

PALEONTOGRAPHICAL SOCIETY.

VOL. LIX.

THE BRITISH FOSSIL
ECHINODERMATA.

VOL. II, PART III.

PAGES 67—90; PLATES XVII—XXVI.

THE CRETACEOUS LAMELLIBRANCHIA.

VOL. II, PART II.

PAGES 57—96; PLATES VIII—XI.

THE
CARBONIFEROUS
LAMELLIBRANCHIATA.

VOL. II.

TITLE-PAGES AND INDEX.

THE INFERIOR OOLITE
AMMONITES.

PART XIII.—SUPPLEMENT.

PAGES clxix—ccviii; PLATES XX—XXIV.

THE FAUNA OF THE
CORNBRASH.

PART I.

PAGES 1—100; PLATES I—IX.

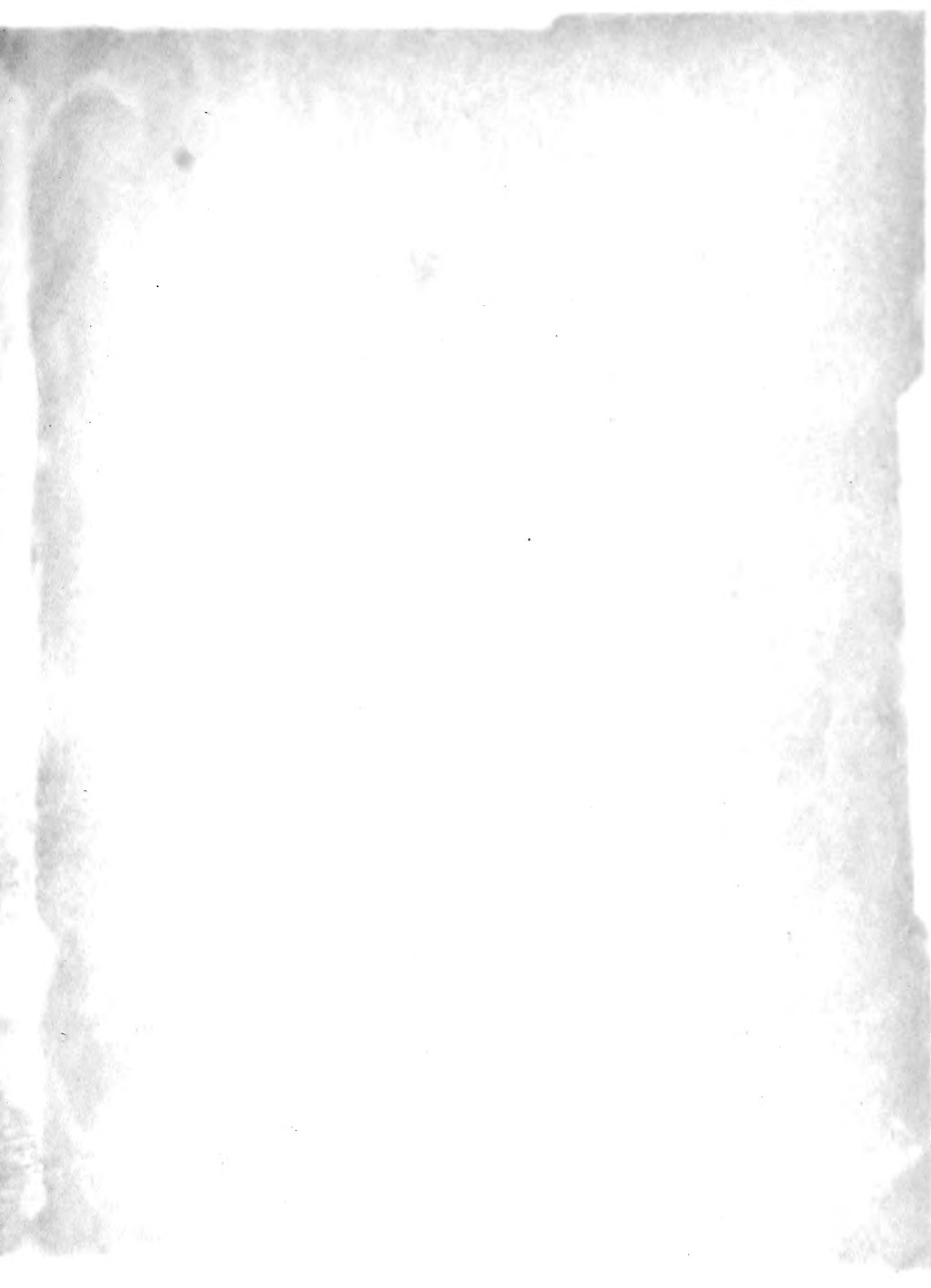
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PALÆONTOGRAPHICAL SOCIETY.

VOLUME LIX.

CONTAINING

1. THE FOSSIL ECHINODERMATA, CRETACEOUS. Vol. II, Part III (Asteroidea). By Mr. W. K. SPENCER. Ten Plates.
2. THE CRETACEOUS LAMELLIBRANCHIA. Vol. II, Part II. By Mr. H. WOODS. Four Plates.
3. THE CARBONIFEROUS LAMELLIBRANCHIATA. Vol. II, Title-pages and Index. By Dr. WHEELTON HIND.
4. THE INFERIOR OOLITE AMMONITES. Part XIII. By Mr. S. S. BUCKMAN. Five Plates.
5. THE FAUNA OF THE CORNBRASH. Part I. By Rev. J. F. BLAKE. Nine Plates.

ISSUED FOR 1905.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

AGENTS FOR THE SOCIETY:
DULAU AND CO., 37, SOHO SQUARE, W.

NOVEMBER, 1905.

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

Each person subscribing ONE GUINEA is considered a Member of the Society, and is entitled to the Volume issued for the Year to which the Subscription relates. The price of the Volume to Non-subscribers is TWENTY-FIVE SHILLINGS NET.

Subscriptions are considered to be due on the 1st of January in each year.

The Annual Volumes are now issued in *two forms of Binding*: 1st, with all the Monographs stitched together and enclosed in one cover; 2nd, with each of the Monographs in a paper cover, and the whole of the separate parts enclosed in an envelope. Members wishing to obtain the Volume arranged in the *LATTER FORM* are requested to communicate with the Secretary.

Most of the *back volumes* are in stock. Monographs or parts of Monographs already published can be obtained, apart from the annual volumes, from Messrs. DULAU AND Co., 37, Soho Square, London, W., who will forward a complete price list on application.

Members desirous of forwarding the objects of the Society can be provided with plates and circulars for distribution on application to the Secretary, Dr. A. SMITH WOODWARD, British Museum (Nat. Hist.), South Kensington, London, S.W.

The following Monographs are in course of publication :

The Fossil Sponges, by Dr. G. J. Hinde.

The Graptolites, by Prof. Lapworth, Miss Elles, and Miss Wood.

The Lower Palæozoic Trilobites of Girvan, by Mr. F. R. Cowper Reed.

The Cretaceous Lamellibranchia, by Mr. H. Woods.

The Inferior Oolite Ammonites, by Mr. S. S. Buckman.

The Sirenoïd Ganoids, the Palæoniscid Fishes of the Carboniferous Formation, and the Fishes of the Old Red Sandstone, by Dr. R. H. Traquair.

The Fishes of the English Chalk, by Dr. A. Smith Woodward.

The Fauna of the Devonian Formation of the South of England, by the Rev. G. F. Whidborne.

The Cornbrash Fauna, by the Rev. J. F. Blake.

The following Monographs are in course of preparation :

The Carboniferous Lepidodendra, by Dr. D. H. Scott.

The Fossil Cycadeæ, by Mr. A. C. Seward.

The Cambrian Trilobites, by Mr. Philip Lake.

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ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1905,

WITH

L I S T

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY
PUBLISHED.

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* Deceased 23rd June, 1905.

ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR ENDING 31ST MARCH, 1905.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE,
16TH JUNE, 1905.

DR. HENRY WOODWARD, F.R.S., PRESIDENT,

IN THE CHAIR.

THE COUNCIL, in presenting their Fifty-eighth Annual Report, have pleasure in congratulating the Society on its continued prosperity. The marked activity in the study of British fossils, to which they referred last year, still continues; and there is no decline in the number or value of the monographs offered to the Council for publication. The volume for 1904 contains the second instalment of Part II of Dr. Traquair's "Fishes of the Old Red Sandstone," and another part of Vol. I of Mr. Buckman's "Inferior Oolite Ammonites," both of which are now nearly completed. There is the final part of Dr. Wheelton Hind's "Carboniferous Lamellibranchiata," which now lacks only the index and title-page. There are also instalments of the Monographs of Cretaceous Lamellibranchia, Girvan Trilobites, and British Graptolites.

The volume for 1904 was arranged to contain only thirty-seven plates, and it was anticipated that the cost of its production would thus be within the limits of the Society's ordinary income. The accompanying letterpress, however, proved to be unusually extensive, with costly tables and inset blocks. The Council therefore regret that they have to record a serious and unexpected

reduction in the balance to the Society's credit. Although the total income for the year was £599 10s. 11d., or much larger than that of any year since 1897, the total expenditure was no less than £684 1s. 4d., necessitating the removal of £84 10s. 5d. from the balance in hand. To remedy this deficiency, the Council propose to issue a comparatively small volume for the year 1905, and they are fortunate in being able to use several plates which have been drawn and paid for in former years.

The financial position of the Society was carefully considered by a Committee appointed by the Council, and two important changes in procedure were decided upon. It was resolved that in future the Society's accounts be balanced on 31st December instead of 31st March as heretofore, so that the financial year shall correspond exactly with the period for which the annual guinea is paid. It was also resolved that the price of the annual volume to non-subscribers (*i. e.* to those who do not pay the guinea regularly in advance) be twenty-five shillings net.

Thanks are due to Miss Elles and Miss Wood for a donation of £5 to the Society's funds.

Thanks are also due to the Geological Society for permission both to store the stock of back volumes and to hold the Council meetings and the Annual General Meeting in their apartments.

In conclusion, it is proposed that the retiring members of Council be Messrs. Bell, Hudleston, and Rowe; that the new Vice-President be Mr. E. T. Newton; that the new members be Prof. W. J. Sollas, Mr. F. W. Harmer, and Mr. Philip Lake; that the President be Dr. Henry Woodward; the Treasurer, Dr. G. J. Hinde; and the Secretary, Dr. A. Smith Woodward.

Annexed is the Balance-sheet.

THE PALÆONTOGRAPHICAL SOCIETY IN ACCOUNT WITH DR. GEORGE J. HINDE, F.R.S., TREASURER.

Ct.

Year ending March 31st, 1905.

Dr.

| | £ | s. | d. | £ | s. | d. | | | | | | | | | | | | | | | | | | | |
|--|-----|----|----|-----|----|---|---|---|----|----|---|---|---|---|-----|----|---|---|---|-----|----|---|------|----|----|
| Balance from last Account— | | | | | | | | | | | | | | | | | | | | | | | | | |
| On Deposit | 100 | 0 | 0 | | | Letterpress printing | | | | | | | | | | | | | | | | | | | |
| Current Account | 137 | 4 | 0 | | | Paper | | | | | | | | | | | | | | | | | | | |
| Cash in hand | 1 | 1 | 0 | | | Small type tables, etc. | | | | | | | | | | | | | | | | | | | |
| | | | | 238 | 5 | 0 | Authors' corrections | | | | | | | | | | | | | | | | | | |
| Subscriptions—1899-1903 | 34 | 13 | 0 | | | Binding | | | | | | | | | | | | | | | | | | | |
| " 1904 | 212 | 2 | 0 | | | Distribution | | | | | | | | | | | | | | | | | | | |
| " 1905 | 227 | 17 | 0 | | | Drawing and preparing illustrations | | | | | | | | | | | | | | | | | | | |
| " 1906-1907 | 3 | 3 | 0 | 477 | 15 | 0 | Colotype and lithographic printing | | | | | | | | | | | | | | | | | | |
| | | | | | | | Secretary's honorarium | | | | | | | | | | | | | | | | | | |
| Carriage paid by Foreign Members | | | | 0 | 19 | 7 | Postage and stationery | | | | | | | | | | | | | | | | | | |
| Bank Charge paid by Member | | | | 0 | 0 | 3 | Audit of stock | | | | | | | | | | | | | | | | | | |
| Sale of back stock to Member | | | | 3 | 3 | 0 | Fire Insurance | | | | | | | | | | | | | | | | | | |
| Sales by Messrs. Dulau & Co. | | | | | 96 | 19 | Bank charges and gratuity | | | | | | | | | | | | | | | | | | |
| Dividends Natal Stock (less tax) | | | | 14 | 5 | 0 | Subscription returned (paid in error) | | | | | | | | | | | | | | | | | | |
| Interest on Deposit | | | | 1 | 8 | 5 | Balance at Bank as per pass-book | | | | | | | | | | | | | | | | | | |
| Donation | | | | | | | Cheque not cleared | | | | | | | | | | | | | | | | | | |
| | | | | 455 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 266 | 7 | 10 | | | | | | | | | | | | | | | | |
| | | | | | | | | | 52 | 10 | 0 | | | | | | | | | | | | | | |
| | | | | | | | | | | | 7 | 1 | 5 | | | | | | | | | | | | |
| | | | | | | | | | | | | | 2 | 2 | 0 | | | | | | | | | | |
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| | | | | | | | | | | | | | | | 152 | 13 | 7 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 1 | 1 | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 153 | 14 | 7 | | | |
| | | | | | | | | | | | | | | | | | | | | | | | £837 | 15 | 11 |

We have examined the above account, compared it with the vouchers, and find it to be correct; we have also seen the receipt for £500 Natal 3 per cent. Consolidated Stock

THOS. LEIGHTON, F. W. RUDLER,
W. E. BALSTON, J. ALLEN HOWE.

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CORRECTED TO 1ST JULY, 1905.

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

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- | | | |
|----------------------------------|----|--|
| Vol. I. Issued for the Year 1847 | | The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood (pp. i—xii, 1—203, pls. i—xxi, and title-page). |
| .. II. | .. | 1848 { The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell (pp. 1—76, pls. i—xxviii, viii A, x A, xiii A, xvi A, xviii A, xix*, xix B, xix C, xix D). The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards (pp. 1—56, pls. i—ix). |
| .. III. ¹ | .. | 1849 { The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones (pp. 1—40, pls. i—vii). The Permian Fossils, by Prof. Wm. King (pp. i—xxxviii, 1—253, pls. i—xxviii*). The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen (pp. 1—68, pls. xxix, i—xvi, ii A). The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime (pp. i—lxxxv, 1—72, pls. i—xi). |
| .. IV. | .. | 1850 { The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood (pp. 1—150, pls. i—xii). The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett (pp. i—viii, 1—130, pls. i—xv). The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson (pp. 1—64, pls. i—xiii). |
| .. V. | .. | 1851 { The Reptilia of the Cretaceous Formations, by Prof. Owen (pp. 1—118, pls. i—xxxvii, vii A, ix A). The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime (pp. 73—146, pls. xii—xxx). The Fossil Lepididæ, by Mr. Charles Darwin (pp. i—vi, 1—88, pls. i—v). |
| .. VI. | .. | 1852 { The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime (pp. 147—210, pls. xxxi—xlvi). The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson (pp. 1—23, pls. i, ii). The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson (pp. 1—54, pls. i—v). The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson (pp. 65—100, pls. xiv—xviii). The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards (pp. 57—122, pls. x—xv). The Echinoderms of the Crag, London Clay, &c., by Prof. E. Forbes (pp. i—viii, 1—36, pls. i—iv, and title-page). |
| .. VII. | .. | 1853 { The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime (pp. 211—244, pls. xlvii—lvi). The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson (pp. 1—136, pls. i—ix). The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe (pp. 1—26, pls. i—x). The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett (pp. 1—80, pls. i—viii). The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood (pp. 151—216, pls. xiii—xx). The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen (pp. 1—12, pls. i—ix). |

¹ The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils'; the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF VOLUMES—Continued.

- | | | | |
|--------------------|-----------------------------|---|---|
| Vol. VIII. | Issued for the Year 1854 | } | The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous (pp. 55—117, pls. vi—xii), with Appendix and Index to Vol. I, by Mr. Davidson (pp. 1—30, pl. A). |
| | | | The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen (pp. 1—54, pls. i—xix, xvIA). |
| | | | The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett (pp. 81—147, pls. ix—xv). |
| | | | The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime (pp. 245—322, pls. lvii—lxxii). |
| | | | The Fossil Balanidae and Verrucidae, by Mr. Charles Darwin (pp. 1—44, pls. i, ii). |
| | | | The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe (pp. 27—36, pls. xi—xvi). |
| | | | The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards (pp. 123—180, pls. xvi—xxii). |
| " IX. ² | " 1855 | } | The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood (pp. 217—342, pls. xxi—xxxI). |
| | | | The Reptilia of the Wealden Formations, Part III, by Prof. Owen (pp. 1—26, pls. i—xii). |
| | | | The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards (pp. 181—240, pls. xxiv—xxvii). |
| | | | The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe (pp. 37—68, pls. xvii—xxvii). |
| " X. | " 1856 | } | The Tertiary Entomostraca, by Mr. T. R. Jones (pp. i—xii, 1—68, pls. i—vi). |
| | | | The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright (pp. v—x, 1—154, pls. i—x). |
| | | | The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright (pp. 155—302, pls. xi—xxii). |
| | | | The Fossil Crustacea, Part I, London Clay, by Prof. Bell (pp. i—viii, 1—44, pls. i—xi). |
| | | | The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson (pp. 1—51, pls. i—iv). |
| " XI. | " 1857 | } | The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson (pp. 1—48, pls. i—viii). |
| | | | The Reptilia of the Wealden Formations, by Prof. Owen, Part IV (pp. 8—26, pls. iv—xi), and Supplement No. 1 (pp. 1—7, pls. i—iii). |
| | | | The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen (pp. 77—79, pls. xxviii A, xxviii B). |
| | | | The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright (pp. 303—390, pls. xxiii—xxvi). |
| " XII. | " 1858 | } | The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson (pp. 49—80, pls. ix—xvii). |
| | | | The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen (pp. 1—19, pls. i—iv). |
| | | | The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen (pp. 20—44, pls. v—xii). |
| | | | The Polyzoa of the Crag, by Prof. Busk (pp. i—xiv, 1—136, pls. i—xxii). |
| " XIII. | " 1858 | } | The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright (pp. 391—468, pls. xxvii—xliii). |
| | | | The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards (pp. 241—330, pls. xxviii—xxxiii). |
| | | | The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen (pp. 27—30, pl. vii, pp. 1—25, pls. i—vi). |
| | | | The Reptilia of the Purbeck Limestones, by Prof. Owen (pp. 31—39, pl. viii). |
| " XIII | " 1859 | } | The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous by Mr. Davidson (pp. 81—120, pls. xvii—xxvi). |
| | | | The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson (pp. 121—210, pls. xxvii—xlvii). |
| | | | The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen (pp. 1—14, pls. i—vi). |
| " XIII | " 1859 | } | The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen (pp. 15, 16, pl. vii). |
| | | | The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood (pp. 1—74, pls. i—xiii). |

¹ This Volume is marked on the outside 1855.² This Volume is marked on the outside 1856.

CATALOGUE OF VOLUMES—Continued.

