterly Journal of the Geological Society,' 1854, p. 378.

† See my paper on *Spalacotherium*, ib., p. 426.

‡ Ἐχῖνος, *hedgehog*, and ὀδοὺς, *tooth*, "prickly tooth."

§ Species of *Valvata*, *Limneus*, *Cypris*, and *Physa*, apparently *Physa Bristovii*.

vegetable remains, high up the cliff, at Durdleston Bay, Isle of Purbeck. They consist of portions of the upper and lower jaws of a Saurian, allied, by the shape of the teeth, to *Macellodon*, but of much larger size, and with the thecodont implantation of the teeth. The crown belongs, in general shape, to that lamelliform, leaf- or scale-shaped type, of which the teeth of *Palæosaurus*, *Cardiodon*, *Hylæosaurus*, *Macellodon*, and even those of *Iguanodon*, are modifications. The teeth of the present genus are distinguished by the marginal serrations of the apical half of the crown, which increase in size from the apex to the base of that angular part of the tooth, the two basal points resembling spines, and terminating respectively, or forming the confluence of, the two thickened ridges (*r*, fig. 2, *c*) bounding the fore and hind borders of the basal half of the crown.

The crown is supported on a subcylindrical fang, and suddenly expands, both transversely (Tab. VIII, fig. 2, *c*) and antero-posteriorly (ib., *b*). In the former direction it as quickly begins to contract, and the outer and inner sides converge in almost a straight line to the apex; in the latter direction the crown continues expanding for about half, or rather more, of its longitudinal extent, with a slightly convex contour; it then rapidly contracts to the apex, the converging borders meeting at a right or somewhat acute angle, and being serrated as above described. The thickest mid-part of the crown forms a longitudinal rising, usually more marked on one side of the tooth; at the apical half the crown gradually becomes thinner towards the fore and hind margins; but at the basal half these margins are thickened, and cause the surface between them and the mid-rising to be undulated transversely. At the apical part of the tooth both the outer and inner sides are gently convex, the transverse section giving the thin-pointed ellipse, as in fig. 6, *b*.

The outer and inner enamelled sides of the crown each describe a curve at their base (fig. 3, *b*, *r*), convex towards the fang; these bases are somewhat thickened and rounded, so as to project from the fang; they converge at the fore and hind parts of the tooth, and unite at an acute angle (fig. 2, *c*, *r*), to form the long, basal points (fig. 3, *b*, *s*) of the serrated half of the crown. The foregoing characters apply to the majority of the teeth of *Echinodon*.

A portion of the left superior maxillary bone, imbedded in the matrix, with its outer surface exposed, is represented in Tab. VIII, fig. 1, and in outline, of the natural size at *a*. The anterior, probably premaxillary, part has been detached and broken. Three teeth, more or less fractured, project from sockets in the alveolar border of this part; their crowns are less expanded than in the typical maxillary and mandibular teeth. Part of the boundary of an external nostril is indicated at *n*. the larger maxillary fragment of the first two teeth present a similar form, and the entire crown of the second shows it to be longer, as well as more slender, than the posterior teeth; it resembles a canine tooth in both shape and position, the crown being subcompressed and slightly recurved, as well as sharp-pointed. It would serve well to pierce and retain a living prey.

The tooth succeeding the laniariform one presents the typical characters; beyond it the jaw-bone has been broken away in splitting the matrix, and the detached part adheres to the opposite layer (fig. 2). In fig. 1 are shown the impressions of four of the teeth preserved in the slab (fig. 2). Above the first impression (*o*, fig. 1) is the crown of a successional tooth, about to displace the tooth (*o*, in fig 2). The outer side of a type upper maxillary tooth is shown, magnified at fig. 1, *b*.

The remainder of the upper maxillary, with part of the palatine and pterygoid bones of the left side, are represented adhering to the other half of the split slab in fig. 2, and of the natural size, in outline, at *a*. The extent of the inner alveolar wall, effecting, with the cross partitions, the lodgement of the teeth in sockets, is here demonstrated. The expanded crowns of the teeth come into contact. The inner surface of the crown is shown at *b*, in which the middle longitudinal rising is rather less prominent than on the opposite surface. The fore part of the crown is represented at *c*, showing the angle at which the obtuse basal borders of the enamelled crown meet there; the cement covering the fang is continued upon the crown within that angle.

The outer side of a portion of the right superior maxillary bone, with eight contiguous molars, is represented in fig. 3, and of the natural size, in outline, at *a*. There is a linear row of small foramina above the alveolar border. The median longitudinal rising of the crown of the teeth is more strongly marked on this, the outer, surface, as shown in the tooth magnified at *b*, fig. 3.