- | | | |
|----------------------|-----------------------------|---|
| Vol. XIV. | Issued for the Year 1860 | <p>The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson (pp. 211—280, pls. xlviii—lv).</p> <p>The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen (pp. 1—26, pls. i—xi).</p> <p>The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen (pp. 27, 28, pl. xii).</p> <p>The Fossil Estheria, by Prof. Rupert Jones (pp. i—x, 1—134, pls. i—v).</p> <p>The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell (pp. i—vii, 1—40, pls. i—xi).</p> |
| .. XV. | .. 1861 | <p>The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright (pp. 1—130, pls. i—x, x A, xi, xii).</p> <p>Supplement to the Great Oolite Mollusca, by Dr. Lycett (pp. 1—129, pls. xxxi—xliv).</p> <p>The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright (pp. 1—64, pls. i—iii, iii A, iv—vii, vii A, viii, xi).</p> <p>The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter (pp. 1—80, pls. i—vi).</p> |
| .. XVI. | .. 1862 | <p>The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson (pp. 1—56, pls. i—ix).</p> <p>The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood (pp. 75—136, pls. xiv—xx).</p> <p>The Reptilia of the Cretaceous and Wealden Formations (Supplement, No. 4), by Prof. Owen (pp. 1—18, pls. i—ix).</p> |
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| „ XLVIII. ¹ | „ 1894 | <ul style="list-style-type: none"> The Jurassic Gasteropoda, Part I, No. 7, by Mr. W. H. Hudleston (pp. 325—390, pls. xxvii—xxxii). Carbonicola, Anthracomya, and Naiadites, Part I, by Dr. W. Hind (pp. 1—80, pls. i—xi). The Inferior Oolite Ammonites, Part IX, by Mr. S. S. Buckman (pp. 377—456, pls. xciii—ciii). The Fishes of the Old Red Sandstone, Part II, No. 1, by Dr. R. H. Traquair (pp. 63—90, pls. xv—xviii). |
| „ XLIX. ¹ | „ 1895 | <ul style="list-style-type: none"> The Crag Foraminifera, Part II, by Prof. T. R. Jones (pp. 73—210, pls. v—vii). The Jurassic Gasteropoda, Part I, No. 8, by Mr. W. H. Hudleston (pp. 391—444, pls. xxxiii—xl). Carbonicola, Anthracomya, and Naiadites, Part II, by Dr. W. Hind (pp. 81—170, pls. xii—xx). The Devonian Fauna of the South of England, Vol. II, Part IV, by the Rev. G. F. Whidborne (pp. 161—212, pls. xviii—xxiv). |
| „ L. ¹ | „ 1896 | <ul style="list-style-type: none"> The Crag Foraminifera, Part III, by Prof. T. R. Jones (pp. 211—314). The Jurassic Gasteropoda, Part I, No. 9, by Mr. W. H. Hudleston (pp. 445—514, pls. xli—xliv, and title-page). Carbonicola, Anthracomya, and Naiadites, Part III, by Dr. W. Hind (pp. 171—182, pl. xxi, and title-page). The Carboniferous Lamellibranchiata, Part I, by Dr. W. Hind (pp. 1—80, pls. i, ii). The Devonian Fauna of the South of England, Vol. III, Part I, by the Rev. G. F. Whidborne (pp. 1—112, pls. i—xvi). |
| „ LI. ¹ | „ 1897 | <ul style="list-style-type: none"> The Crag Foraminifera, Part IV, by Prof. T. R. Jones (pp. vii—xv, 315—402, and title-page). The Carboniferous Lamellibranchiata, Part II, by Dr. W. Hind (pp. 81—208, pls. iii—xv). The Carboniferous Cephalopoda of Ireland, Part I, by Dr. A. H. Foord (pp. 1—22, pls. i—vii). The Devonian Fauna of the South of England, Vol. III, Part II, by the Rev. G. F. Whidborne (pp. 113—178, pls. xvii—xxi). |
| „ LII. ¹ | „ 1898 | <ul style="list-style-type: none"> The Palaeozoic Phyllopora, Part III, by Prof. T. R. Jones and Dr. Woodward (pp. 125—176, pls. xviii—xxv). The Carboniferous Lamellibranchiata, Part III, by Dr. W. Hind (pp. 209—276, pls. xvi—xxv). The Inferior Oolite Ammonites, Part X, by Mr. S. S. Buckman (pp. i—xxxii, Suppl. pls. i—iv). The Carboniferous Cephalopoda of Ireland, Part II, by Dr. A. H. Foord (pp. 23—48, pls. viii—xvii). The Devonian Fauna of the South of England, Vol. III, Part III, by the Rev. G. F. Whidborne (pp. 179—236, pls. xxii—xxxviii). |

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CATALOGUE OF VOLUMES—Continued.

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| Vol. LIII. ¹ | Issued for the Year 1899 | <ul style="list-style-type: none"> { The Palæozoic Phyllopora, Part IV, by Prof. T. R. Jones and Dr. Woodward (pp. i—xv, 175, 176, 177—211, pls. xxvi—xxx1, and title-page). { The Cretaceous Lamellibranchia, Part I, by Mr. H. Woods (pp. 1—72, pls. i—xiv). { The Carboniferous Lamellibranchiata, Part IV, by Dr. W. Hind (pp. 277—360, pls. xxvi—xxxix). { The Inferior Oolite Ammonites, Part XI, by Mr. S. S. Buckman (pp. xxxiii—lxiv, pls. v—xiv). |
| „ LIV. ¹ | „ 1900 | <ul style="list-style-type: none"> { The Cretaceous Lamellibranchia, Part II, by Mr. H. Woods (pp. 73—112, pls. xv—xix). { The Carboniferous Lamellibranchiata, Part V, by Dr. W. Hind (pp. 361—476, pls. xl—liv). { The Carboniferous Cephalopoda of Ireland, Part III, by Dr. A. H. Foord (pp. 49—126, pls. xviii—xxxii). { The British Pleistocene Mammalia, Title-page for Vol. I, by Messrs. Dawkins and Sanford. { The Structure of Carboniferous Plants, Title-page, by Mr. E. W. Binney. |
| „ LV. ¹ | „ 1901 | <ul style="list-style-type: none"> { The Cretaceous Lamellibranchia, Part III, by Mr. H. Woods (pp. 113—144, pls. xx—xxvi). { The Carboniferous Lamellibranchiata, Vol. II, Part I, by Dr. W. Hind (pp. 1—34, pls. i—vi), Title-page and Index for Vol. I. { The Carboniferous Cephalopoda of Ireland, Part IV, by Dr. A. H. Foord (pp. 127—146, pls. xxxiii—xxxix). { British Graptolites, Part I, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. 1—54, pls. i—iv). { Ganoid Fishes of British Carboniferous Formations—Part I, Palæoniscidæ, No. 2, by Dr. Ramsay H. Traquair (pp. 61—87, pls. viii—xviii). |
| „ LVI. ¹ | „ 1902 | <ul style="list-style-type: none"> { The Cave Hyæna, by Prof. S. H. Reynolds (pp. 1—25, pls. i—xiv). { The Fishes of the English Chalk, Part I, by Dr. A. Smith Woodward (pp. 1—56, pls. i—xiii). { The Cretaceous Lamellibranchia, Part IV, by Mr. H. Woods (pp. 145—196, pls. xxvii—xxxviii). { British Graptolites, Part I, No. 2, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. i—xxviii, 55—94, pls. v—xiii). |
| „ LVII. ¹ | „ 1903 | <ul style="list-style-type: none"> { The Fishes of the English Chalk, Part II, by Dr. A. Smith Woodward (pp. 57—96, pls. xiv—xx). { The Cretaceous Lamellibranchia, Part V, by Mr. H. Woods (pp. i—xl3ii, 197—232, pls. xxxix—xlii), Title-page and Index for Vol. I. { The Carboniferous Lamellibranchiata, Vol. II, Part II, by Dr. W. Hind (pp. 35—124, pls. vii—xxi). { The Carboniferous Cephalopoda of Ireland, Part V, by Dr. A. H. Foord (pp. 147—234, pls. xl—xlix), Title-page and Index. { The Lower Palæozoic Trilobites of Girvan, Part I, by Mr. F. R. Cowper Reed (pp. 1—48, pls. i—vi). { British Graptolites, Part III, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. xxix—lii, 103—134, pls. xiv—xix). |
| LVIII. ¹ | „ 1904 | <ul style="list-style-type: none"> { The Fishes of the Old Red Sandstone, Part II, No. 2, by Dr. R. H. Traquair (pp. 91—118, pls. xix—xxvi). { The Cretaceous Lamellibranchia, Vol. II, Part I, by Mr. H. Woods (pp. 1—56, pls. i—vii). { The Carboniferous Lamellibranchiata, Vol. II, Part III, by Dr. W. Hind (pp. 125—216, pls. xxii—xxv). { The Inferior Oolite Ammonites, Part XII, by Mr. S. S. Buckman (pp. lxx—clxviii, pls. xv—xix). { The Lower Palæozoic Trilobites of Girvan, Part II, by Mr. F. R. Cowper-Reed (pp. 49—96, pls. vii—xiii). { British Graptolites, Part IV, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. liii—lxxii, 135—180, pls. xx—xxv). |

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| Vol. LIX. ¹ | Issued for the Year 1905 | } | The Fossil Echinodermata, Cretaceous, Vol. II, Part III, by Mr. W. K. Spencer (pp. 67—90, pls. xvii—xxvi). |
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| | | | The Carboniferous Lamellibranchiata, Vol. II, Title-pages and Index, by Dr. W. Hind. |
| | | | The Inferior Oolite Ammonites, Part XIII, by Mr. S. S. Buckman (pp. clxix—ccviii, pls. xx—xxiv). |
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| <p>Vol. I (1847), March, 1848. .. II (1848), July, 1849. .. III (1849), August, 1850. .. IV (1850), June, 1851. .. V (1851), June, 1851. .. VI (1852), August, 1852. .. VII (1853), December, 1853. .. VIII (1854), May, 1855. .. IX (1855), February, 1857. .. X (1856), April, 1858. .. XI (1857), November, 1859. .. XII (1858), March, 1861. .. XIII (1859), December, 1861. .. XIV (1860), May, 1863. .. XV (1861), May, 1863. .. XVI (1862), August, 1864. .. XVII (1863), June, 1865. .. XVIII (1864), April, 1866. .. XIX (1865), December, 1866. .. XX (1866), June, 1867. .. XXI (1867), June, 1868. .. XXII (1868), February, 1869. .. XXIII (1869), January, 1870. .. XXIV (1870), January, 1871. .. XXV (1871), June, 1872. .. XXVI (1872), October, 1872. .. XXVII (1873), February, 1874. .. XXVIII (1874), July, 1874. .. XXIX (1875), December, 1875. .. XXX (1876), December, 1876.</p> | <p>Vol. XXXI (1877), February, 1877. .. XXXII (1878), March, 1878. .. XXXIII (1879), May, 1879. .. XXXIV (1880), May, 1880. .. XXXV (1881), May, 1881. .. XXXVI (1882), June, 1882. .. XXXVII (1883), October, 1883. .. XXXVIII (1884), December, 1884. .. XXXIX (1885), January, 1886. .. XL (1886), March, 1887. .. XLI (1887), January, 1888. .. XLII (1888), March, 1889. .. XLIII (1889), March, 1890. .. XLIV (1890), April, 1891. .. XLV (1891), February, 1892. .. XLVI (1892), November, 1892. .. XLVII (1893), December, 1893. .. XLVIII (1894), November, 1894. .. XLIX (1895), October, 1895. .. L (1896), October, 1896. .. LI (1897), December, 1897. .. LII (1898), December, 1898. .. LIII (1899), December, 1899. .. LIV (1900), December, 1900. .. LV (1901), December, 1901. .. LVI (1902), December, 1902. .. LVII (1903), December, 1903. .. LVIII (1904), December, 1904. .. LIX (1905), November, 1905.</p> |
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Palaontographical Society, 1905.

A MONOGRAPH

ON THE

BRITISH FOSSIL

ECHINODERMATA

FROM

THE CRETACEOUS FORMATIONS.

VOLUME SECOND.

THE ASTEROIDEA.

BY

W. K. SPENCER, B.A., F.G.S.

PART THIRD.

PAGES 67—90; PLATES XVII—XXVI.

LONDON:

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1905.

of length to breadth are in the case of the interradial supero-marginal plates 5·6 mm. is to 3·7 mm. Further, the tuberculation in this specimen may or may not extend over the whole of the abactinal area, the variations being on adjacent plates, and the abactinal gibbosity is not strongly developed. In the example figured on Pl. IX, fig. 3, the proportions of length to breadth in the case of the interradial supero-marginal plates are as 4·5 mm. is to 3·6 mm.; the granulated areas more generally stop short of the distal edge of the supero-marginal plate and the abactinal gibbosity is well pronounced. In view of these considerable variations it is difficult to refer these forms to more than one species.

3. MITRASTER COMPACTUS, *Forbes*, sp. Pl. XVII, fig. 2; Pl. XXVI, figs. 3, 3 a, 3 b, 3 c.

- GONIASTER COMPACTUS, *Forbes*, 1848. Mem. Geol. Surv. Gt. Brit., vol. ii, p. 468.
 — — — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, p. 333, pl. xxii, fig. 3.
 ASTROGONIUM COMPACTUM, *Dujardin et Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.
 GONIASTER COMPACTUS, *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 366, pl. xxii, fig. 3.

Specific Characters.—Outline pentagonal, slightly cycloidal. Eight supero-marginal plates on each side of the pentagon. Supero-marginal plates form a broad margin, and the breadth of each is about four times its length. Base of ultimate paired supero-marginal plate twice as long as the other, more proximal, supero-marginal plates. Ten corresponding infero-marginalia.

Material.—Only one specimen of this species is known. This formed a portion of Mr. Willett's collection and is now preserved in the Brighton Museum. It apparently escaped the observation of the late Dr. Wright, for the figure on Plate XVII is copied from that in Dixon's 'Geology of Sussex.' As this figure is slightly inaccurate I have had it redrawn and further details added on Plate XXVI.

Description.—The dorsal surface of the disc is covered with a number of small, subequal, closely-fitting plates. It is considerably sunk in the specimen known.

The supero-marginalia bounding the disc form a uniform margin 5·15 mm. broad. They are eight in number along each side, exclusive of the odd terminal or ocular plates. The six middle plates are about 1·2 mm. long. Their breadth is rather more than four times their length, a feature which distinguishes them

from *Mitraster Hunteri* and *M. rugatus*. A further distinctive feature is the size of the distal paired plate. This plate is triangular. The base of the triangle measures 2·7 mm., giving the plate twice the length of the more proximal plates. The plate is gibbous at its outer extremity as in *M. Hunteri*. All the plates are ornamented with a single or double marginal row of small spinelets. The ocular is a small conical plate barely visible in abactinal view. It fits into notches on the lower surface of the distal paired plates, and is, as usual, notched on its inferior surface for the purpose of protecting the unpaired terminal tube foot.

The median infero-marginal plates are rather longer than the corresponding members of the superior series. The first two, reckoning from the median inter-radial line, are 1·85 mm. long, and 8·5 mm. broad. The third is only 1·8 mm. long and not quite as broad. The fourth has approximately the same length but is subtriangular in form. The fifth is a small triangular plate. Two infero-marginals and a portion of a third are situated underneath the distal paired supero-marginal plate.

The ventro-lateral plates visible are small hexagonal plates covered with a fine uniform granulation. The adambulacral plates are small oblong plates. The margin of the disc is very abrupt, but the transition from infero-marginalia to the actinal surface is more gradual than that of the supero-marginalia to the upper surface. A number of small granules are irregularly distributed between the plates.

Remarks.—Unfortunately, the specimen is slightly distorted, so that the pronouncedly cycloidal appearance in the figure is partially due to the unnatural position of the marginal plates, which has brought the inferior series into the dorsal view. The supero-marginal plates appear to have been straight and the inferior series but slightly cycloidal. This, together with the large comparative size of the ultimate paired plate, would bring the species very near to the genus *Metopaster*. Forbes remarked upon the fact that it appeared to be intermediate between *Goniaster* (*Metopaster*, Sladen) *uncatus* and *Goniaster* (*Mitraster*, Sladen) *rugatus*. I have therefore considerable doubt as to the validity of the separation of these two genera.

Locality and Stratigraphical Position.—Upper Chalk of Houghton, Sussex.

Genus—COMPTONIA, *Gray*.

Gray, 1840. Annals and Magazine of Natural History, vol. vi, p. 278.

— 1866. Synopsis of Starfishes in the British Museum.

Body depressed, with produced tapering rays. Disc covered abactinally and actinally with numerous polygonal plates which possess a uniform granulation. Marginal plates numerous. Supero-marginal plates equal in number to the infero-marginals, and forming a moderately broad border to the disc. Infero-marginal plates (as well as all other plates) devoid of spines. Radialia present throughout length of ray.

This genus apparently differs from *Stellaster* only in the absence of spines on the infero-marginalia. It is thus similar to, as well as prior to *Ogmaster* (*von Martens*, 1865) and *Dorigona* (*Gray*, 1866).

1. COMPTONIA COMPTONI, *Forbes*, sp. Pl. XVII, figs. 3, 3 *a*, and 3 *b*; Pl. XVIII, figs. 2, 2 *a*, 2 *b*, 2 *c*, 2 *d*.

STELLASTER COMPTONI, *Forbes*, 1848. Mem. Geol. Surv. Gt. Brit., vol. ii, p. 476.

— — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, pl. xxii, fig. 8, p. 335.

— — *Dujardin et Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 408.

— — *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), pl. xxii, fig. 8, p. 368, 370.

Specific Characters.—Disc large and interbrachial arcs wide, giving the disc a distinctly pentagonal appearance. Major radius rather more than twice the length of the minor radius. Arms elliptical in cross section. Large valvate pedicellariæ present.

Material.—Two specimens (the two cotypes) of this species are in existence. One (formerly in the Bowerbank Collection) displays the actinal aspect (Pl. XVII, fig. 3), and is preserved in the British Museum of Natural History (34311). The other (Pl. XVIII, fig. 2), which shows the dorsal aspect, is preserved in the Northampton Museum. This is the specimen figured in Dixon.

Description.—The large pentagonal disc is covered dorsally with numerous

small closely-fitting plates. In the radial areas these plates are polygonal and are about 1·8 mm. in diameter. In the interradial areas the plates measure only 1 mm. in diameter and are rhomboidal. All the plates are covered with a fine uniform granulation (Pl. XVIII, fig. 2 a). Upon very many of the plates are valvate pedicellariæ. Post-mortem changes have produced a sinking in of the plates over the interradial areas. Depressions, doubtless due to similar causes, appear in recent forms when dried, as also in *C. elegans*. I have been unable to distinguish either the madreporite or the anus.

The arms are not so much produced as in *C. elegans*.

R : r :: 62 mm. : 29 mm. in the specimen at Northampton.

R : r :: 55·6 mm. : 25·8 mm. in the British Museum (Natural History) specimen.

The width of the arms at the sixth supero-marginal (reckoning from the inter-radius) is 11·5 mm.

The supero-marginalia are oblong in shape. In the interradial areas they are of fairly constant size, measuring 5·2 mm. in breadth and 2 mm. in length. They diminish in size distalwards. They are eighteen in number, and often bear one or more valvate pedicellariæ. The margin is rounded and is about 8 mm. high.

The infero-marginalia are equal in number and similar in appearance to the superior series.

The actinal interradial areas are large and filled proximally with a number of small rhomboidal plates about 1·2 mm. in average breadth. The more distal plates are crowded, smaller, and polygonal in appearance. Traces of a fine granulation are visible.

The adambulacrals are a series of small oblong prominent plates. The largest are about 1·6 mm. in length and 1·2 mm. in breadth. Remains of their armature are still present. The mouth-angle plates are small and but slightly prominent. They also bear traces of armature. Valvate pedicellariæ are scattered apparently irregularly over all these various plates.

Locality and Stratigraphical Position.—Upper Greensand of Blackdown.

Remarks.—Forbes considered this species was equivalent to *Asterias Schultzii*, Roemer.¹ In this latter species, however, the superomarginalia meet across the dorsal surface of the ray, which would disprove Forbes' statement.

¹ Roemer, 'Versteinerungen des Norddeutschen Kreidegebirges,' pl. vi, fig. 21.

2. COMPTONIA ELEGANS, *Gray*. Pl. XVII, figs 4 and 4a.

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| COMPTONIA ELEGANS, | <i>Gray</i> , 1840. <i>Ann. & Mag. Nat. Hist.</i> , vol. vi, p. 278. |
| STELLASTER ELEGANS, | <i>Forbes</i> , 1848. <i>Mem. Geol. Surv. Gt. Brit.</i> , vol. ii, p. 476. |
| — — | <i>Forbes</i> , 1850. In <i>Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex</i> , London, p. 336, pl. xxii, fig. 9. |
| COMPTONIA ELEGANS, | <i>Morris</i> , 1854. <i>Catalogue of British Fossils</i> , 2nd ed., p. 50. |
| — — | <i>Dujardin et Hupé</i> , 1862. <i>Hist. Nat. Zooph. Échin. (Suites à Buffon)</i> , p. 408. |
| STELLASTER ELEGANS, | <i>Forbes</i> , 1878. In <i>Dixon's Geology of Sussex (new edition, Jones)</i> , pp. 369, 370, pl. xxii, fig. 9. |

Specific Characters.—Disc strongly convex, covered with small polygonal plates. Actinal interradial areas large. Arms well produced, the major radius being at least three times as long as the minor radius. Interbrachial arcs paraboloid.

Material.—The specimen figured by Dixon, at that time in the Bowerbank Collection, is now preserved in the British Museum of Natural History (E. 2567). Both dorsal and ventral aspects are exposed. Another specimen showing an impression of the ventral surface exists in the Oxford University Museum.

Dixon's specimen, however, can hardly be the type, since Gray (1840) stated that the specimens described by him were in the British Museum or in the collection of the Zoological Society. Forbes (1848) refers only to specimens in the British Museum and the collection of the Marquess of Northampton. No part of the Bowerbank Collection is known to have come to the British Museum before 1865. The type specimen therefore must be either lost or still unrecognised in the national collection. Since it was never figured it could never be identified with certainty. It is therefore advisable to take the specimen E. 2567 as type.

Description.—The disc is high in the central and radial regions. In the interradial areas, however, post-mortem changes have caused a collapse of the test and the consequent production of deep triangular depressions. The plates covering the disc are minute, polygonal, and closely fitting. The centrale is the

only plate of the dorsal surface which is larger or more conspicuous than the remainder; all are covered with a minute uniform granulation of a quite characteristic appearance. The anus is almost central in position. It is surrounded by a circle of plates, amongst which is the centrale. The madreporite is, as usual, situated in the next (clockwise) interradius, almost halfway between the centrale and the margin. It is a triangular plate, the apex of the triangle being a markedly acute angle.

The arms are well produced. R : r : : 30 mm. + : 9 mm. Their breadth at the base is 9 mm. Radialia, adradialia, and dorso-lateralia extend into the base of the arms. The dorso-lateralia soon disappear, but the adradialia persist as far as the seventh or eighth supero-marginal plate. When the adradials disappear the radialia become larger. They are at this point 1 mm. broad and 1.1 mm. long and therefore appear almost square.

The supero-marginalia are oblong plates of curiously uniform size in the portions of the specimen preserved. They are 1.6 mm. long and from 1.2 mm. to 1.3 mm. broad. The infero-marginalia are of the same length and are opposite to the supero-marginalia. In lateral view the supero-marginalia appear higher than the inferior series. Both series are ornamented with a number of small, fine granules which are uniformly distributed over their surfaces.

The ventral surface is concave. The ventro-lateral plates are rhomboidal in the region of the mouth. They become polygonal and crowded as they approach the margin. Some of these plates extend into the base of the arms. Around the edges of the plates spinelets are visible. The spines of the adambulacral plates are still present. Unfortunately, it is not possible to make out their exact distribution. The mouth-angle plates are not prominent.

There is no trace in this species of such valvate pedicellariæ as characterise *C. Comptoni*.

Remarks.—Gray compared this species with *Calaster*, Agassiz.¹ The rather vague diagnosis of *Calaster* given by Agassiz renders exact identification impossible.

Locality and Stratigraphical Position.—Upper Greensand of Blackdown. Also in the Upper Greensand at Folkestone (observed by Forbes).

¹ Agassiz, 'Annales des Sciences Naturelles,' 1837. Translated in 'Annals and Magazine of Natural History,' vol. 1, 1838.

Genus—NYMPHASTER, *Sladen*, 1885. (See p. 14.)

4. NYMPHASTER RADIATUS, n. sp. Pl. XXV, figs. 1, 1 a, 1 b.

Specific Characters.—Arms very much produced. R : r : : 150 mm. : 10 mm. Supero-marginalia in contact almost the whole length of arm.

Material.—The only specimen of this species, formerly in the collection of Mr. J. Starkie Gardner, is preserved in the British Museum of Natural History (E. 375). The plates have, unfortunately, disappeared from the disc. Practically all that remains is the greater portion of one arm.

Description.—At the base of the arm the supero-marginalia are oblong. Each measures 2·8 mm. in breadth, 2 mm. in length, and 3 mm. in height. Distally these plates become almost square. They are ornamented by small granules which tend to run together transversally to the length of the arm (Pl. XXV, fig. 1), and articulations for spines and deep depressions for pedicellariæ are also present. They are about twenty-five in number. The infero-marginalia equal in number and size and oppose the supero-marginalia. Further they are about the same height in marginal view.

The breadth of the arm at the fourth supero-marginal is 6 mm.

Stratigraphical Position.—Lower Chalk. Locality uncertain.

Genus—PENTAGONASTER, *Linck*. (See p. 24.)

3. PENTAGONASTER ROBUSTUS, n. sp. Pl. XXI, figs. 2, 2 a.

Specific Characters.—Disc covered with small rounded plates. Margin high. Rays short, high and robust. R : r : : 21·5 mm. : 9·9 mm. The supero-marginal plates meet along the median line throughout almost the whole length of the arm, and form a broad border to the disc. Interbrachial arcs paraboloid.

Material.—The only specimen of this species is the one here described, formerly in the Mantell collection and now preserved in the British Museum of Natural History (48085). The locality from which it was derived is stated rather

vaguely as Upper Chalk, Sussex. The specimen is somewhat imperfect, consisting only of the dorsal view of three arms and a portion of the disc.

Description.—The disc appears to have been covered on its dorsal surface by a large number of small, rounded, closely-fitting plates. Mostly they are subequal in size and have an approximate diameter of 2 mm. An uncertain number of even smaller granule-like plates exist scattered between these.

Both radialia and adradialia extend into the base of the arms, but only as far as the third supero-marginal plate, counting from the median interrarial line. The arms themselves are short and high. The height of the specimen in the interradius is 9·2 mm. From this point the height gradually diminishes to the extremity of the ray, where it is 5 mm.

The supero-marginalia are about twelve in number. They form a broad margin to the disc and rays. Each supero-marginal plate is high, and is very convex dorsally. Hence every plate is very distinct. The six proximal supero-marginals diminish only slightly in size distalward along the ray. The next six, however, diminish much more rapidly. The supero-marginal nearest the interradius has the following measurements: height, 5·75 mm.; breadth, 4·5 mm.; length, 3 mm.

The ocular plate has broken away, and there is no trace of a madreporite.

The infero-marginalia alternate with the supero-marginal series. They are not so high and much squarer in appearance. They decrease in size much more rapidly than the upper series (see Pl. XXI, fig. 2 *a*). The infero-marginal plates, nearest the interradius, measure 4·5 mm. high and 3·2 mm. in length. Any ornament that may have existed has disappeared from all parts.

Locality and Stratigraphical Position.—Upper Chalk, Sussex.

4. PENTAGONASTER OBTUSUS, *Forbes*, sp. Pl. XXII, figs. 1, 1 *a*, 1 *b*, 2, 2 *a*, 3 *a*, 3 *b*,
3 *c*, 3 *d*, 3 *e*, 3 *f*, 3 *g*.

OREASTER OBTUSUS, *Forbes*, 1848. Mem. Geol. Surv. Gt. Brit., vol. ii, p. 468.

— — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, p. 330, pl. xxi, fig. 12.

— — *Dujardin et Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 389.

— — *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), pl. xxi, fig. 12, pp. 364, 370.

Specific Characters.—Disc slightly convex. Majority of the plates covering the disc of subequal size and closely set. R : r : : 25 mm. : 12 mm. Extremities of arms obtuse. Interbrachial arcs only slightly rounded, giving the disc a distinctly pentagonal appearance.

Material.—The two extremities of the arms from which Forbes originally described the species when in the Dixon collection, are now preserved in the British Museum (Natural History). They are not on the same slab of chalk as represented by Forbes, but are and probably always have been two independent specimens, E. 5038 (Pl. XXII, figs. 3 *b, c, d*), and E. 5039 (fig. 3 *a*). More complete specimens have since been added to the collection (40400, Pl. XXII, fig. 1 *ex* J. Simmons' Coll., and 35481, Pl. XXII, fig. 2, *ex* H. W. Taylor's Coll.). Two extremities of arms are also preserved in the Brighton Museum.

Description.—The disc is high and distinctly pentagonal. At the edge of the disc the dorsal covering plates are crowded and polygonal in appearance. Towards the centre they become slightly smaller and rounded. The average diameter of these plates is 1.7 mm.

The madreporite is subcentral in position. It is about the same size as the other plates of the disc and is pentagonal in shape (Pl. XXII, fig. 1 *a*).

The arms are stoutly built. A triple row of polygonal plates enters their bases. The adradial series soon disappears, leaving the single radial series, which appears to persist until it reaches that part of the ray which is obtuse. From this point the supero-marginal plates may or may not be adjunct up to the end of the ray. Considerable variation appears to exist as to this point in the single specimen examined. The arms are distinctly obtuse in their distal half. This has given the species its name.

The supero-marginalia form a rather broad border to the disc. There are nine supero-marginals from the median interradius to the extremity of the ray. Towards the end of the ray the plates of this series become narrower, more oblong in appearance, and distinctly convex.

The infero-marginalia are equal in number and situated generally alternating with the supero-marginal series. They are distinctly square in shape, especially at the obtuse extremities of the ray. Their ornament is in some specimens not so coarse as that of the supero-marginals.

The actinal interradiial areas are very distinct and are occupied by four series of ventro-lateral plates. As usual, the actinal plates near the mouth are larger and more rhomboidal than the distal plates. Ventro-lateral plates only extend throughout about a quarter of the length of the arm.

The mouth-angle plates are not prominent. The adambulacral plates possess a triple row of spines.

Dimensions.—Specimens 35,481 and 40,400.—The greatest width of the ray varies from 8·3 to 6·5 mm., and the least width from 7·2 to 5·7 mm. The supero-marginal plates are 3·2 mm. broad near the interradii.

Specimen E. 5038.—Greatest width of ray 10·5 mm.

Specimen in Brighton Museum.—Greatest width of ray 9·2 mm.

Locality and Stratigraphical Position.—Upper Chalk, Lancing, Sussex, and also from the Upper Chalk of Kent.

Family—PENTACEROTIDÆ (*Gray*) *emend. Perrier*, 1884.

Phanerozonte Asteroids with unequally developed marginal plates, the superior series being frequently masked or hidden in membrane. Abactinal skeleton reticulate. Plates with large isolated tubercles, or spinelets, or granules, or covered with membrane. Actinal interradial areas with large pavement-like plates which bear unequal-sized granules.

Genus—PENTACEROS, *Schulze*, 1760.

- PENTACEROS, *Schulze*, 1760. Betrachtung der versteinerten Seesterne und ihrer Theile, Warschau u. Dresden, p. 50.
 GONIASTER (paris), *Agassiz*, 1835. Mem. Soc. Sci. Nat. Neuchatel, t. i, p. 191.
 PENTACEROS, *Gray*, 1840. Ann. and Mag. Nat. Hist., vol. vi, p. 276.
 OREASTER, *Müller and Troschel*, 1842. System der Asteriden, p. 44.

Generic Characters.—Form stellate, marginal plates conspicuous, defining the ambitus. Abactinal plates regular, with more or less definite intermediate papular areas. Prominent localised mammillated tubercles or spines present.

All the fossil species of this genus possess intermarginalia, but do not otherwise approach Sladens' genus *Pentaceroopsis* which possesses this character. In view of the fact that intermarginalia may occur as a variation in unmistakable recent species of *Pentaceros* this character cannot invalidate the admission to the present genus of the species about to be described.

1. PENTACEROS BULBIFERUS, *Forbes*, sp. Pl. XX, figs. 1, 1 *a*, 1 *b*, and 1 *c*; figs. 2, 2 *a*, and 2 *b*; Pl. XXI, figs. 1, 1 *a*, 1 *b*, 3, 3 *a*, 4, 4 *a*; Pl. XXIII, figs. 2, 2 *a*.

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| OREASTER BULBIFERUS, <i>Forbes</i> , 1848. | Mem. Geol. Surv. Gt. Brit., vol. ii, p. 468. |
| — — | <i>Forbes</i> , 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, pp. 328, 329, pl. xxiv, fig. 7. |
| — — | <i>Dujardin et Hupé</i> , 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 389. |
| — — | <i>Forbes</i> , 1878. In Dixon's Geology of Sussex (new edition, Jones), pp. 363, 370, pl. xxiv, fig. 7. |
| — — | <i>P. H. Carpenter</i> , 1882. Geol. Mag., p. 12. |

Specific Characters.—Disc and arms very convex. The centrale and primary interradialia large and tuberculiform. The major radius approximately twice the minor radius. Radialia of the arm conspicuous. Extremities of the arms swollen.

Material.—The specimens figured and described are all preserved in the British Museum (Natural History). E. 5040 (Pl. XXI, fig. 1), 40175 (Pl. XX, fig. 1), 48748 (Pl. XX, fig. 2), and E. 5041 (Pl. XXI, fig. 3), which were bought from J. Simmons, and 40399 (Pl. XXI, fig. 4), from the collection of E. Charlesworth, are all labelled as coming from the Upper Chalk of Bromley, Kent, which, however, seems to be an inexact dealer's locality, probably intentionally misleading. E. 5042 (Pl. XXIII, fig. 2), also bought of J. Simmons, is labelled "Upper Chalk, Charlton, Kent."

Other specimens are known in the Sedgwick Museum, Cambridge, Northampton Museum, and Brighton Museum. Specimens have also been described by Valette from the South of France.

This seems to be much the commonest as well as the most graceful of the Chalk Pentacerotidæ.

Description.—The general aspect of the plates of the disc gives this species a very characteristic appearance, for the five primary interradialia and the centrale are very prominent. They have a lobed widely-spreading base, and are swollen on the upper surface into an almost spherical form. Their weathered surfaces are pitted in a very regular manner, the pits indicating the former presence of

granules. Sometimes the granules are still present *in situ*. The pits are separated in the example figured Pl. XXI, fig. 1, on an average rather less than their own diameter apart. There may or may not be a slight margin to the plate. The centrale in a specimen R : r : : 40 : 20 measures 8.5 mm. in diameter. The primary interradialia are rather smaller, being 6.7 mm. in diameter. Radially the most conspicuous plates of the disc are the proximal radialia. They have a very characteristic appearance, their general shape reminding one of a breastplate. The remainder of the plates of the disc are of very various sizes and distributed in a fairly regular manner. The general arrangement of these plates is given in the general account at the conclusion of these volumes.

The madreporite is a conspicuous plate lying at the distal end of a primary interradial. The two neighbouring adradialia are notched for its reception.

The arms are moderately produced, the major radius being about twice the minor radius. Measurements of five specimens give the following :

| R | r |
|--------|--------|
| 40 mm. | 20 mm. |
| 35 mm. | 17 mm. |
| 50 mm. | 25 mm. |
| 50 mm. | 25 mm. |
| 50 mm. | 20 mm. |

At the base of each arm there are five series of plates visible on the dorsal surface—the radialia, adradialia, and supramarginalia. All the plates at the base of the arm overlap. They are of a type which may be derived from the breastplate shape mentioned above. They gradually become narrowed in length and increased in breadth until they are shaped somewhat like an inverted T (Pl. XX, fig. 2 b). The granulation is generally confined to the central region of each plate.

The arm about halfway along its length becomes swollen and the plates no longer overlap but are contiguous. They lose their T-shaped form, become almost oblong, and at the same time rather tumid. This is especially noticeable in the case of the radialia. The form of the plates is, however, rarely absolutely regular, but one which is generally derivable from the breastplate shape.

If we examine a cross-section of the arm, we see that the base of the plates of the dorsal intermediate series is prolonged inwards (and ventralward), so that a single isolated plate appears club-shaped.

All the plates are pitted for granules except at the extreme margin.

The supero-marginal plates are from twelve to thirteen in number, the infero-marginals from thirteen to fourteen in number. The arm is very high and both

infero- and supero-marginal plates appear in dorsal view. In fact, the infero-marginal plates do not take any part in the formation of the actinal surface. This is paralleled in modern species of *Pentaceros*, e. g. *P. clavatus*. In marginal view the supero- and infero-marginals at the extremity of the ray very distinctly alternate. This alternation persists at the base of the arms, but here it is not always so obvious.

The supero-marginals are much higher than the infero-marginals, and also more oblong in shape. Both supero- and infero-marginal plates are regularly but coarsely pitted for granules.

In specimen figured on Pl. XX, fig. 1, we obtain the following measurements :

| | | | | | | |
|--|---|-----------------|---|---|---|-----------|
| Breadth of fifth infero-marginal from the extremity of ray | | | | | | . 5.8 mm. |
| Length | „ | „ | „ | „ | „ | . 4 „ |
| Breadth | „ | supero-marginal | „ | „ | „ | . 9.2 „ |
| Length | „ | „ | „ | „ | „ | . 3.9 „ |
| Breadth | „ | radialia | „ | „ | „ | . 5.8 „ |
| Length | „ | „ | „ | „ | „ | . 4.4 „ |
| Width of ambulacral groove | . | . | . | . | . | . 1.2 „ |

The ocular is visible in this specimen. It is about 1.6 mm. in length and breadth. The extremity is slightly pointed, and its ventral surface is hollowed out.

A ventral view is figured on Pl. XXI, fig. 1. Vento-lateral plates extend almost to the extremity of the arms. These are, as usual, rather greater in breadth than in length. The adambulacral plates appear to be about half the length of the bordering actinal plates. Their armature consists of several rows of spinelets arranged in pairs.

A few intermarginalia are present in the interradii. They, as usual, press the supero- and infero-marginalia on to the abactinal and actinal surfaces of the disc respectively.

Locality and Stratigraphical Position.—Upper Chalk, Bromley, Kent; according to Dr. Rowe, probably from the Chislehurst caves near that locality.

Variations.—Variations occur amongst all the specimens, especially with regard to the ornamentation of the plates and the madreporite. The British Museum specimens, 48748, which occur together in a slab, are especially noteworthy, inasmuch as the lowest situated individual possesses on the disc no plate, which is bulbiform or raised conspicuously above the remainder.

2. PENTACEROS BOYSII, *Forbes*, sp. Pl. XXII, figs. 4, 4*a*, 4*b*, 4*c*; Pl. XXIII, figs. 1, 1*a*, 1*b*; Pl. XXVI, figs. 2, 2*a*, 2*b*.

- OUREASTER BOYSII, *Forbes*, 1848. Mem. Geol. Surv. Gt. Brit., vol. ii, p. 468.
 — — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, p. 328, pl. xxi, fig. 6.
 — — *Dujardin et Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 389.
 — — *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), pp. 362, 370, pl. xxi, fig. 6.

Specific Characters.—The primary radialia and interradialia are large hemispheroid punctate tubercles. R : r :: 80 mm. : 18 mm. Rays well produced, steep-sided, almost square in section, and tapering gradually to the extremity. Only a few of the plates of the disc enter the base of the arm. Supero- and infero-marginal plates adjunct, the intermarginalia being represented only by a few scattered granules.

Material.—The type specimen was said by Forbes (1848) to be in the collection of the Marquess of Northampton. The specimen figured and described in Dixon's 'Geology of Sussex' (see reference) was said by Forbes to have been "discovered by Major Boys and formed part of his interesting collection." This statement does not preclude the hypothesis that the specimen figured was also the type specimen. Neither specimen (if there were two) can now be traced. The following description is based chiefly on a specimen in the Sedgwick Museum, Cambridge (Pl. XXVI, fig. 2), which shows the actinal surface of the arms and a portion of the disc. It is supplemented by reference to a less nearly perfect specimen preserved in the British Museum of Natural History (J. Simmons' Coll., 46600), which presents views of isolated rays (Pl. XXII, fig. 4), and an isolated ray seen from the dorsal surface (Pl. XXIII, fig. 1) in the same museum (Dixon Coll., 48083).

Description.—The disc is covered with a number of rounded or irregularly-shaped plates. A circlet of large tubercles is very distinct and characteristic of the species. These tubercles are hemispherical and not so swollen as those of *P. bulbiferus*. They are smooth, and possess a fine distinct ornament, thus distinguishing them from the circlet of *P. coronatus*. Their diameter is about 8.5 mm., and they seem to be arranged radially and interradially, making a total of ten. The madreporite was figured by Forbes. It is roughly triangular in shape.

The arms are well produced. $R = 80$ mm. and $r = 18$ mm., the major radius being thus about four and a half times the minor radius. They taper gradually to the extremity. The breadth of the ray about the fourth supra-marginal plate is 6·8 mm. The height of the ray at the same spot is almost exactly the same. The rays are steep-sided, and consequently appear almost square in cross section.

The supero-marginalia are adjunct throughout almost the whole length of the ray, for only one or two single radialia enter the base of the ray. At the base of the ray they are flat and slightly rhomboidal. They possess an anterior indentation on their inner surface and are about 3·5 mm. in breadth. They gradually diminish in size distally and at the same time become distinctly swollen. They number about twenty-eight.

The infero-marginal plates are approximately of the same size and number as the supero-marginals. Both series imbricate slightly. The ornament of these plates consists of a number of fine granules in the centre, while there is a distinct margin without granulations.

Between the supero- and infero-marginal plates a few scattered granules represent a slight development of the intermarginalia.

The adambulacrals are a series of small oblong plates. They border the infero-marginals from about the eleventh supra-marginal onward. They are much worn, and but slight traces of their armature remain. About five adambulacrals occupy the same length as two infero-marginal plates. Proximally there is a single row of small plates which separate the two series.

Only a few scattered ossicles of the actinal surface of the disc remain.

Locality and Stratigraphical Position.—Upper Chalk, Kent.

Remarks.—Valette ('Bull. Soc. Yonne,' 1902) has described a number of species of starfishes from the Senonian of the South of France. The remains are found as scattered ossicles. Some of these are grouped by Valette as a new species which he calls *P. senonensis*. They are noticed by the author to resemble *P. Boysii* except that they are smooth and therefore do not have the ornament possessed by *P. Boysii*. Valette regards this absence of ornament as rendering them specifically distinct from *P. Boysii*, as other ossicles found in close proximity still possess the ornament. In view of the vagaries of the way in which solution may occur, I cannot admit this contention and consider that it is much more probable that the ossicles at one time possessed ornament and were identical with *P. Boysii*. All the other ossicles except those of the so-called *Arthraster senonensis* (*vide infra*, p. 92) were identified with English Cretaceous genera, which would support this contention.

3. PENTACEROS CORONATUS, *Forbes*, sp. Pl. XIX, figs. 1, 1 *a*; Pl. XXIV, figs. 2, 2 *a*, 2 *b*, 2 *c*; Pl. XXV, fig. 9.

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| OREASTER CORONATUS, <i>Forbes</i> , 1848. Mem. Geol. Surv. Gt. Brit., vol. ii, p. 467. |
| — — <i>Forbes</i> , 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, pp. 327, 328, pl. xxi, fig. 7 <i>a—d</i> . |
| — — <i>Dujardin et Hupé</i> , 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 389. |
| — — <i>Forbes</i> , 1878. In Dixon's Geology of Sussex (new edition, Jones), pp. 362, 370, pl. xxi, figs. 7, 7 <i>a—d</i> . |

Specific Characters.—Disc large, with conspicuous nodular primary radialia and interradialia. The major radius is about five times the length of the minor radius. Sides of arms very steep, so that the arm appears to be square in cross section. A triple row of intermarginalia present in the interbrachial areas.

Material.—The type specimen of this species is preserved in the British Museum of Natural History (Dixon's Coll., 35480). Unfortunately, only one arm and a portion of the disc are preserved. A further specimen, registered E. 2562, from the cabinet of Mrs. Smith, of Tunbridge Wells, is preserved in the same museum, and another example is to be seen in the Museum of Practical Geology, Jermyn Street.

Description.—The most conspicuous feature of the disc is the circlet of ten "large, more or less polygonal nodose pyramidal tubercles."¹ These are the primary radialia and interradialia. The interradial tubercles are rather larger than the radial tubercles, the former measuring 9.2 mm., the latter 7.7 mm. in diameter. The remainder of the disc is covered by irregularly shaped plates.