In fig. 4 is represented the inner surface of the posterior part of a right, superior maxillary bone, containing six contiguous teeth, with a less prominent or less defined median rising of the teeth in this fragment; the last three teeth gradually decrease in size. There is no discernible trace of the socket of another tooth beyond the sixth (*x*). A portion of the bony palate remains, which gives evidence of a large palatal vacuity, probably internal nostril, at *u*, and of a posterior palatal vacuity at *v*, probably corresponding with those in the Iguana.

The inner surface of a portion of a ramus of the mandible, with eight contiguous teeth, is represented at fig. 5, and in outline, of the natural size, at *a*.

The fore part of a right ramus, consisting chiefly of the dentary element, is represented in figs. 6—8, and of the natural size, in outline, at *a*. Fig. 6 gives the outer side, but the whole vertical extent of the bone is only preserved at the symphysial end. The apex of a young tooth projects from the fifth of the sockets here preserved; it is represented magnified at *a* and *b*.

There is a linear series of small, nervo-vascular foramina a little below the alveolar border. The crowns of the developed teeth have been broken away;

their fangs in the sockets are shown in fig. 7; the anterior teeth are narrower than the rest, as in the upper jaw. The crushed or broken state of the specimen at the opposite end prevents a determination of the total number of sockets in this ramus. On the inner side of the specimen (fig. 8), a considerable extent of the symphysis (*s*, *s*) is shown.

The posterior part of a broken and distorted dentary element of the left ramus of the mandible is represented in fig. 9, showing the last eight teeth, and the impressions of the crowns of as many in advance. A portion of the crown, displaced, of the fourth from the last is preserved, and likewise portions also of those in advance, which have been broken in splitting the slab, so that they appear smaller than they actually were. The last three teeth are entire, and show a gradual decrease of size, as in the portion of upper jaw (fig. 4). A magnified view of the inner surface of the last lower tooth is given at *a*, fig. 9.

From the characters of jaws and teeth above described, the extinct animal presenting them might be referred to the modern Lacertian group: but the structure of the vertebræ and limb-bones must be ascertained before the ordinal affinities of *Echinodon* can be satisfactorily determined.

The modifications of the mode of implantation of the teeth in the known limits of the Dinosaurian order affect the value of the thecodont character as a mark of affinity. The dentition of *Echinodon*, in respect to the shape of the crowns of the teeth, appertains to the category embracing *Macellodon, Cardiodon*,* *Hylæosaurus*, and *Iguanodon*. From *Macellodon* the present genus differs in the swollen borders of the basal half and the stronger serration of the apical half of the dental crown. The similarly expanded crown of the tooth of *Cardiodon* has thicker and apparently not serrate margins, it is not divided into a basal and apical portion, and the apex is more obtuse. In *Hylæosaurus* the crown of the tooth is thicker and less expanded than in *Echinodon;* the borders of the apical half are usually abraded by masticatory acts, show no marks of serration, and meet at an angle of 80°; but the crowns of the teeth were in contact, as in *Echinodon*. The more complex structure of the teeth of *Iguanodon* appears, nevertheless, to be due to additions superposed upon a type of tooth which is essentially like that of *Echinodon*. The expanded crown is divided into a basal and apical portion; the marginal serrations of the latter are coextended with the increased thickness of the part into small lamellæ, themselves more minutely dentate. The middle longitudinal rising of the enamel, which in *Echinodon* has appeared to me to be stronger on the outer side of the upper teeth and on the inner side of the lower teeth, is exclusively developed, as the "primary ridge" on the corresponding aspects of the teeth of the upper and lower jaws in *Iguanodon*. In the small teeth, or those of the

* From the Oolitic Formation, called "Forest-Marble," near Bradford, Wilts. See my 'Odontography,' p. 291, pl. 75*a*, fig. 7.

young *Iguanodon*, the primary ridge is median and well-marked, and in the unworn tooth forms, or terminates at, the apex of the crown, increasing its resemblance to the Echinodont type of tooth. The difference of dental structure between *Echinodon* and *Iguanodon* is of the adaptive kind; relating in the former to animal food, in the latter to a mixed or vegetable diet. The entire dentition of *Echinodon* appears so well fitted to pierce the scaly covering of fishes, and retain the struggling prey, that I suspected the species to have been ichthyophagous, and, like the *Amblyrhynchus* of the Gallopagos Islands,* to have been aquatic in its habits.