The madreporite has been broken away from the disc of the specimen no. 35480. It is figured Plate XXV, fig. 9.

R : r : : 58 mm. : 19 + mm. in the type specimen where the single arm is broken short. In specimen no. E. 2562 R : r : : 100 mm. : 20 mm. The arms are 30 mm. broad at the base. Their surface is flat, and the sides slope away at right angles, so that a cross section of the arm is square.

Both radial and adradial plates are present in the base of the ray. The adradials are irregular in shape and soon disappear. The radials are roughly oblong in appearance, and exist throughout that portion of the arm preserved. They diminish in size, however, distally.

The supero-marginal plates are indented on their anterior median surface.

¹ Forbes, in Dixon's 'Geology of Sussex,' p. 327.

They appear to imbricate slightly at their margins. The breadth of the fourth supero-marginal is 7 mm., the length 4 mm., and the height 3.5 mm. The height of the ray at this point is 12.2 mm.

The infero-marginal plates are opposite to the supero-marginals. They are approximately about the same size and number. Between the supero- and infero-marginal series a triple series of intermarginalia occurs in the interradian areas. The inner and larger intermarginals persist throughout the greater part of the length of the arm. It is this intercalated series which gives to the arm its great proportionate depth. The outer and smaller series disappear at about the seventh and ninth infero-marginal plates.

The ornamentation of the plates appears to have been worn away, although upon many of the plates a distinct marginal area may be seen.

Upon most of the plates there occur small entrenched pedicellariæ which are very characteristic of this species of *Pentaceros*. They consist of a small pit from which radiate two fine entrenchments (see Pl. XXIV, fig. 2 a).

One of the rows of specimen no. E. 2562 is distorted so as to bring the ventral surface into view. This shows that the ventro-lateral plates extend well towards, and perhaps all the way to, the extremities of the arm.

Locality and Stratigraphical Position.—The locality of the type specimen is given as Lower Chalk, Washington, Sussex. The specimen registered E. 2562 is from the Lower Chalk, Burham, Kent, and the specimen in the Museum of Practical Geology is from the Lower Chalk, Dover.

Remarks.—The specimen registered E. 2562 presents only one or two pedicellariæ, which are so characteristic and numerous on the other two specimens.

4. PENTACEROS SQUAMATUS, *Forbes*, sp. Pl. XXV, figs. 3, 3 a, 3 b, 3 c.

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| OREASTER SQUAMATUS, | <i>Forbes</i> , 1848. | Mem. Geol. Surv. Gt. Brit., vol. ii, p. 468. |
| — | — | <i>Forbes</i> , 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, p. 328, pl. xxiii, fig. 7. |
| — | — | <i>Dujardin et Hapé</i> , 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 389. |
| — | — | <i>Forbes</i> , 1878. In Dixon's Geology of Sussex (new edition, Jones), pp. 363, 370, pl. xxiii, fig. 7. |

Specific Characters.—Disc high, with conspicuous primary radialia, inter-

radialia and centrale. Major radius about four times the length of the minor radius. Only radialia enter the base of the arm. Dorsal surfaces of arms flat, sides slope away at an obtuse angle from this. Ossicles distinctly imbricating. A few intermarginalia present.

Material.—The only specimen of this species is preserved in the Brighton Museum. The specimen consists of the disc and a portion of three arms. On the whole little displacement of the ossicles has taken place.

Description.—The disc is strongly convex, and is covered with the circler of primary radialia and interradialia which are disposed around the centrale. All these ossicles appear shaped like a breast-plate. The centrale has a diameter of 4.2 mm. The primary interradialia are larger, possessing a diameter of 5.3 mm., whilst the primary radialia are the smallest of the series, measuring only 3.7 mm. across. Between the centrale and the primary interradialia a number of irregularly distributed plates appear. In the next right-hand interradial to the madreporite a number of these appear to have surrounded an anal opening. The primary interradialia almost touch one another, and the radialia consequently rest on the bases of pairs of ossicles. A few adradialia are present, but they are confined to the disc. A pair of them help to enclose the madreporite, which is a polygonal plate 9 mm. in greatest diameter. The ornamentation of the ossicles is rather coarse when present, but usually it is very much worn away.

The arms are well produced. $R : r :: 30 + \text{mm.} : 7.8 \text{ mm.}$ They are 1.3 mm. in breadth at the base. After the fourth or fifth radiale the remainder become minute but persist throughout the length of the arm preserved.

The supero-marginalia are finger-shaped; they, as also the infero-marginalia, distinctly imbricate. The dimensions of the third supero-marginal, reckoning from the median interradial line, are as follows: length 2.3 mm., breadth 3.1 mm. The long axes of the supero-marginal plates slope away distally, thus causing pairs of plates to assume the shape of arms of a **V**. They are at least thirteen in number.

The infero-marginal plates are similar in size and number to the supero-marginal series. In the interradia a few intermarginalia are present. These force the supero-marginal series to the surface of the disc.

Nothing is known of the ventral surface.

Locality and Stratigraphical Position.—Upper Chalk, Woolwich.

5. PENTACEROS OCELLATUS, *Forbes*, sp. Pl. XXV, figs. 4, 4 a.

- OREASTER OCELLATUS, *Forbes*, 1848. Mem. Geol. Surv. Great Brit., vol. ii, p. 468.
 -- — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, p. 329, pl. xxi, fig. 13.
 -- — *Dujardin et Hupé*, 1862. Hist. Nat. Zooph. Echin. (Suites à Buffon), p. 389.
 -- — *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), pp. 364, 370, pl. xxi, fig. 3.
 PENTACEROS — *McPherson, W.*, 1902. Rep. Brighton Nat. Hist. Soc.

Specific Characters.—Ventro-lateral plates (as probably also the dorsal plates) depressed and finely striated on their truncated surface so as to simulate the surface of a madreporite, with sides rugged and ocellato-punctate. Between these plates smaller ossicles of a similar character are interspersed.

Material.—But one specimen of this species was known to Forbes. This is preserved in the British Museum of Natural History (Dixon Coll., E. 2571). It is a mass of ossicles which look as if they were derived from the dorsal surface of the disc. They are more spheroidal and somewhat larger than the ossicles of the ventral surface of the more nearly perfect example discovered by Mr. William McPherson in the Senonian Marsupites band at Brighton. This he presented to the British Museum (Natural History) in 1901 (E. 5012).

Description.—The disc and arms are unknown. The specimen no. E. 5012 shows a well-preserved portion of the ventral surface. The mouth-angles were occupied by single initial rhomboidal ossicles. To these succeed the ventro-lateral ossicles which border the ambulacral groove. These are pentagonal ossicles of very uniform size. The length of the exposed sides of the ossicles bordering the groove is 4.4 mm. and the greatest breadth of an ossicle 4.2 mm. The remaining ventro-lateral plates are hexagonal, but of almost the same dimensions, although the plates appear to become a little larger distally.

The plates overlap one another considerably, rendering precise measurement difficult. Between the larger plates are interspersed large numbers of smaller and more irregular ossicles which fill up the angles between their sides. The whole test would be thus very strongly built.

Both larger and smaller plates are curiously similar in appearance. The

madreporiform striations on the truncated summits and the ocellato-punctate sides give a most characteristic appearance and render the species unmistakably distinct from all known species of *Pentaceros*.

The ambulacral groove is 3.5 mm. wide. The adambulacrals are difficult of recognition and have probably for the most part been lost, but a large number of the hour-glass shaped ambulacrals may be seen.

Locality and Stratigraphical Horizon.—Upper Chalk, Kent; Upper Senonian, Brighton.

6. *PENTACEROS ABBREVIATUS*, n. sp. Pl. XXIV, figs. 1, 1 *a*, 1 *b*, 1 *c*.

Specific Characters.—Body of medium size. Arms moderately produced, but their breadth making them appear stumpy, rounded at the extremities, and hemispherical in cross section. Five series of dorsal ossicles enter their base. Of these the radialia and adradialia persist throughout the length of the arm. A few small intermarginalia are present.

Material.—There is only one specimen known of this species, and of this practically all that remains are two arms. It is preserved in the British Museum of Natural History (J. Tennant's Coll., 57538).

Description.—These arms are characteristically wide, the width of the arm at the base being 31 mm. They narrow very gradually towards the extremity. Throughout the ray the ossicles, except for the differences noted below, are very similar in appearance. At the base of the ray, where dorso-lateralia also enter into the composition of the dorsal skeleton, they are rounded and possess interspaces of considerable extent. These interspaces are often filled by smaller granules arranged irregularly. At times, however, between two radialia or adradialia one of the smaller ossicles is arranged in a very regular and alternating manner. Both large and small ossicles are finely granulated, and the large ossicles alone are perforated for pedicellariæ. The average size of the larger ossicles at the base of the arms is about 6 mm. Towards the extremity of the ray the radialia, adradialia, and marginalia become hexagonal, and fit very closely so as to make a compact skeleton. The terminal ocular plate is hexagonal and conspicuous. It has a flattened articulation which undoubtedly was originally occupied by a spine. Several of the other dorsal plates in the distal portion of the ray also possess similar articulation.

The supero-marginalia and infero-marginalia are equal in number. There were probably thirteen of each in the space between an interradius and an extremity of an arm.

In the interbrachial are there is a series of minute granular intermarginalia.

The traces of the disc which are present suggest that the ossicles of this region were oval in shape and minute in size. I exposed a portion of the ventral surface of the arm, but, unfortunately, little trace of structure was shown. The ventro-lateralialia extended to the extremity of the ray. The ridges of the adambulacral armature are lost.

Locality and Stratigraphical Position.—Upper Chalk, Charlton, Kent.

7. PENTACEROS BISPINOSUS, n. sp. Pl. XXIII, figs. 3, 3 *a*, 3 *b*, 3 *c*.

Specific Characters.—Disc large. Arms moderately produced. Single isolated marginal ossicles vertebra-shaped with biconcave extremities. Ventro-lateral plates with strongly marked sockets for two or more spines.

Material.—The only specimen of this species is that preserved in the British Museum of Natural History (H. W. Taylor's Coll., 35482). Only the ventral surface is exposed, and this is very much distorted.

Description.—The disc appears to have been large. Its actinal surface is covered with a number of sub-equal oblong or polygonal plates, which possessed sockets in which fitted spines (Pl. XXIII, fig. 3*c*). These plates are 4·8 mm. long, and 3·1 mm. wide.

The arms are moderately broad, and at least four series of ventro-lateral plates enter at the base. R : r : : 60 mm. : 20 mm. (approximately), the major radius therefore measuring about three times the minor radius. The marginal ossicles are shaped very much like the centrum of a vertebra, and are biconcave. They possess a distinct granulation in their central region, which is surrounded by a wide margin. The infero-marginals at the base of the ray are about 3·2 mm. wide and 2·1 mm. long. There were probably sixteen of them from the interradius to the extremity of the ray.

The specimen is otherwise so distorted that little can be made of its structure.

Locality and Stratigraphical Position.—Upper Chalk, Sittingbourne, Kent.

The following are placed provisionally in the genus *Pentaceros* :

8. *PENTACEROS PUNCTATUS*, n. sp. Pl. XXVI, figs. 1, 1 a, 1 b.

Specific Characters.—Body of large size. Marginal series of plates possessing well-developed foraminate pedicellariæ. Intermarginalia present.

Material.—The only example of this species is a fragmentary portion of an arm preserved in the British Museum (Natural History) and bearing the registered number E. 2561.

Description.—The body of the starfish must have been of large size. The supero-marginals are in contact in the extremity of the arm, although interspersed granular plates occur. Proximally, at least, radial plates were present. The largest supero-marginal present is 11·2 mm. high and 6·5 mm. long in its widest point. It is of rather irregular shape and possesses two foraminate pedicellariæ. The infero-marginal plates alternate with the supero-marginals. They are of the same height as the supero-marginals but only 5 mm. broad. They are oblong in shape; the two interior corners of the oblong, however, are cut away, making the ossicles six-sided. The foramina once occupied by the pedicellariæ are deep and often situated in a depression. From the foramen itself ridges may run out, which probably served for the attachment of muscles.

The infero-marginal series border only the side of the arm and take but little part in the formation of the ventral surface.

An intermarginal series of rounded granular plates occurs.

Locality and Stratigraphical Position.—Upper Chalk.

9. *PENTACEROS PISTILLIFERUS*, *Forbes* sp. Pl. XXV, fig. 5.

OEEASTER PISTILLIFERUS, *Forbes*, 1848. Mem. Geol. Surv. Great Brit., vol. ii, p. 467.

— — — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, p. 329, pl. xxi, fig. 15.

— *PISTILLIFORMIS*, *Dujardin et Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 389.

— *PISTILLIFERUS*, *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), pp. 363, 370, pl. xxi, fig. 15.

Specific Characters.—Primary radialia (or interradialia) large with a dilated summit which possesses no ornament and is excavated into pits. “Ossicles of the arm are narrow, shuttle-shaped, tumid in the centre and slightly impressed towards each extremity” (Forbes).

Material.—Several fragmentary remains of this species are known. The most nearly perfect remains are those in the Museum of Practical Geology, Jermyn Street. Other specimens are in the British Museum (Natural History), registered E. 5037, 57624, E. 2564 (all Pl. XXV, fig. 5), 7600, E. 25637, E. 2565.

Description.—Nothing is known further than the description given in the diagnosis. Forbes' description reads as if he had described the species from the specimen in the Museum of Practical Geology. This originally was in the collection of the Marquis of Northampton. Forbes seems to have described the large ossicles upside down. He also says they were in a circlet of five, which is not apparent in any specimen known. The roughened and pitted surface recalls in some respects the primary radialia and interradialia of *P. coronatus*.

Locality and Stratigraphical Position.—Upper Chalk, Kent and Sussex.

10. PENTACEROS, sp. Pl. XXV, fig. 7.

This specimen is preserved in the British Museum of Natural History (no. 5514).

It consists of five marginal plates which are 12·3 mm. high, and have an average length of 5·5 mm. The plates are rugged in appearance and the ornament is worn away. A cirral of a crinoid (probably *Bourguetocrinus*) has become fixed between two of these plates.

11. PENTACEROS, sp. Pl. XXV, fig. 8.

The only specimen is preserved in the Brighton Museum. It consists of a few marginal plates. The supero-marginals are rather irregular in shape, some being almost wedge-shaped. On an average they are 4 mm. high and 3·2 mm. long. The infero-marginals are opposite and equal in length to the supero-marginals. They are only 2·9 mm. high. The plates possess a distinct margin, but the

ornament otherwise is worn away. There are a few small granular inter-marginalia.

With these plates is associated a large plate which appears to be a worn radial or interradial of *P. Boysii*.

Family—ASTROPECTINIDÆ (*Gray*, 1840), *emend.* Sladen, 1886.

Phanerozonte Asteroids with large marginal plates bearing spines or spiniform papillæ. Abactinal skeleton with true columnar papillæ. Actinal interradial areas small, interradial plates when present spinose. Ambulacral plates short and more or less compressed. Superambulacral plates present. Aprotuchous. Pedicellariæ rarely present.

Genus—ASTROPECTEN, *C. F. Schulze*, 1760.

Adambulacral plates touching the infero-marginal plates along the ray. Marginal and adambulacral plate not correspondent in length and number. Superomarginal plates more or less well developed. Marginal plates long and more or less quadrate. Superior and inferior series subequal.

ASTROPECTEN, sp. Pl. XXV, figs. 2, 2 *a*.

Material.—There is one specimen in the Sedgwick Museum at Cambridge, which looks like an *Astropecten*. It is figured on Pl. XXV, figs. 2 and 2 *a*. Practically only the marginal plates are preserved.

Description.—R : r : : 45 mm. : 15 mm. The interbrachial arcs are well rounded. The supero-marginalia are remarkably uniform in size throughout the greater portion of the ray. Their breadth is 4 mm. and length 1·7 mm. About thirty of these are present from the interradius to the extremity. At the apex of the ray these plates are adjunct. The upper surface of each plate is rounded.

The infero-marginalia are equal in size, opposite to, and, as far as one can judge, similar in appearance to, the superior series. There is a distinct groove between the two series.

Locality and Stratigraphical Position.—Upper Greensand, Blackdown (?).

PLATE XVII.

METOPASTER MANTELLI, *Forbes*, sp. (Page 38.)

From the Upper Chalk.

FIG.

1. Actinal aspect; natural size. (Coll. Brit. Mus., 40402.)
 - a. Infero-marginal plate; magnified 4 diameters.

MITRASTER COMPACTUS, *Forbes*, sp. (Page 67.)

From the Upper Chalk.

2. Actinal aspect; copied from Forbes in Dixon's 'Geology of Sussex,' pl. XXII, fig. 3.

COMPTONIA COMPTONI, *Forbes*, sp. (Page 69.)

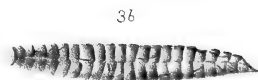
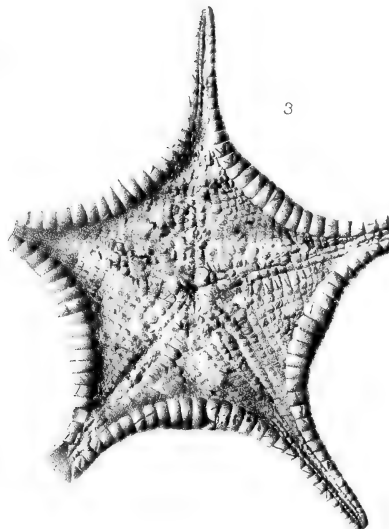
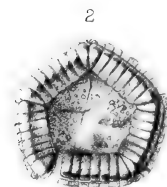
From the Upper Greensand.

3. Actinal aspect; natural size. (Coll. Brit. Mus., 34311.)
 - a. Infero-marginal plate; magnified 3 diameters.
 - b. Lateral view of interbrachial arc; natural size.

COMPTONIA ELEGANS, *Gray*. (Page 71.)

From the Upper Greensand.

4. Abactinal view; natural size. (Coll. Brit. Mus., E. 2567.)
 - a. Actinal view of same specimen; natural size.



A.H. Searle del. et lith

Pitcher Lith imp

CRETACEOUS ASTEROIDEA.

PLATE XVIII.

ARTHRASTER DIXONI, *Forbes*. (Page 91.)

From the Lower Chalk.

FIG.

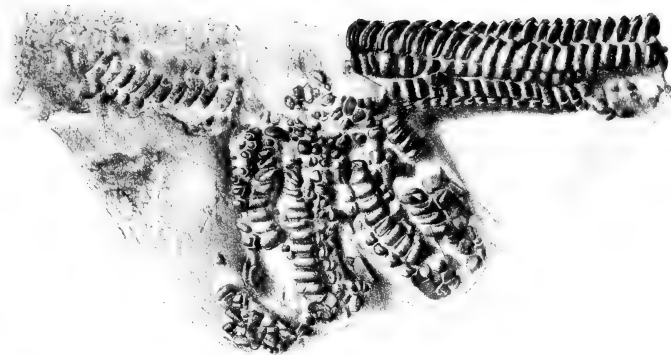
1. Actinal aspect; natural size. (Coll. Brit. Mus., 47000.)
a. Supero-marginal plate; magnified 3 diameters.

COMPTONIA COMPTONI, *Forbes*, sp. (Page 69.)

From the Upper Greensand.

2. Abactinal view; natural size. (Coll. Northampton Mus.)
a. Isolated plate of interradial portion of disc; magnified 6 diameters.
b. Isolated radial; magnified 6 diameters.
c. Lateral view of interbrachial arc; natural size.
d. Supero-marginal plate; magnified 3 diameters.

1



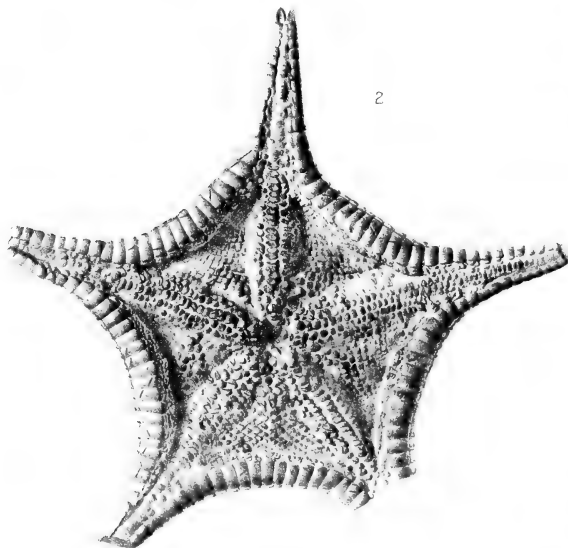
1a



2a



2



2a



2b



2c



PLATE XIX.

PENTACEROS CORONATUS, *Forbes*, sp. (Page 82).

From the Lower Chalk.

FIG.

1. Abactinal aspect; natural size. (Coll. Brit. Mus., E. 2562.)
 - a. Lateral view of arm; natural size.

METOPASTER PARKINSONI, *Forbes*, sp. (Page 31.)