My fellow-labourer in palæontology, Dr. Falconer, F.R.S., by whose labours that science has been so much enriched, suggested the name *Sauraechinodon* for the present Purbeck reptile; but as I am not aware that the more abridged form has been preoccupied, I have adopted *Echinodon* as sufficiently distinctive, having reference to the almost spiny character of the larger basal serrations of the apical half of the tooth.

The present species is dedicated to its discoverer, Mr. Beckles, of whose collection of Purbeck fossils the specimens here described form part; and I record with pleasure my grateful sense of the liberality with which they have been confided to me for elucidation.

* Darwin, 'Voyage of the *Beagle*,' vol. iii, p. 466.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

SUPPLEMENT No. I.

PAGES 1—7: PLATES I—III.

DINOSAURIA (IGUANODON).

[WEALDEN.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

Issued in the Volume for the Year 1856.

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1858.

SUPPLEMENT (No. I)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

ORDER—DINOSAURIA, *Owen.*

Genus—IGUANODON, *Mantell.*

IN the 'Monograph on the Iguanodon,' in a former volume of the publications of the Palæontographical Society,* the characteristic form of certain toe-phalanges was described; such phalanges, at least, were inferred to belong to the Iguanodon, with a high degree of probability, on evidence of association with other undoubted parts of the skeleton of that reptile, and more especially in the instance of the Maidstone skeleton;† but at that period the exact structure and number of toes of either fore or hind foot were unknown.

On the basis, however, of the determination of detached phalangeal bones in that Monograph, the present restoration of an entire—probably hind—foot, the carpus or tarsus excepted, of the Iguanodon, has been carried out; the ungual phalanges in the series of bones of this foot (T. I, II, III) closely corresponding in shape with the depressed and obtuse phalanges referred to that extinct animal in the above-cited volume, 1855, pp. 42—44. This most interesting and instructive framework of the foot of the great Dinosaurian herbivorous reptile was, moreover, found in a formation and at a locality where unequivocal vertebræ and other parts of the Iguanodon are common;

* 'Fossil Reptilia of the Wealden Formations,' Part ii, p. 40, t. xvi and xvii, (vol. for 1854.)

† 'Fossil Reptilia of the Cretaceous Formations,' Part i, p. 105, t. xxxiii, (vol. for 1851.)

so that it is with much confidence that the present contribution towards a complete reconstruction of the Iguanodon is now submitted to palæontologists.

The discovery and acquisition of the unique specimen, figured in T. I, II, and III, are due to S. H. Beckles, Esq., F.G.S., the author of the papers on the 'Ornithoïdichnites of the Wealden,'* and who first definitely called the attention of geologists to the singular "trifid," or tridactyle impressions in the Wealden of Sussex, of which he was the chief discoverer, and has been the most persevering investigator.

It seems a peculiarly appropriate reward for these researches, that the acquisition of the fossils demonstrating the tridactyle structure of one of the feet of the Iguanodon should have been reserved for Mr. Beckles. These fossils, moreover, were not fortuitously acquired, but were the fruit of special researches, assiduously carried on by Mr. Beckles on the south-west coast of the Isle of Wight, with a view to materials for completing our knowledge of the great Wealden reptiles.

Between Brook and Brixton, in the submerged Wealden bed, near low-water mark, indications of the entire skeleton of a young, perhaps half-grown, Iguanodon were detected. The bones of the foot which were most within reach had been very little disturbed. The metatarsus (T. II, fig. 2) was extracted in one piece; the phalanges of an outer toe (T. I, 1 IV—5 IV) were extracted in a second piece: they had been somewhat distorted at the time of imbedding, for the matrix had hardened around, and preserved them in that state. The phalanges of the toe of the opposite side of the foot (ib., 1 II—3 II) were extracted similarly cemented together by the matrix, but in their natural juxtaposition. Three of the phalanges of the middle toe (ib., 1 III—3 III) were also joined together by the matrix; the fourth, or ungual phalanx of this toe, was extracted separately; but Mr. Beckles's attention having been, unluckily, diverted to another subject at this time, the fossil got into the hands of an idle looker-on, who cast it into the sea. All the other bones of the foot Mr. Beckles caused to be carefully packed, and transmitted to me for description.

I employed a skilful lapidary to clear away the adherent matrix, and to separate the cemented phalanges of the distorted toe, for the examination of their articular surfaces, and the result of my comparisons were communicated briefly to the Geological Society of London, on the occasion of exhibiting the specimen at the meeting held June 17th, 1857.

As has already been stated, the bones, whether carpal or tarsal, which unite the foot proper to the limb, are wanting. The metapodium,† fortunately, yields the required proof of the precise number of toes.