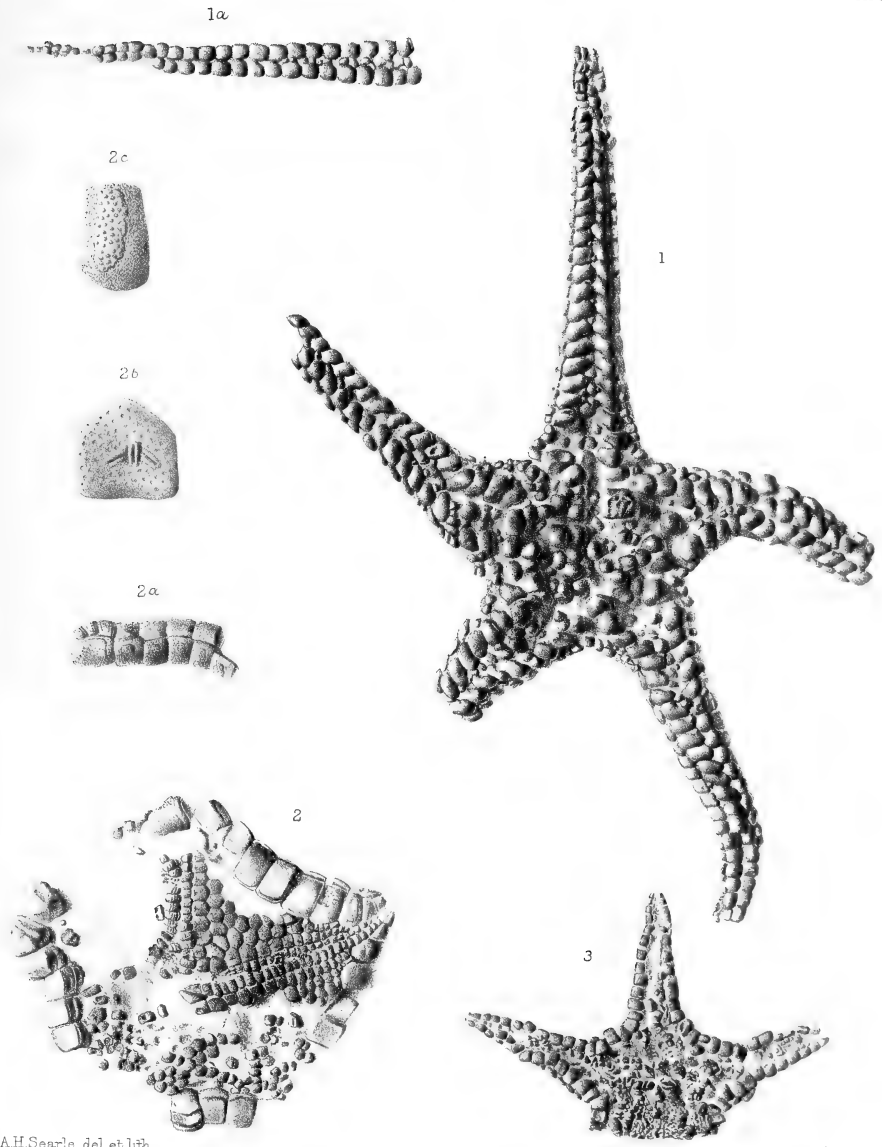
From the Upper Chalk.

2. Actinal aspect; natural size. (Coll. Brit. Mus., E. 5027.)
 - a. Lateral view; natural size.
 - b. Ventro-lateral plate; magnified 5 diameters, showing entrenched pedicellaria.
 - c. Supero-marginal plate; magnified 3 diameters.

NYMPHASTER COOMBII, *Forbes*, sp. (Page 15.)

From the Upper Greensand.

3. Actinal aspect; natural size. (Coll. Brit. Mus., 48620.)



A.H.Searle del. et lith.

Pitcher Ltd imp

PLATE XX.

PENTACEROS BULBIFERUS, *Forbes*, sp. (Page 77.)

From the Upper Chalk.

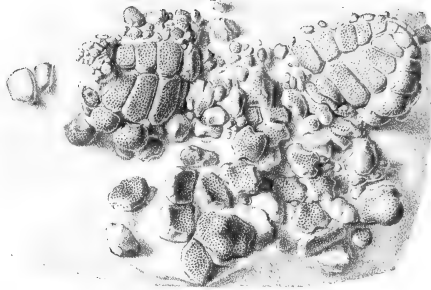
FIG.

1. Abactinal view; natural size. (Coll. Brit. Mus., 40175.)
 - a. Plate from dorsal part of disc; magnified 3 diameters.
 - b. Supero-marginal plate; magnified 3 diameters.
 - c. Plate from dorsal part of disc; magnified 2 diameters.
2. Abactinal view of two specimens; natural size. (Coll. Brit. Mus., 48748.)
 - a. Madreporite; magnified 6 diameters.
 - b. Proximal supero-marginal plate; magnified 4 diameters.

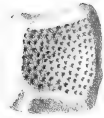
1b



1.



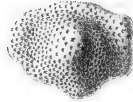
1c.



2a.



1a.



2b.



2.

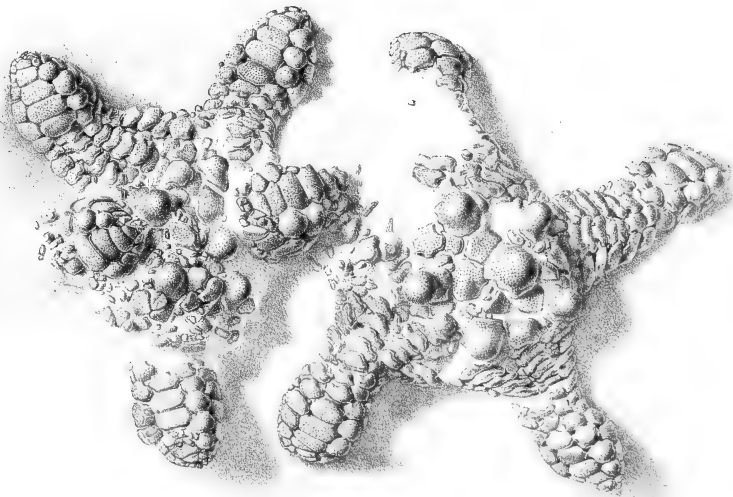


PLATE XXI.

PENTACEROS BULBIFERUS, *Forbes*, sp. (Page 77.)

From the Upper Chalk.

FIG.

1. View of the extremities of three arms and portion of disc; natural size.
(Coll. Brit. Mus., E. 5040.)
 - a. Vento-lateral plate; magnified 6 diameters.
 - b. Actinal view of the extremities of two of the above arms; natural size.

PENTAGONASTER ROBUSTUS, n. sp. (Page 73.)

From the Upper Chalk.

2. Abactinal aspect; natural size. (Coll. Brit. Mus., 48085.)
 - a. Lateral view of an arm; natural size.

PENTACEROS BULBIFERUS, *Forbes*, sp. (Page 77.)

From the Upper Chalk.

3. Abactinal aspect; natural size. (Coll. Brit. Mus., E. 5041.)
 - a. Madreporite; magnified 6 diameters.
4. Abactinal aspect; natural size. (Coll. Brit. Mus., 40399.)
 - a. Madreporite; magnified 6 diameters.

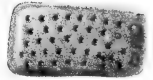
1



1b



2a



2



3a



4a



2c



3



4

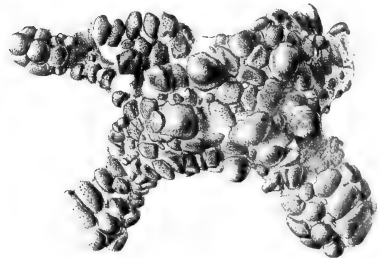


PLATE XXII.

PENTAGONASTER OBTUSUS, *Forbes*, sp. (Page 74.)

From the Upper Chalk.

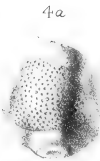
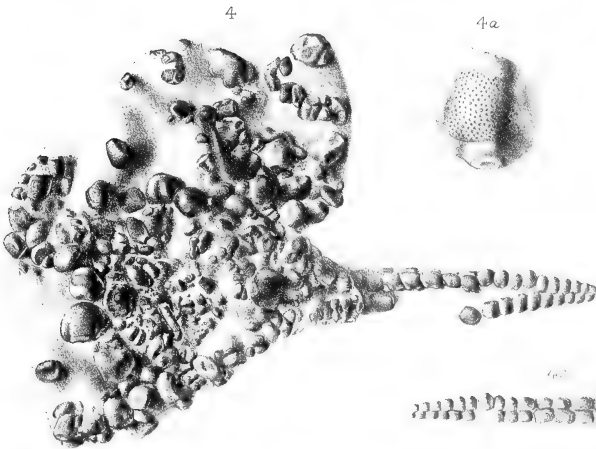
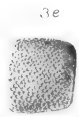
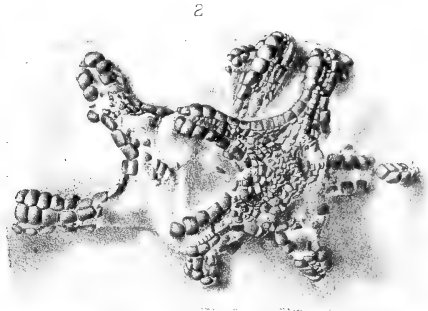
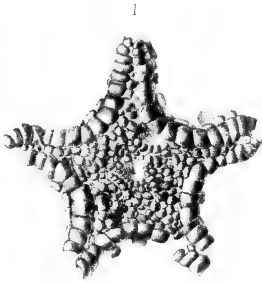
FIG.

1. Abactinal aspect; natural size. (Coll. Brit. Mus., 40400.)
 - a. Madreporite; magnified 10 diameters.
 - b. Lateral view of margin, abactinal side upwards; natural size.
2. Actinal aspect of two specimens; natural size. (Coll. Brit. Mus., 35481.)
 - a. Lateral view of extremity of arm of the underlying specimen; natural size.
- 3 a. Dorsal view of extremity of arm; natural size. (Coll. Brit. Mus., E. 5039.)
 - b. End view of extremity of arm; natural size. (Coll. Brit. Mus., E. 5038.)
 - c. Side view of extremity of same arm; natural size.
 - d. Ventral end of extremity of same arm; natural size.
 - e. Supero-marginal plate; magnified 3 diameters.
 - f. Infero-marginal plate; magnified 3 diameters.
 - g. Adambulacral plate; magnified 5 diameters.

PENTACEROS BOYSII, *Forbes*, sp. (Page 80.)

From the Upper Chalk.

4. Abactinal view; natural size. (Coll. Brit. Mus., 46600.)
 - a. Isolated ossicle of disc; magnified 4 diameters.
 - b. Isolated ossicle of disc; magnified 4 diameters.
 - c. Lateral view of arm; natural size.



A. S. Woodward del et lith.

CRETACEOUS ASTEROIDEA

Geological Survey of Canada

PLATE XXIII.

PENTACEROS BOYSII, *Forbes*, sp. (Page 80.)

From the Upper Chalk.

FIG.

1. Supero-marginal plate; magnified 4 diameters. (Coll. Brit. Mus., 48083.)
 - a. Lateral view of extremity of arm from which the above supero-marginal plate was drawn; natural size.
 - b. Dorsal view of extremity of same arm; natural size.

PENTACEROS BULBIFERUS, *Forbes*, sp. (Page 77.)

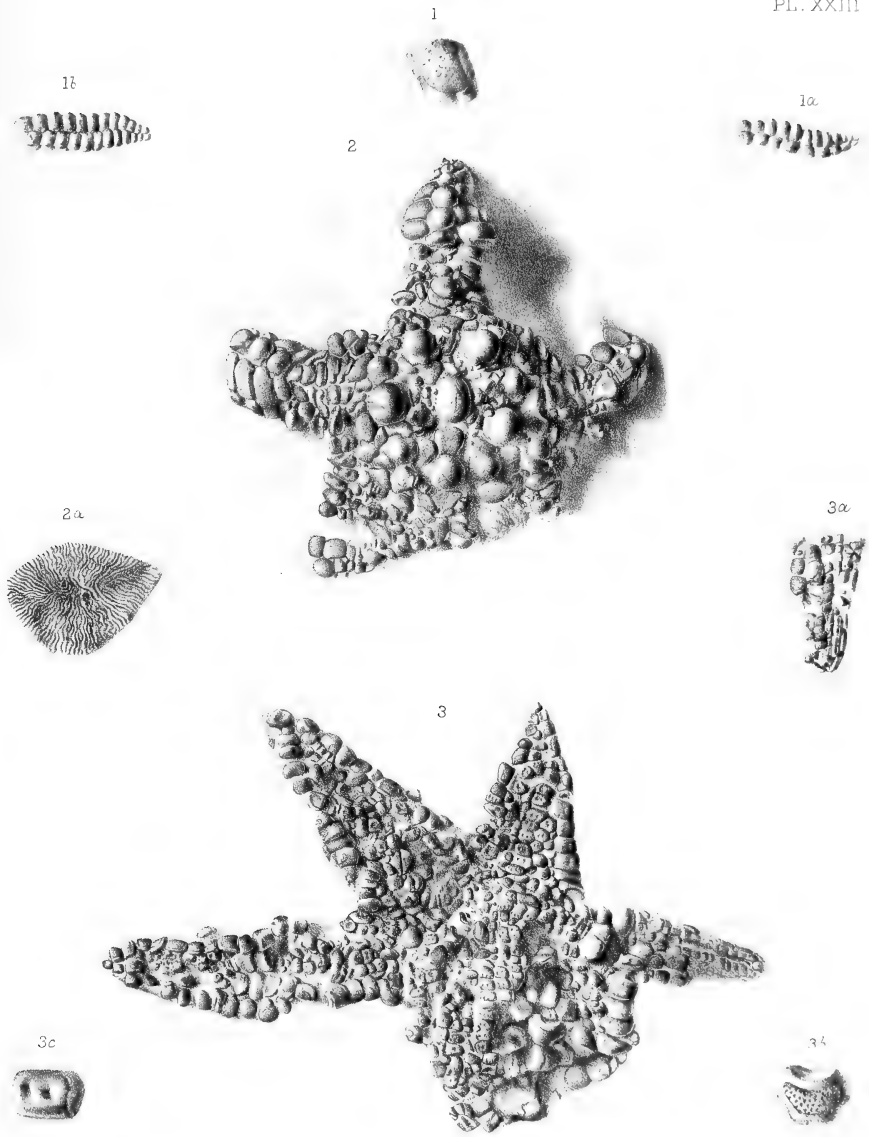
From the Upper Chalk.

2. Abactinal aspect; natural size. (Coll. Brit. Mus., E. 5042.)
 - a. Madreporite; magnified 5 diameters.

PENTACEROS BISPINOSUS, n. sp. (Page 87.)

From the Upper Chalk.

3. Actinal aspect; natural size. (Coll. Brit. Mus., 35482.)
 - a. Actinal view of extremity of arm; natural size.
 - b. Infero-marginal plate; magnified 3 diameters.
 - c. Ventro-lateral plate; magnified 4 diameters.



A.H. Searle del. et lith.

Pl. XXXIII

CRETACEOUS ASTEROIDEA .

PLATE XXIV.

PENTACEROS ABBREVIATUS, n. sp. (Page 86.)

From the Upper Chalk.

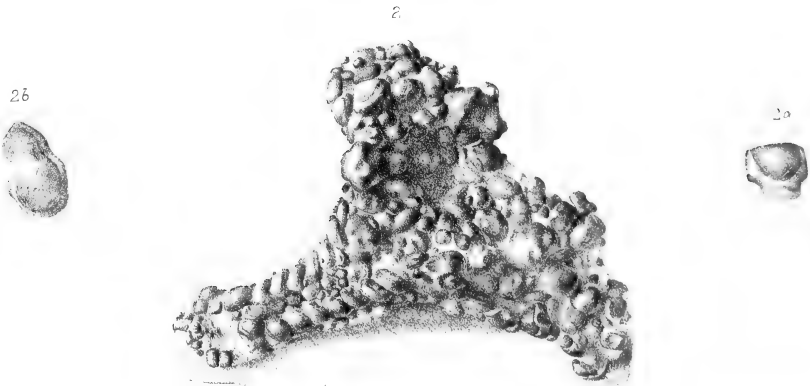
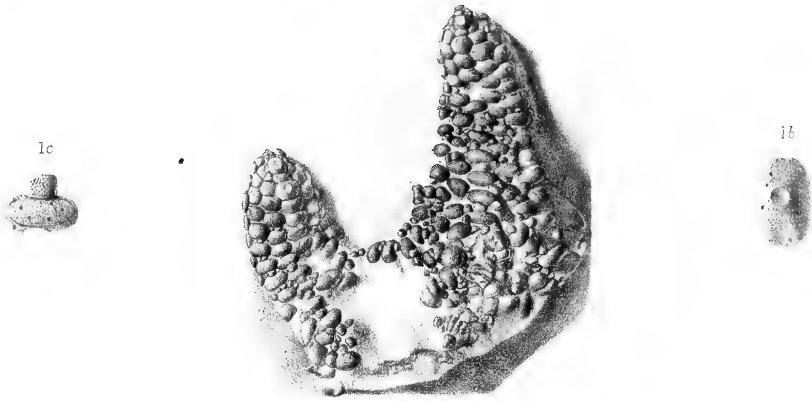
FIG.

1. Abactinal aspect; natural size. (Coll. Brit. Mus., 57538.)
 - a. Lateral view of arm; natural size.
 - b. Radial plate; magnified 3 diameters.
 - c. Two succeeding supero-marginal plates; magnified 3 diameters.

PENTACEROS CORONATUS, *Forbes*, sp. (Page 82.)

From the Lower Chalk.

2. Abactinal aspect; natural size. (Coll. Brit. Mus., 35480.)
 - a. Plate of disc; magnified 3 diameters.
 - b. Supero-marginal plate; magnified 3 diameters.
 - c. Lateral view of arm; natural size.
[See also Pl. XXV, fig. 9.]



AH Searle del et lith

PLATE XXV.

NYPHASTER RADIATUS, n. sp. (Page 73.)

From the Lower Chalk.

FIG.

1. Abactinal view; natural size. (Coll. Brit. Mus., E. 375.)
 - a. Lateral view of margin; natural size.
 - b. Supero-marginal ossicle; magnified 4 diameters.

ASTROPECTEN ? n. sp. (Page 90.)

From the Upper Greensand.

2. Abactinal view; natural size. (Coll. Sedgwick Museum, Cambridge.)
 - a. Isolated marginal ossicle; magnified 4 diameters.

PENTACEROS SQUAMATUS, *Forbes*, sp. (Page 83.)

From the Upper Chalk.

3. Abactinal view; natural size. (Willett Coll., Brighton Mus.)
 - a. Madreporite; magnified 6 diameters.
 - b. Marginal view of arm; natural size.
 - c. Supero-marginal ossicle; magnified 6 diameters.

PENTACEROS OCELLATUS, *Forbes*, sp. (Page 85.)

From the Upper Chalk.

4. Actinal view; natural size. (Coll. Brit. Mus., E. 5012.)
 - a. Vento-lateral ossicle; magnified 4 diameters.

PENTACEROS PISTILLIFERUS, *Forbes*, sp. (Page 88.)

From the Upper Chalk.

5. Ossicles of disc; natural size. (Coll. Brit. Mus.; from left to right the register numbers are E. 5037, 57634, E. 2564.)

GENUS ? sp. ? (Page 93.)

From the Chalk.

6. Ossicles; natural size. (Coll. Brit. Mus.)
 - a. Isolated ossicle; magnified 4 diameters.

PENTACEROS ? n. sp. (Page 89.)

From the Chalk.

7. Marginal view of ossicles of arm; natural size. (Coll. Brit. Mus., 5514.)

PENTACEROS ? n. sp. (Page 89.)

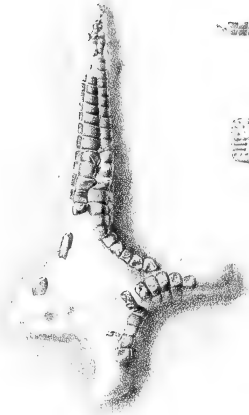
From the Chalk.

8. Marginal view of ossicles; natural size. (Willett Coll., Brighton Mus.)

PENTACEROS CORONATUS, *Forbes* sp. (Page 82.)

9. Madreporite; magnified 4 diameters. (Coll. Brit. Mus., 35480.)

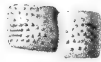
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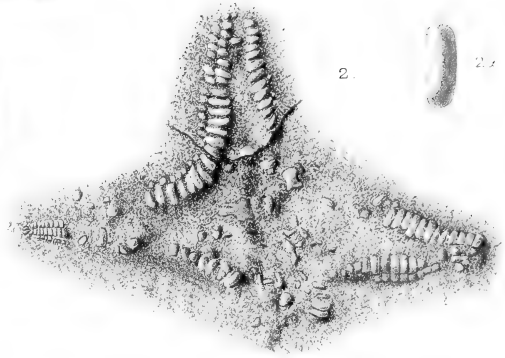
1a



1c



2.



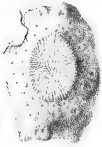
2a



4.



4a.



3b.



3a.



6.



3c.



3.



6a.



9.



7.



8.



PLATE XXVI.

PENTACEROS PUNCTATUS, n. sp. (Page 88.)

From the Upper Chalk.

Fig.

1. Abactinal view of remains of arms; natural size. (Coll. Brit. Mus., E. 2561.)
 - a. Lateral view of margin; natural size.
 - b. Enlarged view of single ossicle; magnified 2 diameters.

PENTACEROS BOYSII, *Forbes*, sp. (Page 80.)

From the Upper Chalk.

2. Actinal view; natural size. (Coll. Sedgwick Mus., Cambridge.)
 - a. Lateral view of margin; natural size.
 - b. View of isolated ossicle; magnified 4 diameters.

MITRASTER COMPACTUS, *Forbes*, sp. (Page 67.)

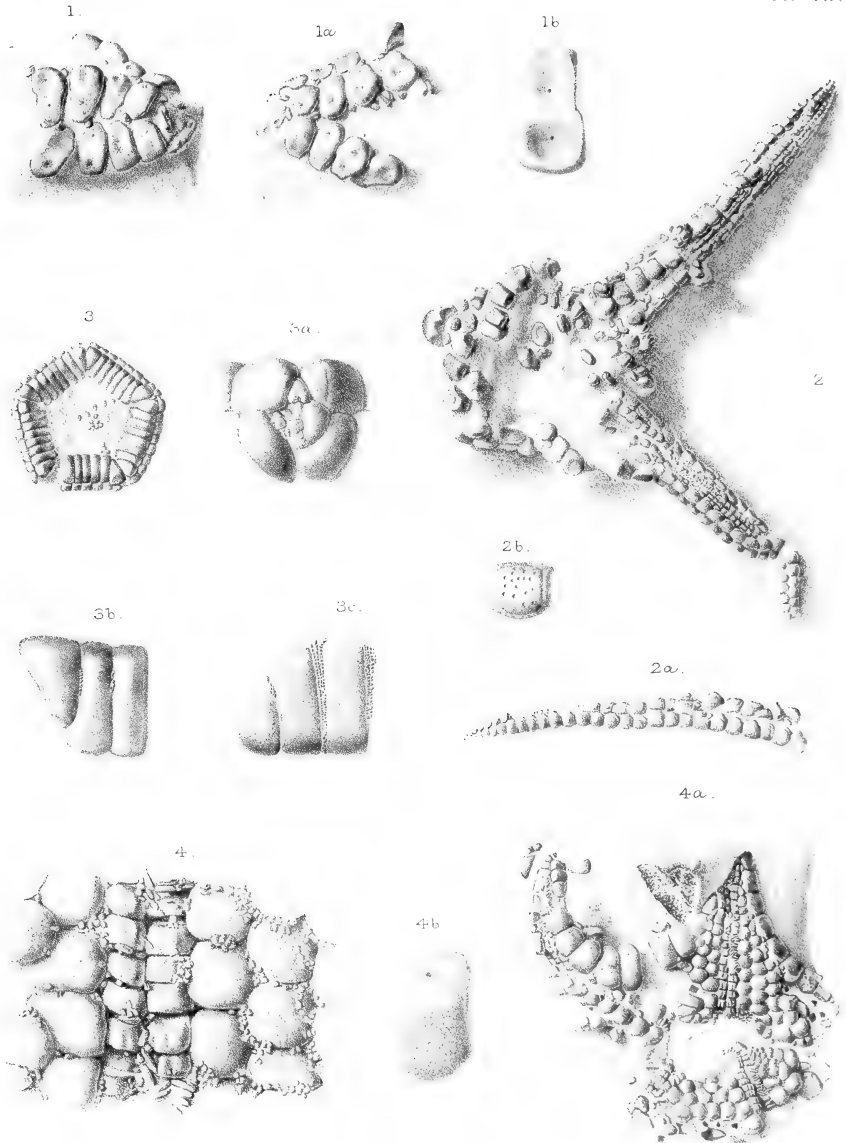
From the Upper Chalk.

3. Abactinal view; natural size. (Willett Coll., Brighton Mus.)
 - a. View of end of arm; magnified 4 diameters.
 - b. Lateral view of supero-marginal ossicles; magnified 4 diameters.
 - c. Lateral view of infero-marginal ossicles; magnified 4 diameters.

CALLIDERMA MOSAICUM, *Forbes*, sp. (Page 9.)

From the Lower Chalk.

4. Actinal view of ambulacral groove; magnified 4 diameters. (Coll. Sedgwick Museum, Cambridge.)
 - a. Actinal view; natural size.
 - b. Infero-marginal ossicle; magnified 4 diameters.



A.H. Searle del et lith.

Fischer del et lith.

CRETACEOUS ASTEROIDEA

Palaontographical Society, 1905.

A MONOGRAPH

OF THE

CRETACEOUS LAMELLIBRANCHIA

OF

ENGLAND.

BY

HENRY WOODS, M.A.

UNIVERSITY LECTURER IN PALEOZOOLOGY, CAMBRIDGE.

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This species was figured from the Norwich Chalk by S. Woodward (1833) as *Plagiostoma granulatum*, but apparently he was unaware that it had been previously described and figured by Nilsson under the similar name *P. granulatum*. Woodward's figure seems to have been overlooked by later writers.

Distribution.—*Actinocamax quadratus* zone of East Harnham, Salisbury. *Belemnitella mucronata* zone of Alderbury, Clarendon (near Salisbury), and various localities near Norwich. Chalk of Trimmingham.

Family—PTERIIDÆ, Meek.

Genus—PTERIA, J. A. Scopoli, 1777.¹

(‘*Introd. Hist. Nat.*,’ p. 397.)

Sub-genus—OXYTOMA, Meek, 1864.

(‘*Check List Invert. Foss., N. America*,’ p. 39; *Meek and Hayden*, ‘*Palæont. U. Missouri*,’ 1864, Part I, p. 79.)

PTERIA (OXYTOMA) CORNUELIANA (*d'Orbigny*), 1846. Plate VIII, figs. 1, 2, 3 *a*, *b*, 4–7.

- | | | |
|---------|--------------------------------------|--|
| 1836. | AVICULA MACROPTERA, F. A. Römer. | Die Verstein. nord-deutsch. Oolith-geb., p. 86, pl. iv, fig. 5 (non <i>Avicula macroptera</i> , Lamarck, 1819). |
| 1841. | — — — | Die Verstein. d. nord-deutsch. Kreidegeb., p. 64. |
| 1846. | — CORNUELIANA, A. <i>d'Orbigny</i> . | Pal. Franç. Terr. Crét., vol. iii, p. 471, pl. cccxxxix, figs. 3, 4. |
| 1846. | — PECTINATA, <i>d'Orbigny</i> . | Ibid., p. 473, pl. cccxci, figs. 1–3. |
| 1850. | — CORNUELIANA, — | Prodr. de Pal., vol. ii, p. 82. |
| 1850. | — PECTINATA, — | Ibid., p. 82. |
| ? 1868. | — CORNUELIANA, E. Eichwald. | Lethæa Rossica, vol. ii, p. 508, pl. xxii, fig. 1. |
| 1869. | — — — | F. J. Pictet and G. Campiche. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 66, pl. clii, figs. 1–4. |
| 1877. | — — — | G. Böhm. Zeitschr. d. deutsch. geol. Gesellsch., vol. xxix, p. 237. |
| ? 1883. | — — — | W. Keeping. Foss., etc., Neoc. Upware and Brickhill, p. 109, pl. v, fig. 2. |
| 1884. | — — — | O. Weerth. Die Fauna des Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 50. |

¹ Syn. *Avicula*, Bruguière, 1791.

1889. AVICULA INEQUIVALVIS, *G. W. Lamplugh*. Quart. Journ. Geol. Soc., vol. xlv, p. 615.
1895. — CORNUELIANA, *G. Maas*. Zeitschr. der deutsch. geol. Gesellsch., vol. xlvii, p. 267.
1895. — — — *F. Vogel*. Holländisch. Kreide, p. 55.
1896. — — — *A. Wollemani*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvi, p. 842.
1900. — — — — Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 52.
1901. OXYTOMA INEQUIVALVE var. MACROPTERA, *L. Waagen*. Jahrb. d. k.-k. geol. Reichsanst., vol. li, pp. 12, 15, pl. i, figs. 7, 14, 15.

Description.—Shell obliquely oval, rounded. Height a little greater than length.

Left valve moderately convex. Anterior ear triangular. Posterior ear larger and longer than the anterior. Surface of valve with from 12 to 21 main ribs which are rounded, and form projections on the margin of the valve. Between the main ribs are broad flat interspaces in the middle of each of which a smaller rib occurs, and between these secondary ribs and the main ribs one or more still smaller ribs are found. On the middle and posterior parts of the valve the ribs are nearly straight, but on the anterior part they curve forward. Similar ribs occur on the anterior ear; on the posterior ear much smaller ribs are present, and growth lines are seen. Fine concentric ridges cross both ribs and interspaces.

Right valve nearly flat, with many small, sometimes irregular ribs, which may be alternately large and small. Anterior ear rather small, with a well-marked byssal sinus. Posterior ear large, pointed, with small radial ribs.

Measurements :

| | (1) | (2) | (3) |
|--------------|-----|-----|--------|
| Length . . . | 26 | 24 | 13 mm. |
| Height . . . | 27 | 25 | 15 „ |

(1, 2) Speeton Clay (D 1), Speeton.

(3) Claxby Ironstone, Claxby.

Affinities.—*P. (Oxytoma) Cornueliana* is distinguished from the other Cretaceous species of *Oxytoma* by the broad interspaces on which several smaller ribs occur. It belongs to the persistent and variable series of forms, ranging from the Rhætic to the Chalk, of which *Pteria inequivalvis* (Sowerby) is the type, and it is regarded by L. Waagen as only a variety of that species.

In most of the English specimens the main ribs are more numerous but less prominent than in the examples figured by d'Orbigny and by Pietet and Campiche.

But the number of those ribs varies considerably, and our specimens agree perfectly with the figures given by Waagen. The specimens from Faringdon are smaller than those found in the Speeton Clay, and they present some resemblance to *P. pectinata* (see below), but the presence of several smaller ribs in the interspaces connects them with *P. Cornucliana*.

Types.—From the Hils-thon of Elligser Brink. The specimen from Upware figured by Keeping is in the Sedgwick Museum; it is imperfectly preserved, but is probably an example of this species.

Distribution.—Speeton Clay (zone of *Belemnites lateralis*, D1) of Speeton. Claxby Ironstone (zone of *B. lateralis*) of Claxby. Tealby Clay (zone of *B. jaculum*) of Claxby. Lower Greensand of Faringdon. Gault of Folkestone.¹

PTERIA (ONYTOMA) PECTINATA (*Sowerby*), 1836. Plate VIII, figs. 8*a*, *b*, 9, 10*a*, *b*, 11–13, 14*a*, *b*.

- | | | |
|-----------|--|--|
| 1836. | AVICULA PECTINATA, <i>J. de C. Sowerby</i> . | Trans. Geol. Soc., ser. 2, vol. iv, pp. 128, 338, pl. xiv, fig. 3. |
| 1854. | — — — <i>J. Morris</i> . | Cat. Brit. Foss., ed. 2, p. 163. |
| 1869. | — — — <i>F. J. Pictet and G. Campiche</i> . | Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 70. |
| Non 1846. | — — — <i>A. d'Orbigny</i> . | Pal. Franç. Terr. Crét., vol. iii, p. 473, pl. ccxcix, figs. 1–3. |

Description.—Shell small, obliquely oval, with evenly rounded margin. Height a little greater than length.

Left valve convex, ornamented with numerous slender ribs often having sharp summits. Frequently the ribs are of two sizes—larger and smaller, alternating in a more or less regular manner. But in some cases the ribs near the margin of the valve are of equal or nearly equal size. The interspaces are flattened and considerably broader than the ribs. Anterior ear moderately large, triangular, the outer angle nearly a right angle; surface with ribs similar to those on the rest of the valve. Posterior ear much longer than the anterior, wing-like, with concave growth-lines; on the dorsal part a few slender ribs occur but are often indistinct or absent near the valve.

Right valve moderately convex dorsally, flattened ventrally, surface smooth or with very fine radial and concentric ribs. Posterior ear large, not distinctly limited. Anterior ear small.

¹ The only specimen seen from this horizon is in the British Museum, No. L. 16,880.

Measurements :

| | (1) | (2) | (3) | (4) | (5) |
|-----------------------|-----|-----|-----|-----|-------|
| Length . | 16 | 10 | 9.5 | 9 | 8 mm. |
| Height ¹ . | 17 | 12 | 10 | 11 | 9 „ |

(1) Hythe Beds (Bargate Stone), St. Katherine's Chapel, Guildford.

(2-5) Folkestone Beds, Folkestone.

Affinities.—The shell in this species is smaller than in *P. Cornueliana* (see above); also the main ribs on the left valve are closer together, more numerous, and between them not more than one small rib is found. The ornamentation on the right valve is very much finer than in *P. Cornueliana*. See also *Pteria* (*Oxytoma*) *tennicostata* (below).

Type.—The type came from the Folkestone Beds of Risborough, but appears to have been lost. Another specimen, however, from the same locality is in the Fitton Collection in the Museum of the Geological Society.

Distribution.—Hythe Beds (Bargate Stone) of St. Katherine's Chapel, Guildford. Sandgate Beds of Parham. Folkestone Beds of Folkestone. Recorded by Topley from the Hythe Beds of Hythe. Gault of Folkestone (British Museum, No. L. 4926).² Upper Greensand of Ventnor, and Crook Hill, Cheddington (Dorset).

PTERIA (OXYTOMA) sp. Plate VIII, fig. 15 *a*, *b*.

Some very small examples of a *Pteria* similar to *P. pectinata* are found in the Totternhoe Stone of Hitchin. They are not well preserved, but appear to be distinguished from *P. pectinata* by the presence of transverse ribs placed at regular distances in the spaces between the radial ribs.

PTERIA (OXYTOMA) DUBIA (*Etheridge*), 1881. Plate VIII, fig. 16 *a*, *b*.

1881. AVICULA DUBIA, *R. Etheridge*. In Penning and Jukes-Browne, Geol. Cambridge, p. 145, pl. ii, figs. 4, 4 *a*.

Remarks.—This is known only by the two type specimens—one being a right valve separated from the matrix, the other a left showing the interior only. The surface of the right valve is smooth. Since the exterior of the left valve is un-

¹ Measured obliquely to the hinge-line.

² The species recorded from the Gault of Folkestone as *Avicula Rauliniana*, d'Orbigny (see Jukes-Browne, 'Cretaceous Rocks of Britain,' vol. i, p. 465), is probably *Pteria pectinata*.

known, the characters and affinities of this "species" cannot be determined. The left valve has a length of 6 mm.

Types.—In the Sedgwick Museum, Cambridge.

Distribution.—Totternhoe Stone (zone of *Holaster subglobosus*) of Burwell.¹

PTERIA (OXYTOMA) TENUICOSTATA (*Römer*), 1841. Plate VIII, figs. 17 *a-d*, 18, 19 *a, b*, 20 *a, b*, 21 *a, b*, 22, 23.

1841. AVICULA LINEATA, *F. A. Römer*. Die Verstein. d. nord-deutsch. Kreidegeb., p. 64, pl. viii, fig. 15 (*A. tenuicostata* on pl. viii).
1850. — SUBLINEATA, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 249.
1869. — TENUICOSTA, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. St. Croix (Matér. Pal. Suisse, ser. 5), p. 73.
1878. — TENUICOSTATA, *J. F. Blake*. Proc. Geol. Assoc., vol. v, p. 259.
1882. — — *H. Schröder*. Zeitschr. d. deutsch. geol. Gesellschaft, vol. xxxiv, p. 271.
1888. — — *A. Peron*. L'Hist. du Terr. de Craie, p. 153, pl. i, figs. 11, 12.
1904. — — *A. W. Rowe*. Proc. Geol. Assoc., vol. xviii, p. 266.
- Non 1845. — — *A. d'Orbigny*, in *Murchison, de Verneuil, and Keyserling*. Géol. de la Russie d'Europe, vol. ii, p. 490, pl. xliii, figs. 5—7.
- 1854. — LINEATA, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 163.

Description.—Shell obliquely oval, usually longer than high.

Left valve moderately convex; with evenly convex margins, except the postero-dorsal, which is slightly concave. Ears large, the anterior indistinctly limited, and with its outer angle rectangular or slightly obtuse. Posterior ear longer and more distinctly limited than the anterior, with the dorsal portion extended and wing-like.

Ornamentation of left valve consists of numerous (sometimes as many as 100) narrow, well-marked, evenly rounded ribs separated by broad, flat interspaces. The anterior ribs are slightly less prominent than the others; those near the posterior border are often closer together. At the margin of the valve the ribs usually

¹ Another specimen from the same locality and horizon was described by Etheridge as *Avicula filata* (Penning and Jukes-Browne, 'Geol. Camb.,' p. 144, pl. ii, fig. 3). I am unable to accept the generic position assigned to this species by Etheridge; it may be an *Ostrea*, but appears to be closely allied to the shell described as *Anomia subradiata* by Reuss ('Die Verstein. der böhm. Kreideformat.,' pt. 2, 1846, p. 45, pl. xxxi, figs. 18, 19). The type and three other specimens of *Avicula filata* are in the Sedgwick Museum, Cambridge.

show a more or less regular alternation in size, but sometimes two or three of the larger ribs occur in proximity without the intervention of smaller ribs. In some cases between the large and small ribs a rib of still smaller size is found. Some of the large ribs start from near the umbo; others start at some little distance from it but soon reach the same size as the primary ribs; still other ribs are intercalated at a greater distance from the umbo and do not attain the same size as the earlier ribs. The anterior and posterior ribs have a slight curvature; the others are more nearly straight. Occasionally the anterior and posterior ribs have a faintly marked nodose appearance. The interspaces are smooth, or have a very faintly marked radial ribbing. The anterior ear is ornamented with ribs similar to those on the remainder of the valve, but they are of uniform or nearly uniform size. The posterior ear is marked with growth-lines parallel to its posterior concave border; radial ribs also occur, and are rather larger and more widely separated on the dorsal portion than on the part near the junction with the rest of the valve.

Right valve much smaller than the left; flattened, but convex in the median dorsal part. Anterior ear with a deep sinus. Posterior ear much larger, but not marked off from the rest of the valve. Surface smooth, or with very faint concentric lines.

Measurements of left valves:

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|------------------|------|-----|-----|------|-----|-----|-------|---------|
| Length | 27 | 26 | 26 | 20·5 | 19 | 19 | 13·5 | 12 mm. |
| Height (oblique) | 25·5 | 23 | 22 | 19 | 18 | 17 | 14·75 | 11·25,, |

(1, 8) *A. quadratus* zone, West Hamham.

(2, 5) „ „ „ Coddendam.

(4) Upper Chalk, Ruston Parva.

(3, 6, 7) „ „ Wells.

Affinities.—*Pteria danica* (Ravn)¹ is similar in outline and the general character of its ornamentation to *Pteria tenuicostata*, but appears to be distinguished by the possession of fewer ribs and by their absence in the neighbourhood of the umbo.

In the character of its ornamentation *P. tenuicostata* closely resembles *P. pectinata* (see p. 59), but is distinguished by its larger size, relatively greater length, and smaller convexity; also the ribs are more numerous, the ears are relatively larger, and the anterior left ear is less distinctly limited.

The specimen from Simbirsk figured by d'Orbigny (1845) as *Avicula tenuicostata* differs from that species in the possession of fewer and stronger ribs. It was subsequently regarded by d'Orbigny² as an example of *Avicula laripes*, Morton.³

¹ 'Mollusk. i. Danmarks Kridtaflej,' i. (1902), p. 79, pl. i, figs. 1, 2.

² 'Prodr. de Pal.,' vol. ii (1850), p. 249.

³ 'Synopsis Org. Remains Cret., U.S.' (1834), p. 63, pl. xvii, fig. 5.

Remarks.—In England this species has, up to the present time, been definitely recognised in the *Actinocamax quadratus* zone only.

The specimen figured by Römer is relatively higher than most of the English examples, but in other characters there is close agreement.

Pteria seminuda (Dames)¹ resembles *Pteria tennicostata*, but appears to differ in the ribs on the left valve being of more nearly uniform size, and in the presence of distinct ornamentation on the right valve.

Type.—The type is stated by Römer to have come from the Lower Chalk of Lindner Berg, near Hanover, but according to Dr. J. Böhm the horizon is really the *quadratus* Chalk.

Distribution.—Zone of *Actinocamax quadratus* of West Harnham, near Salisbury, and Sewerby (Yorkshire). Upper Chalk (? *A. quadratus* zone) of Coddendam (Suffolk), Wells (Norfolk), and Ruston Parva (Yorkshire).

Sub-genus—PSEUDOPTERA, *F. B. Meek*, 1873.

(‘6th Ann. Rep. U.S. Geol. Survey of the Territories,’ p. 489; *Meek*, ‘Invert. Cret. and Tert. Foss. U. Missouri’ (Rep. U.S. Geol. Survey, vol. ix, 1876), p. 29.)

PTERIA (PSEUDOPTERA) SUBDEPRESSA (*d’Orbigny*), 1850. Plate IX, fig. 1a, b.

| | | |
|-------|--------------------------------------|---|
| 1845. | AVICULA DEPRESSA, <i>E. Forbes</i> . | Quart. Journ. Geol. Soc., vol. i, p. 247, pl. iii, fig. 7 (non <i>A. depressa</i> , Münster, 1841). |
| 1850. | — SUBDEPRESSA, <i>A. d’Orbigny</i> . | Prodr. de Pal., vol. ii, p. 119. |
| 1854. | — DEPRESSA, <i>J. Morris</i> . | Cat. Brit. Foss., ed. 2, p. 163. |
| 1855. | — SUBDEPRESSA, <i>G. Cotteau</i> . | Moll. Foss. de l’Yonne, p. 104. |
| 1869. | — — | <i>F. J. Pictet and G. Campiche</i> . Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 70. |
| 1871. | — — | <i>F. Stoliczka</i> . Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 398. |

Remarks.—This species is very imperfectly known at present. It resembles *P. haldonensis* from the Upper Greensand of Haldon (see below) but is easily distinguished by the strong concentric ridges; it also appears to be relatively longer and less convex.

Type.—In the Museum of the Geological Society (No. 2050).