* 'Quarterly Journal of the Geological Society,' January, 1851, and November, 1852.

† I use this word to signify the same segment in both fore- and hind-limbs: "metacarpus" is the specific term for the segment in the fore limb; "metatarsus" for that in the hind limb. But, in the gradual reconstruction of the skeleton of a strange reptile, it is requisite to have a term expressive of the more general kind of knowledge at first acquired. Metapodial is equivalent to metacarpal or metatarsal.

The ungual phalanx (IV 5) is relatively more slender than in the inner toe: its length is 4 inches; its basal breadth 1 inch 10 lines. The obliquity of the bone is slight, and in the opposite direction to that of the inner toe.

Should any rudimental or spurious claw have been supported by the metapodial of the innermost digit (T. II, fig. 2, I), the development of which toe is so remarkably arrested, it would probably present that form, and in regard to the fully grown Iguanodon, that size, which characterises the claw-phalanx which has been mistaken for the "horn" of the Iguanodon. It is probable that, in the fore-foot, the toe answering to the innermost in the Iguana's foot was better developed than its homotype in the hind-foot.

Not far from where the foot-bones were found, the femur, tibia, and fibula, of the same Iguanodon were extracted,—a circumstance which adds to the probability of their belonging to the same limb.

The modification of the present foot, whether of the fore- or hind-limb, of the Iguanodon is unique, according to present knowledge, in the class *Reptilia.* It exhibits an adaptation to terrestrial progression, and the support of a weighty superincumbent trunk, akin to that which we observe in the tridactyle foot of the heavy perissodactyle Pachyderms, represented at the present day by the Rhinoceros and Tapir.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

SUPPLEMENT No. II.

PAGES 20—44; PLATES V—XII.

CROCODILIA (STREPTOSPONDYLUS, &c.)

[WEALDEN.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

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1859.

SUPPLEMENT (No. II)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE WEALDEN AND PURBECK FORMATIONS.

ORDER—*CROCODILIA.*

Genus—STREPTOSPONDYLUS, *Von Meyer.*

THIS name, from the Greek στρέφω, I turn, σπονδύλος, vertebra, was applied by M. Hermann v. Meyer to the Crocodilian reptile distinguished by Cuvier as the "second espéce de Crocodile de Honfleur,*" and characterised by the same great anatomist as "having the cervical and anterior dorsal vertebræ, with the articular ends of the centrum, convex in front and concave behind."† By this character was distinguished the "second Gavial of Honfleur" from a "first Gavial of Honfleur," in which the articular ends of the centrum were both slightly concave.

With regard to these kinds of fossil vertebræ Cuvier writes: "je nommerai l'un *système convexe* en evant, et l'autre *système concave.*"‡ To the former he referred a gavial-like skull with a shorter and more obtuse upper jaw, and a less depressed symphysis of the lower jaw;§ to the latter a more gavial-like skull, with longer and more slender jaws.||

* 'Ossemens Fossiles,' ed. 8vo, 1836. Explication des Planches, p. 78, pl. ccxxxviii, figs. 5, 6 et 7.

† Ib., t. ix, p. 309.

‡ Ib., p. 308.

§ Subsequently named *Steneosaurus rostro-minor*, by Geoffroy St. Hilaire.

|| *Steneosaurus rostro-major*, ib.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

SUPPLEMENT No. III.

PAGES 19—21; PLATE X.

DINOSAURIA (IGUANODON).

[WEALDEN.]

BY

PROFESSOR OWEN, D.C.L., F.R.S., F.L.S., F.G.S., &c.

Issued in the Volume for the Year 1862.

LONDON:

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1864.

SUPPLEMENT (No. III)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

ORDER—DINOSAURIA, *Owen.*

Genus—IGUANODON, *Mantell.*

(*Mandible of a young Iguanodon.*)

I HAVE been favoured by the Rev. W. Fox, M.A., Rector of Brixton, Isle of Wight, with the inspection of a portion of the left mandibular ramus of an Iguanodon (Tab. X, figs. 1—4), including the entire series of alveoli. These are fifteen in number, and are clearly indicated by the angular risings of the outer alveolar wall, forming the intervals or divisions of the alveoli (fig. 4, 1—15). Between the summits of the angular processes the upper margin of the socket is deeply concave, and, the sockets being contiguous, a strongly marked crenate character is given to the border of the outer alveolar wall.

The longitudinal extent of the alveolar portion of the present ramus is 4 inches 3 lines. About an inch of the edentulous fore part of the ramus is preserved, but the symphysial end is broken away. At the opposite part of the fragment it has broken off, about three lines behind the last alveolus, from the rest of the jaw.