Distribution.—Lower Greensand (Crackers) of Atherfield. Recorded by Topley from the Atherfield Clay of Peasmarsh and Shalford.

¹ ‘Zeitschr. d. deutsch. geol. Gesellsch.,’ vol. xxvi (1874), p. 765, pl. xxi, fig. 3; Nötling, ‘Die Fauna d. baltisch. Cenoman’ (Paleont. Abhandl., vol. ii, 1885), p. 21, pl. iii, figs. 7, 8.

PTERIA (PSEUDOPTERA) ANOMALA (*Sowerby*), 1836. Plate IX, figs. 2*a-d*, 3*a, b*, 4*a, b*.

| | | | |
|-----------|------------------|--------------------------------------|--|
| 1836. | AVICULA ANOMALA, | <i>J. de C. Sowerby.</i> | Trans. Geol. Soc., ser. 2, vol. iv, pp. 240, 342, pl. xvii, fig. 18. |
| ‡ 1846. | — | <i>A. E. Reuss.</i> | Die Verstein. der böhm. Kreideformat., pt. 2, p. 22, pl. xxxii, figs. 1—3. |
| ‡ 1842. | GERVILLIA | <i>H. B. Geinitz.</i> | Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 3, p. 80, pl. xx, fig. 38. |
| ? 1845-6. | AVICULA | — | Grundriss d. Verstein., p. 459, pl. xx, fig. 5. |
| ? 1850. | — | — | Das Quadersandst. oder Kreidegeb. in Deutschland, p. 170 (<i>partim</i>). |
| 1854. | — | <i>J. Morris.</i> | Cat. Brit. Foss., ed. 2, p. 163. |
| 1868. | — | <i>A. Briart and F. L. Cornet.</i> | Descript. Mineralog. Géol. et Pal. de la Meule de Bracquagnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 52, pl. iv, fig. 7. |
| 1869. | — | <i>F. J. Pictet and G. Campiche.</i> | Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 71. |
| 1871. | — | <i>F. Stoliczka.</i> | Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 398. |
| ? 1873. | — | <i>H. B. Geinitz.</i> | Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 207, pl. xlvi, figs. 5, 6. |
| 1893. | — | <i>R. Michael.</i> | Zeitschr. der deutsch. geol. Gesellsch., vol. xlv, p. 233. |
| Non 1846. | — | <i>A. d'Orbigny.</i> | Pal. Franç. Terr. Crét., vol. iii, p. 478, pl. ccxcii, figs. 1—3. |
| — 1850. | — | <i>d'Orbigny.</i> | Prodr. de Pal., vol. ii, p. 167. |
| ? — 1877. | — | <i>A. Fritsch.</i> | Stud. im Gebiete der böhm. Kreideformat.: II, Weissenberg. u. Malnitz. Schicht., p. 128, fig. 108. |
| — 1883. | — | — | Ibid., III, Iserschicht., p. 109. |

Description.—Shell rather large; outline (without the ears) triangular, very oblique; anterior margin convex, forming a rounded angle with the sinuous postero-ventral margin. Umbo of left valve pointed, acute, near the anterior extremity. Apical angle about 45°.

Left valve very convex, with a strong, rounded ridge extending from the umbo to the postero-ventral extremity. In front of this ridge the shell curves rapidly downwards, and becomes nearly vertical to the plane of the valves near the anterior margin and near the anterior ear. Behind the ridge the valve is flattened and slopes dorsally (fig. 2*a*); but this part is sometimes divided into two

by a median step-like fold (fig. 3 *a*). A narrow part adjoining the posterior ear slopes rather rapidly.

Anterior ear of moderate size, convex, much higher than long. Posterior ear large, united to the whole of the postero-dorsal margin of the valve; posterior margin of ear slightly concave or sinuous, forming an obtuse angle with the hinge-line and also with the postero-ventral margin.

Ornamentation consists of numerous radial ribs which are straight or slightly undulating, and extend over the larger part of the valve. On the posterior ear the ribs are narrow and separated by broad, flat or slightly concave interspaces. On the flattened part of the valve the ribs are rather more rounded and become less distinct towards the postero-ventral margin in large specimens. In front of the main ridge the ribs are closer together and the interspaces very narrow; on the anterior part of the valve and on the anterior ear, ribs are either absent or indistinct. Numerous, close-set, regular, concentric linear ridges cross both ribs and interspaces.

In small specimens (figs. 4 *a*, *b*) having the ornamentation well preserved, the ribs on the flattened part of the valve are narrow, rounded, distinctly limited, and separated by broad interspaces; new ribs are introduced in the middle of some of the interspaces. The ribs and interspaces are crossed at regular intervals by concentric ridges which form squares or oblongs with the ribs. On the posterior ear similar ornamentation occurs, but the concentric ridges cut the ribs obliquely.

Right valve not seen.

Measurements :

| | | |
|-----------------------------------|-----|--------|
| | (1) | (2) |
| Umbo to postero-ventral extremity | 86 | 75 mm. |
| Length of hinge-line | 49 | 54 „ |

(1, 2) Blackdown.

Affinities.—The specimen from the Cenomanian of Le Mans figured by d'Orbigny as *Aricula anomala* appears to be distinct from Sowerby's species on account of its larger apical angle and its fewer, stronger, and more spiny ribs. See also *P. (Pseudoptera) haldonensis* (below).

The character of the hinge in this and the other species here included in the sub-genus *Pseudoptera* is unknown; consequently their systematic position cannot be regarded as definitely determined.

Remarks.—The only examples which I have seen are the type specimen, six specimens in the British Museum, and two in the Museum of Practical Geology. Those from Haldon have the ornamentation very perfectly preserved.

Type.—In the Bristol Museum, from Blackdown.

Distribution.—Upper Greensand (zone of *Schlenbachia rostrata*) of Blackdown and Haldon.

PTERIA (PSEUDOPTERA) HALDONENSIS, sp. nov. Plate IX, figs. 5, 6 *a, b*, 7, 8 *a-c*, 9, 10.

Description.—Shell of moderate size, triangular, very oblique. Anterior margin slightly convex, forming a rounded angle with the postero-ventral margin. Umbo pointed, acute, near the anterior extremity. Apical angle about 43° .

Left valve very convex, with a sharp carina extending from the umbo to the postero-ventral angle. The part of the valve in front of the carina is bent sharply downwards along its whole length, and is ornamented with from ten to eighteen slender, linear ribs, which are separated by broad flat interspaces. The number of ribs increases with age owing to the intercalation of new ribs in the interspaces. The space between the carina and the first rib, and sometimes also between the first and second rib, is greater than the space between the ribs near the middle of the anterior part of the valve. Minute spiny projections are present on the ribs in well-preserved specimens. A similar but rather stronger rib, also with spiny projections, occurs on the carina. Behind the carina two short ribs, extending from near the middle to the margin of the valve, are sometimes seen. The larger part of the valve behind the carina is flattened and smooth except for numerous, slightly curving growth-ridges, which are continued on to the posterior ear, and are sometimes seen in front of the carina, where they may become more prominent.

Anterior ear small, with rounded margin, indistinctly separated from the remainder of the valve, ornamented with radial ribs similar to those on the adjoining part of the valve.

Posterior ear compressed, very large, separated from the remainder of the valve by a very shallow depression. Growth-ridges concave and parallel with the posterior margin.

Right valve not seen.

Measurements :

| | (1) | (2) | (3) | (4) | (5) |
|-----------------------------------|-----|-----|-----|-----|--------|
| Height (oblique) . | 28 | 26 | 25 | 23 | 18 mm. |
| Length of hinge-line ¹ | 19 | 16 | 18 | 15 | 12 ,, |

(1—5) Upper Greensand, Haldon.

Affinities.—This species is closely allied to *Pteria* (*Pseudoptera*) *varicosta* (Reuss),² from the Gosau Beds of St. Wolfgang (Salzburg), but is distinguished by the smaller obliquity of the shell, by the angle formed by the anterior and postero-

¹ This measurement is approximate only, since the posterior wing is usually imperfectly preserved.

² Reuss, 'Char. d. Kreideschicht. in den Ostalpen,' etc. (Denkschr. d. k. Akad. Wissensch. Wien, Math.-nat. Cl., vol. vii, 1854), p. 147, pl. xxviii, fig. 16; K. A. Zittel, 'Die Bivalven d. Gosaugeb.' (Ibid., vol. xxv, pt. ii, 1866), p. 90, pl. xiii, fig. 6; *A. glabra*, Geinitz, 'Das Elbthalegeb. in Sachsen' (Palaeontographica, vol. xx, pt. i, 1873), p. 208, pl. xlvi, fig. 7, and pt. ii, pl. xi, fig. 2?; Nötling, 'Die Fauna d. baltisch. Cenoman.' (Palaeont. Abhandl., vol. ii, 1885), p. 22, pl. iii, fig. 9.

ventral margins being smaller, and by the shorter postero-ventral margin. It also resembles *P. (Pseudoptera) ignabergensis* (Lundgren),¹ from the Senonian of Ignaberga.

P. (Pseudoptera) haldonensis is distinguished from the young of *P. (Pseudoptera) anomala* (see above) by its sharp carina; by the part of the valve behind the carina, and the posterior wing, being smooth; also by the strong and more widely separated ribs in front of the carina.

Types.—In the British Museum and the Sedgwick Museum.

Distribution.—Upper Greensand (zone of *Pecten asper*) of Haldon.

PTERIA (PSEUDOPTERA) GAULTINA, sp. nov. Plate IX, figs. 11 *a, b*, 12 *a, b*.

Description.—Shell small, very oblique. Umbo acute, near the anterior extremity. Apical angle 26° to 32°.

Left valve moderately convex, with the median triangular part raised but flattened; in front of this the valve bends sharply to the anterior margin; behind, it bends rather sharply to join the posterior ear, which is distinctly demarcated. Anterior ear small. Posterior ear moderately large, united to the greater part of the postero-dorsal margin of the valve; its posterior margin concave.

A few narrow, well-defined radial ribs occur on the anterior part of the raised triangular portion and just in front of it. In some cases less distinct ribs with spiny projections are present on the whole of the triangular part of the valve. Growth-ridges are often well-marked, and are continued on to the posterior ear.

Measurements :

| | |
|----------------------------|--------|
| Hinge-line | 11 mm. |
| Height (oblique) | 21 „ |

Black Ven.

Affinities.—This species is distinguished from *Pteria (Pseudoptera) haldonensis* (see above) by (1) the greater obliquity of the shell, (2) the smaller apical angle, (3) the absence of the sharp carina, (4) the distinctly limited posterior ear.

Types.—In the Museum of Practical Geology (No. 10,780) and the Sedgwick Museum.

Distribution.—Gault of Black Ven.

PTERIA (PSEUDOPTERA) CERULESCENS (*Nilsson*), 1827. Plate IX, figs. 13–16, 17 *a, b*, 18, 19 *a, b*.

| | | |
|---------|--|---|
| 1827. | AVICULA CERULESCENS, <i>S. Nilsson</i> . | Petrif. Suecana, p. 18, pl. iii, fig. 19. |
| ? 1836. | — — — — — <i>A. Goldfuss</i> . | Petref. Germ., vol. ii, p. 132, pl. cxviii, fig. 6. |

¹ 'Mollusk. i *Mammillatus* och *Macronata* Zonerne i Nordöstra Skåne' (1894), p. 44, pl. i, fig. 2.

| | | | | |
|---|-------|----------------------|---------------------------|---|
| ? | 1841. | AVICULA CÆRULESCENS, | F. A. Römer. | Die Verstein. d. nord-deutsch. Kreidegeb., p. 64. |
| | 1850. | — | — | A. d'Orbigny. Prodr. de Pal., vol. ii, p. 249. |
| | 1888. | — | CÆRULESCENS A. Peron. | Hist. Terr. de Craie, p. 155, pl. i, fig. 14. |
| ? | 1889. | — | CÆRULESCENS E. Holzappel. | Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 227. |
| | 1897. | — | — | A. Hennig. Revis. Lamell. i Nilsson's 'Petrif. Suecana,' p. 54, pl. iii, figs. 25—27. |

Description.—Shell rather small, oblique, triangular. Anterior margin slightly convex or nearly straight. Umbo rather near the anterior extremity, sometimes curved slightly backwards. Anterior ear small, not distinctly marked off from the rest of the valve. Posterior ear large, triangular, its inner margin not limited, its posterior margin slightly concave and continuous with the postero-ventral margin of the valve. Median part of the valve raised, extending obliquely backwards, sometimes subcarinate anteriorly. In front of this raised part the valve is bent more or less sharply; behind, it is compressed gradually. Surface with weak radial ribs, which are straight or slightly undulating, and bear small spiny or scaly projections sometimes close together, sometimes more or less widely separated. The ribs may occur on the anterior part only, or may be present over the entire shell, including the ears. Often on the anterior part they are closer together than elsewhere. The number of ribs and the width of the flat interspaces vary in different specimens. New ribs may be introduced in the interspaces at varying distances from the umbo. In some specimens numerous fine concentric lines are seen.

Measurements :

| | (1) | (2) | (3) | |
|--------------|-----|-----|------|-----|
| Length . . . | 11 | 11 | 10 | mm. |
| Height . . . | 13 | 12 | 10·5 | „ |

(1) *A. quadratus* zone, East Harnham.

(2) *B. mucronata* zone, Norwich.

(3) „ „ Clarendon.

Affinities.—The imperfect specimen from the Lower Senonian of Brunswick figured by G. Müller¹ as *Avicula* sp. may perhaps be an example of *P. cærulescens*.

Avicula glabra, Reuss,² resembles in form *P. cærulescens*, but is distinguished by the absence of radial ribs.

Avicula subnodosa, Hagenow,³ from the Senonian of Rügen, is perhaps identical with *P. cærulescens*, but in the absence of a figure of the former I am unable to make a comparison.

¹ 'Mollusk. d. Untersen. v. Braunschweig u. Ilsele' (1898), p. 39, pl. v, fig. 10.

² 'Die Verstein. der böhm. Kreideformat.' (1846), pt. 2, p. 22, pl. xxxii, figs. 4, 5.

³ 'Neues Jahrb. für Min.,' etc. (1842), p. 559.

Remarks.—The English specimens have the median part of the valve apparently less sharply marked off from the anterior and posterior parts than it is in the examples figured by Hennig, but they agree in this respect with the figure given by Peron.

The specimens show some variation in obliquity and in their relative height and length. The differences seen in the ornamentation are probably due, in part, at any rate, to imperfections in the preservation of the surface layer of the shell. Like Peron, I have seen no specimen of the right valve.

Examples of this species are preserved in the Norwich Museum, in Dr. Blackmore's collection, and in Mr. Brydone's collection.

Distribution.—Zone of *Actinocamæa quadratus* of East and West Harnham (Salisbury). Zone of *Belemnitella mucronata* of Clarendon (Salisbury) and Norwich. Chalk of Trimmingham.

Genus—AUCELLA, *A. Keyserling*, 1846.

('Reise in das Petschora-Land,' p. 297.)

AUCELLA VOLGENSIS, *Lahusen*, 1888. Plate X, figs. 1 *a-c*, 2 *a-c*.

- | | | | |
|-------|--------------------|--------------------|---|
| 1888. | AUCELLA VOLGENSIS, | <i>J. Lahusen.</i> | Ueber die russischen Aucellen (Mém. du Comité géol. Russ., vol. viii, No. 1), p. 38, pl. iii, figs. 1—17. |
| 1896. | — | — | <i>A. P. Pavlov.</i> Quart. Journ. Geol. Soc., vol. lii, p. 549, pl. xxvii, fig. 1. |
| 1896. | — | — | <i>var. RADIOLATA, Pavlov.</i> Ibid., p. 550, pl. xxvii, fig. 2. |

Description.—Shell large, obliquely ovate, much higher than long, moderately inflated, with regularly curving margin.

Right valve of moderate convexity, flattened. Umbo relatively small, and curving only slightly. Anterior ear triangular, with a deep, narrow byssal sinus. Posterior ear indistinctly limited.

Left valve very convex and rounded, the dorsal portion continued into a large and prominent umbo which curves anteriorly. Postero-ventral part of valve produced and somewhat compressed.

Surface of valves with concentric growth-ridges, sometimes produced into lamellæ, and forming regular curves.

Measurements :

| | | |
|--------------------------------|-----|--------|
| | (1) | (2) |
| Length | 45 | 36 mm. |
| Height of left valve (oblique) | 66 | 55 " |
| Thickness (both valves) | 32 | 22 " |

(1, 2) Spilsby Sandstone, Donnington.

Affinities.—The shell in this species is larger, relatively higher, more oblique, and less inflated than in *A. Keyserlingiana* (see below). The right valve is more flattened, and its umbo is only slightly curved. The umbo of the left valve is larger and more prominent.

Remarks.—The only specimens I have seen are internal casts from the Spilsby Sandstone. The example of this species described by Pavlow as var. *radiolata* shows faint radial ribs on the internal cast of the right valve, and a slight depression on the left valve extending from the umbo to the postero-ventral margin (Plate X, fig. 2).

Types.—From the Upper Volga beds of Kaschpur (Simbirsk), Staraja-Rjasan, and Olenek. The specimens figured by Pavlow are in the Sedgwick Museum and are here re-figured.

Distribution.—Spilsby Sandstone (zone of *Belemnites lateralis*) of Donnington.

AUCELLA KEYSERLINGIANA, *Trautschold*, 1868. Plate X, figs. 3*a*—*d*, 4*a*, *b*, 5.

1837. INOCERAMUS CONCENTRICUS, *G. Fischer de Waldheim*. Oryctographie du gouvern. de Moscou, p. 177, pl. xx, figs. 1—3.
1846. AUCELLA CONCENTRICA, var. RUGOSA, *A. Keyserling*. Reise in das Petschora-Land, p. 300, pl. xvi, fig. 16.
1850. AVICULA (BUCHIA) n. sp., *F. Römer*. Neues Jahrb. für Min., etc., p. 393.
1868. AUCELLA KEYSERLINGIANA, *H. Trautschold*. Verhandl. d. russisch-kaiserlich. mineral. Gesellsch. in Petersburg, ser. 2, vol. iii, p. 250.
1874. — CONCENTRICA, var. RUGOSA, *F. Toulou*. Mesozoisch. Verstein. v. d. Kuhn-Insel (Die zweite deutsch. Nordpolf., in 1869, 1870, unter Kapitän K. Koldewey), vol. ii, p. 503, pl. ii, figs. 2, 3.
1874. — — var. RUGOSISSIMA, *F. Toulou*. Ibid., p. 504, pl. ii, fig. 4.
1875. PERNA IMBRICATUS [Bean MS.], *J. Phillips*, Geol. Yorks., pt. i, ed. 3, p. 247.
- — VENUSTULUS [Bean MS.], *Phillips*. Ibid., p. 247.
1884. AVICULA? TEUTOBURGIENSIS, *O. Weerth*. Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 50, pl. ix, fig. 9.
1886. AUCELLA KEYSERLINGIANA, *J. Lohusen*. Mém. Acad. Imp. St. Pétersbourg, ser. vii, vol. xxxiii, No. 7, p. 4.
1888. — KEYSERLINGI, *J. Lohusen*. Ueber die russischen Aucellen (Mém. Comité géol. Russ., vol. viii, No. 1), pp. 21, 40, pl. iv, figs. 18—23.
1889. INOCERAMUS VENUSTULUS et IMBRICATUS, *G. W. Lamplugh*. Quart. Journ. Geol. Soc., vol. xlv, p. 615.

| | | |
|-------|---|--|
| 1896. | AUCELLA KEYSERLINGI, <i>A. P. Pavlov.</i> | <i>Ibid.</i> , vol. lii, p. 550, pl. xxvii, fig. 3. |
| 1899. | — — | <i>G. Maas.</i> Zeitschr. d. deutsch. geol. Gesellsch., vol. li, p. 249. |
| 1900. | — — | <i>A. Wollemann.</i> Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 56, pl. ii, figs. 6—9. |
| 1901. | — — | <i>J. F. Pompeckj.</i> Neues Jahrb. für Min., etc., Beil.-Bd. xiv, p. 319, pl. xv, figs. 3, 6, 8—10, 13, 14, 17, 18, 20, 21. |
| 1903. | — — | <i>A. Wollemann.</i> Zeitschr. d. deutsch. geol. Gesellsch., vol. lv, p. 34 (Briefl. Mitteil.). |

Description.—Shell of moderate size, oblique, with more or less triangular outline and rounded margins, higher than long, inflated. Umbones prominent, at the anterior end of the hinge-line, almost touching, curved inwards and forwards.

Right valve convex in the neighbourhood of the umbo, but usually flattened elsewhere. Anterior ear close to the umbones, triangular, convex, narrow where united to the rest of the valve, with a deep and narrow byssal sinus. Posterior ear longer, but indistinctly limited.

Left valve much more convex than the right valve, especially in the dorsal part, somewhat compressed posteriorly; greatest convexity between the umbo and the postero-ventral extremity. Umbo more prominent than in the right valve. Ears indistinctly limited.

Both valves ornamented with many narrow, concentric lamellæ which are placed more or less vertically to the surface and are separated by broad, flat interspaces. The lamellæ occur at fairly regular intervals, but the distance between them varies on different parts of the shell. They curve gently on the median part of the valve, but bend more sharply in passing on to the anterior and posterior parts, where they become closer to one another. The lamellæ have often disappeared from the parts near the umbones.

Measurements :

| | | | | |
|---------------|-----|-----|-----|--------|
| | (1) | (2) | (3) | (4) |
| Length . . . | 31 | 28 | 24 | 18 mm. |
| Height . . . | 39 | 32 | 30 | 24 „ |
| Thickness . . | — | 16 | 16 | 12 „ |

(1—4) Claxby Ironstone, Claxby.