The teeth which occupied the alveolar depressions of the outer wall are gone. The germs of three successional teeth (ib., figs. 1 and 2, 6, 12, 14) are preserved. The summit of the hindmost (14) has risen to the level of the opening of the antepenultimate socket; the next in advance (12) has risen half way towards the outlet of the twelfth socket; the crown of the third just shows at the bottom of the sixth socket, counting from before backward. Each of these germ-teeth has the inner surface exposed of the summit of the crown, the anterior one showing the least proportion of the tooth. The primary longitudinal ridge (fig. 5, *a*) and the marginal serrations (*cc'*) are boldly and beautifully marked on the dark, lustrous enamel, the serrations being continued by grooves, some way upon the exposed inner side of the crown. The primary ridge more equally divides the summit of the crown here seen than in the part below, but the greater extent of the anterior area (*c*) is appreciable; the secondary longitudinal ridge (*b*) is discernible in both the anterior and posterior areæ of the crown, in the last two germs (fig. 1, 12, 14, and fig. 6. So much of the crown as appears in these teeth shows greater fore-and-aft breadth than the socket they would rise into, or rather than the socket of their predecessor, and the difference of breadth is so much greater in the basal part of the crown as to suggest much growth of the jaw in the progress of the germ to the state of a fully developed tooth in place. We thus obtain evidence of the immaturity of the specimen, and that it has not belonged to a distinct and diminutive species of *Iguanodon.*

Like all reptiles, the Iguanodon shed and renewed its teeth many times during the course of life; the new following the old teeth vertically, and being, therefore, in the growing animal, of a larger size than those they were about to displace. With the shedding of the deciduous teeth there was more or less absorption of their sockets, and with the rise of the successional teeth there was a concomitant formation of suitable, and, therefore, larger sockets.

In the Crocodile the number of teeth, or of sockets of one and the same set of teeth, does not vary with age, according to the observations of Cuvier.* Each tooth succeeds its forebear vertically, and none are added to the series, as in mammalia, from behind.

I believe myself able now to adduce evidence that the Iguanodon added this mammalian mode of succession to some other characters, which have been in previous Monographs pointed out, exemplifying its greater resemblance to the warm-blooded beasts than any existing form of reptile manifests.

The mandible of the young Iguanodon here described shows at the utmost fifteen sockets in the unquestionably entire series, occupying a longitudinal extent of four inches and a quarter. The mandible of the somewhat older Iguanodon, from the Wealden of Stammerham, Sussex, described and figured in my Monograph, 1855, Tabs. X and XI, shows eighteen alveoli, occupying a longitudinal extent of six inches.

* "Les dents offrent plusieurs remarques intéressantes dans le crocodile. La première, c'est que leur nombre ne change point avec l'âge. Le crocodile qui sort de l'œuf les a autant que celui de vingt pieds de long."—"Je me suis assuré de ce fait dans une série de huit têtes croissant en grandeur, depuis un pouce jusqu'à deux pieds." Cuvier, 'Ossemens Fossiles,' 4to, tom. v, pt. ii (1825), p. 90.

The mandible of the Iguanodon from the Wealden of Tilgate, Sussex, figured by Mantell in the 'Philosophical Transactions' for 1848, Pl. xvii, seems to have had at least twenty alveoli in a longitudinal extent of fourteen inches. The back part of the series is too much mutilated for precisely showing the divisions of the sockets; but the number, eighteen, which I originally estimated, from the figures of the fossil in the 'Philosophical Transactions,' is clearly below the number which may be estimated in the alveolar tract of the original specimen now in the British Museum.

From the foregoing facts, therefore, it may be concluded that the Iguanodon, in the progress of growth, from the period at which the dentigerous part of each ramus of the mandible is four inches in length to that in which the same part is fourteen inches in length, acquires four or five additional teeth in each series, which, from the rapidly decreasing depth of the three or four hindmost alveoli, I infer to be developed, like the true molars of mammals, in new and distinct alveoli behind those in place.

My obliging correspondent, Mr. Fox, who had been struck with the inferiority of number of the alveoli in his small specimen, compared with the indication of them in Mantell's plate of the larger jaw from Tilgate, supposed that it might indicate a distinction of species; but the whole evidence of the Iguanodon's mandibular structure, including the intermediate-sized specimen obtained by Mr. Holmes from Stammerham, appears to me to show only difference of age, and to bring to light a new and important characteristic of the dentition of the large extinct Herbivorous Reptile.

2