Affinities.—See *Aucella volgensis* (p. 69).

Type.—The specimens figured by Pavlov are in the Sedgwick Museum.

Distribution.—Claxby Ironstone (zone of *Belemnites lateralis*) of Claxby. Speeton Clay (zone of *Belemnites jaculum*) of Speeton.

Genus—AUCELLINA, *J. F. Pompeckj*, 1901.

(‘*Neues Jahrb. für Min.*,’ etc., Beil.-Bd. xiv, p. 365.)

AUCELLINA GRYPHÆOIDES (*Sowerby*), 1836. Plate X, figs. 6 *a*—*d*, 7 *a*—*c*, 8 *a*, *b*,
9 *a*—*c*, 10—13.

1836. AVICULA GRYPHÆOIDES, *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol. iv.
pp. 156, 335, pl. xi, fig. 3.
1841. — — — *F. A. Römer*. Die Verstein. d. nord-deutsch.
Kreidegeb., p. 64, pl. viii, fig. 16.
1846. INOCERAMUS COQUANDIANUS, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii,
p. 505, pl. ccciii, figs. 6—8.
1850. — — — — — Prodr. de Pal., vol. ii, p. 139.
1853. AUCELLA GRYPHÆOIDES, *A. v. Strombeck*. Zeitschr. der deutsch. geol.
Gesellsch., vol. v, p. 509.
1854. AVICULA — — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 163.
1856. AUCELLA — — — *A. v. Strombeck*. Zeitschr. der deutsch. geol.
Gesellsch., vol. viii, p. 488.
1864. — — — — — *H. Bötsche*. Neues Jahrb. für Min., etc., p. 669.
1869. INOCERAMUS COQUANDIANUS, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét.
Ste. Croix (Matér. Pal. Suisse,
ser. 5), p. 111, pl. cx, figs. 9, 10.
1875. AVICULA GRYPHÆOIDES, *A. J. Jukes-Browne*. Quart. Journ. Geol. Soc., vol.
xxx, p. 298.
1882. — — — — — *R. Windmüller*. Jahrb. d. k. preussisch. geol.
Landesanst. für 1881, pp. 20, 21.
1893. — — — — — *A. v. Strombeck*. Zeitschr. der deutsch. geol.
Gesellsch., vol. xlv, pp. 490, 493.
1895. — — — — — *E. Tiessen*. Zeitschr. der deutsch. geol. Gesellsch.,
vol. xlvii, p. 478.
1899. AUCELLA COQUANDI, *D. J. Anthula*. Kreidefoss. des Kaukasus (Beitr. z.
Paläont. u. Geol. Osterr.-Ungarns u.
d. Orients, vol. xii), p. 78.
1901. AUCELLINA GRYPHÆOIDES, *J. F. Pompeckj*. Neues Jahrb. für Min., etc.,
Beil.-Bd. xiv, pp. 354, 365,
pl. xvi, figs. 6—8.
1902. — — — — — *A. Wollemann*. Lüneburg. Kreide (Abhandl. d.
k. preussisch. geol. Landesanst., N. F.,
Heft 37), p. 64, pl. iii, figs. 2, 3.
- Non 1829. AVICULA — — — *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol.
iii, p. 119 [*Pseudomonotis*
speluncaria (Schlotheim)].
- ? Non 1847. — — — — — *J. Müller*. Petref. der Aachen. Kreidef., pt. I,
p. 29.

Description.—Shell oval, very oblique, very inequivalve; dorsal part of posterior margin more or less straightened, the remaining margins forming a regular curve.

Right valve flattened, but convex near the umbo; height and length nearly equal. Umbo small, near the middle of the hinge-line, curving slightly. Hinge-area obtusely triangular. Anterior ear long, triangular, with a very deep, narrow, curved byssal sinus on each edge of which is a row of tubercles. Posterior ear usually of about the same length as the anterior ear, but indistinctly limited, with the outer angle obtuse.

Left valve convex, especially the dorsal part, more compressed postero-ventrally, sometimes with a shallow sulcus extending from the umbo to the postero-ventral extremity. Dorsal portion of the valve produced into a large, prominent, much curved umbo. Hinge-area obtusely triangular. Posterior ear larger than the anterior, with a rounded depression between it and the umbo; anterior ear short, triangular.

Ornamentation consists of numerous concentric growth-lines which sometimes become lamellar, and are separated by flat interspaces. Small, close-set, radial ribs occur, especially in the neighbourhood of the umbo.

Measurements of left valve:

| | (1) | (2) | (3) | (4) |
|------------------|-----|-----|-----|--------|
| Length | 22 | 21 | 18 | 14 mm. |
| Height (oblique) | 29 | 27 | 25 | 17 „ |

(1—4) Cambridge Greensand.

Affinities.—The probable relationship of this species to *Aucella* has been pointed out by von Strombeck, Stoliczka, and Jukes-Browne. Recently its affinities to *Pseudomonotis* and *Aucella* have been fully discussed by Prof. Pompeckj, by whom the genus *Aucellina* has been established to include *Avicula aptiensis*, d'Orbigny, and *Avicula gryphæoides*, Sowerby. *Aucellina* is very closely allied to *Aucella*, but differs from it in the absence of an articulating groove in the hinge-area of the left valve.

Inoceramus Coquandianus, d'Orbigny, was regarded by Jukes-Browne as identical with *Aucellina gryphæoides*, and I agree with that view. The identity is also supported by the fact that Pictet and Campiche referred the specimens found in the Cambridge Greensand to *Inoceramus Coquandianus*.

Types.—I have not seen the types; Fitton stated that they were in the collection of Mrs. Murchison, and came from the Upper Greensand of Nursted and Cambridgeshire (? Cambridge Greensand).

Distribution.—Upper Gault of Folkestone and Eastbourne. Red Limestone of Hunstanton and Speeton. Cambridge Greensand (derived).

Upper Greensand (zone of *Schlenbachia rostrata*) of Hampshire, Devizes, and near Didcot; (zone of *Pecten asper*) of Okeford Fitzpaine and Warminster. Cam-

bridge Greensand (indigenous). Chloritic Marl of Maiden Bradley, Devizes, Isle of Wight, Urchfont (Wilts), Holybourne (Hants), and Eastbourne. Chalk Marl (zone of *Schloenbachia varians*) of the Isle of Wight, Folkestone, Hunstanton, Lincolnshire, and Yorkshire. Totternhoe Stone of Fulbourn and Burwell. Zone of *Holaster subglobosus* (above Totternhoe Stone) of Eversden (Cambs.).

Family—PERNIDÆ, Zittel.

Genus—GERVILLIA, *M. J. L. DeFrance*, 1820.
(‘Dict. Sci. nat.’ vol. xviii, p. 502.)

GERVILLIA SUBLANCEOLATA (*d’Orbigny*), 1850. Plate X, figs. 14—16; Plate XI, fig. 1. Text figures 7, 8.

1826. GERVILLIA AVICULOIDES, *J. de C. Sowerby*. Min. Conch., vol. vi, p. 16, pl. dxi, figs. 1, 2, 3, 5 (not 4), [non *Perna aviculoides*, Sowerby, 1814].
1845. — — — *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 246.
— AVICULA LANCEOLATA, — Ibid., p. 247, pl. iii, fig. 8.
1850. — SUBLANCEOLATA, *A. d’Orbigny*. Prodr. de Pal., vol. ii, p. 119.
1853. GERVILLIA ALPINA, *F. J. Pictet and W. Roux*. Moll. Foss. Grès verts de Genève, p. 496, pl. xli, fig. 3.
1854. GERVILLIA ANCEPS, *J. Morris*. Cat. Brit. Foss., ed. ii, p. 167.
— AVICULA LANCEOLATA, *Morris*. Ibid., p. 163.
1858. GERVILLIA ANCEPS, *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 121, pl. xvii.
1865. — — — *H. Coquand*. Mon. Aptien de l’Espagne, p. 145.
1869. — ALPINA, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 83, pl. clv, figs. 2—4.
1902. GERVILLEIA ANCEPS, *F. Frech*. Centralb. für Min., etc., p. 612 (text-figure).

Description.—Shell elongate, very oblique, slightly inequivalve, the left valve rather more convex than the right. Posterior extremity lanceolate, but rounded. Postero-dorsal margin slightly sinuous. Antero-ventral marginal parts nearly perpendicular to the plane between the valves and slightly concave. Umbones inconspicuous, almost terminal. Only a very small portion of the valve is seen in front of each umbo; on the left valve this portion is bounded by a linear depression, but on the right valve it is not limited. The median part of each valve is convex, but becomes compressed towards the posterior extremity. Between the convex portion and the hinge-line (posterior to the umbo) is a long, triangular, compressed, wing-like portion, of which the inner boundary is not limited, and the posterior margin

is slightly convex or sometimes almost straight; on this part the growth-lines are convex posteriorly and curve towards the umbo, except in young specimens where they curve posteriorly as they approach the hinge-line.

Hinge-line long, forming rather less than half the greatest length of the valve,

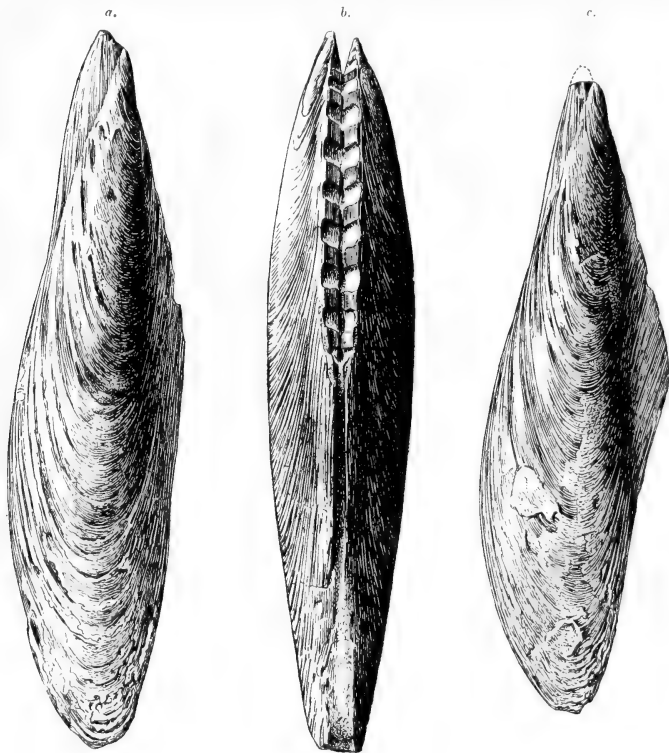


FIG. 7.—*Gervillia sublancoolata* (d'Orbigny). Lower Greensand (Crackers), Atherfield. Sedgwick Museum.
 x $\frac{3}{4}$. a, left valve; b, antero-dorsal view of another specimen; c, left valve of another specimen.

and making an obtuse angle with the posterior margin. Ligament pits large, usually from six to nine in number, placed at nearly equal distances, and usually of nearly equal size, except the anterior and posterior, which may be smaller than the others.

Surface of valves ornamented with growth-lamellæ only.

Measurements :

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|-----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| Hinge-line | 92 | 86 | 86 | 83 | 74 | 66 | 41 | 54 | 41 mm. |
| Umbo to posterior extremity | 182 | 200 | 182 | 163 | 152 | 149 | 89 | 110 | 86 „ |

(1—7) Crackers, Atherfield.

(8, 9) Greensand, Blackdown.

Affinities.—*Gervillia sublanccolata* is closely allied to *G. anceps*, Deshayes,¹ of which the types are from the Neocomian of Aube. The English specimens have usually been referred to the latter species, but Pictet and Campiche regarded them as distinct.

The characters which separate the two species are (1) the antero-ventral margin is concave in *G. sublanccolata*, whereas in *G. anceps* it is slightly convex or almost straight; (2) the posterior margin of the posterior wing-like part is convex, or in some cases nearly straight, and the growth-lines on this part of the shell are convex, whilst in *G. anceps* the corresponding margin and growth-lines are concave, and the wing-like part is more distinct; (3) the line of greatest convexity—extending from the umbo posteriorly—is near the middle of the valve in *G. sublanccolata*, but near the antero-ventral margin in *G. anceps*; (4) it is possible that *G. sublanccolata* is less inequivalve than *G. anceps*,² but at present this point cannot be proved, since only a few specimens of the latter species showing both valves have been found. All the examples known of *G. anceps* appear to be larger and to have thicker shells than *G. sublanccolata*.

Pictet and Campiche thought that *G. anceps* could be distinguished by the second and third ligament pits being close together, whereas in *G. sublanccolata* the pits are nearly equidistant. An examination of specimens of the former shows that the position of the second and third pits, shown in d'Orbigny's figure, is an individual variation,³ and is not usually found. Pictet and Campiche mention as another distinction the sharp line of separation between the posterior wing and the rest of the valve in *G. anceps*; although this feature is shown in d'Orbigny's figure it is not evident in the specimens.

G. sublanccolata differs from *G. cosnenis*, de Loriol,⁴ in the rapid tapering of the shell towards the posterior extremity and in the less extensive development of the posterior wing-like part.

Remarks.—Examples of this species from Atherfield were described and figured as *Gervillia alpina*, Pictet and Roux, by Pictet and Renevier and by Pictet and

¹ 'Mém. Soc. géol. de France,' vol. v (1842), p. 9, pl. x, fig. 3; D'Orbigny, 'Terr. Crét.,' vol. iii (1846), p. 482, pl. ccxciv; Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1869), p. 82, pl. clv, fig. 5.

² See Deshayes' fig. 3c.

³ The probability of this has been mentioned by E. G. Skeat and V. Madsen, 'Jur. Neoc. and Gault Boulders in Denmark' ('Danmarks geol. Undersøg.,' vol. ii, No. 8, 1898), p. 163.

⁴ 'Gault de Cosne' (1882), p. 83, pl. ix, figs. 21, 22.

Campiche. The specimen figured by Pictet and Roux is not sufficiently perfect to enable us to state whether it is specifically identical with *G. sublancoolata*, but since Pictet, Renevier, and Campiche were acquainted with the type and other specimens of *G. alpina*, and had also good specimens from Atherfield, we may feel every confidence in their judgment in this matter.

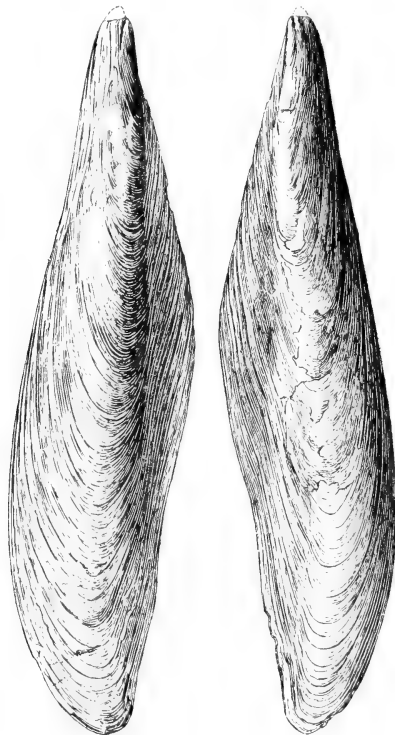


FIG. 8.—*Gervillia sublancoolata* (d'Orbigny). Lower Greensand (Crackers), Atherfield. Sedgwick Museum.
Right and left valves of the same specimen. $\times 4$.

A young individual of this species from Atherfield was described and figured by Forbes as *Avicula lancoolata*. This name, however, had previously been employed by Sowerby (1826) for a species from the Lias, and consequently d'Orbigny altered the name of Forbes' species to *Avicula sublancoolata*. Goldfuss (1836) had also used the name *Gervillia lancoolata* for a species from the Middle Jurassic of Württemberg. Since d'Orbigny's name has priority over *Gervillia alpina* of Pictet

and Roux, the species now under consideration must be known as *Gervillia sublanceolata* (d'Orbigny).

The young individuals of *G. sublanceolata* differ from the adults in that the anterior part of the shell is relatively longer and more wing-like, the posterior ear is more sharply limited and its growth-lines are concave posteriorly, and the valves are more unequal (Plate X, figs. 14, 15).

G. sublanceolata belongs to Frech's 'Group of *G. aviculoides*.' Frech gives a figure of the hinge and interior of a specimen from Atherfield.

I am greatly indebted to Professor Douvillé for the opportunity of seeing a specimen of *Gervillia anceps* from Aube, and also for his kindness in comparing *G. sublanceolata* with the specimens of *G. anceps* in the École des Mines, Paris.

Types.—One of the specimens figured by Sowerby (fig. 5) is in the British Museum; the others (figs. 1—3) cannot be traced. Sowerby's fig. 4 is from the Corallian of Shotover, and does not belong to this species. *Avicula lanceolata*, Forbes, from the Lower Greensand (probably Crackers) of Atherfield, is in the Museum of the Geological Society (No. 2057). The type of *Gervillia alpina* came from the Gault of Saxonet.

Distribution.—Lower Greensand (Crackers and Fitton's Beds 20 and 45) of Atherfield. Atherfield Beds of Sevenoaks.

Recorded by Topley from the Atherfield Beds of Haslemere, Peasmarsh, Shalford, and Redhill; from the Hythe Beds of Hythe, Lympne, Maidstone, and Pulborough; and from the Sandgate Beds of Sandgate, Folkestone, and Parham.

Upper Greensand (zone of *Schlarbachia rostrata*) of the Isle of Wight, Blackdown, and Haldon.

GERVILLIA LINGULOIDES, *Forbes*, 1845. Plate XI, figs. 2-8.

1845. GERVILLIA LINGULOIDES, *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 246,
pl. iii, fig. 9.
— AVICULA EPHEMERA, *Forbes*. *Ibid.*, p. 247, pl. iii, fig. 6.
1846. GERVILLIA LINGULOIDES, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p.
485, pl. cccxvi, figs. 1-4.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 119.
— AVICULA EPHEMERA, — *Ibid.*, p. 119.
1854. GERVILLIA LINGULOIDES, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 167.
— AVICULA EPHEMERA, *Morris*. *Ibid.*, p. 163.
1858. GERVILLIA LINGULOIDES, *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien
(Matér. Pal. Suisse, ser. 1),
p. 123, pl. xviii, figs. 3, 4.
1869. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste.
Croix (Matér. Pal. Suisse,
ser. 5), p. 91.

Description.—Shell small, thin, elongate, compressed, very oblique, angular anteriorly, truncated posteriorly. Left valve more convex than the right. Umbones almost terminal. Ligament area narrow, with four or five pits, one of which is under the umbo. Anterior part of the shell very small, compressed. Median part flattened. Postero-dorsal part relatively large, compressed, wing-like. On the left valve a rounded ridge extends from the umbo to the postero-ventral angle; below this ridge the shell is bent sharply.

Surface smooth, or ornamented with concentric lines.

Measurements:

| | (1) | (2) | (3) |
|-------------------------------|------|-----|--------|
| Length of hinge | 15.5 | 15 | 13 mm. |
| Umbo to postero-ventral angle | 23 | 29 | 25 „ |

(1—3) Crackers, Atherfield.

Affinities.—*G. recta*, Meek and Hayden,¹ from the Fox Hill Beds of the Upper Missouri, is closely allied to this species. The imperfectly known *Gervillia Reichi*, Römer,² resembles *G. linguloides*, but appears to have the posterior wing more distinctly limited.

In the form of its shell *G. linguloides* resembles some of the species of *Pteria* which belong to the sub-genus *Pseudoptera* (see p. 63), but the presence of ligament pits proves it to be a *Gervillia*.

Remarks.—Pictet and Renevier showed that *Avicula ephemera*, Forbes, is only an internal cast of *Gervillia linguloides*.

This species occurs commonly in the Crackers of Atherfield and is gregarious.

Types.—From the Crackers of Atherfield, in the Museum of the Geological Society (Nos. 2040, 2054). The types of *Avicula ephemera*, also from Atherfield, are in the same collection (Nos. 2051, 2052).

Distribution.—Lower Greensand (Crackers) of Atherfield. Recorded by Topley from the Atherfield Clay of Peasemarsch and Shalford.

GERVILLIA ALIFORMIS (*Sowerby*), 1819. Plate XI, figs. 9 *a-d*, 10 *a-d*, 11. Text-figures 9—14.

1819. MODIOLA? ALIFORMIS, *J. Sowerby*. Min. Conch., vol. iii, p. 93, pl. ccli.

1835. PERNA ALIFORMIS, *Sowerby*. Ibid., vol. vi, systematical index, p. 243.

1845. — ALIFORMIS, *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 246, pl. iii, fig. 2.

¹ 'Proc. Acad. Nat. Sci. Philad.' vol. xiii (1861), p. 441. F. B. Meek, 'Invert. Cret. and Tert. Foss. U. Missouri' (1876), p. 66, pl. xxix, fig. 1 *a, b*.

² 'Die Verstein. d. nord-deutsch. Kreidegeb.' (1841), p. 64, pl. viii, fig. 14 (named *G. Cottw* on pl. viii).

CRETACEOUS LAMELLIBRANCHIA.

1846. *GERVILIA ALEFORMIS*, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 484, pl. ccxcv, figs. 1—3.
 1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 82.
 1852. *AVICULA RHODANI*, *F. J. Pictet and W. Roux*. Moll. Foss. Grès verts de Genève, p. 494, pl. xli, fig. 2.
 1854. *GERVILLIA ALEFORMIS*, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 167.
 1853. *GERVILIA ALIFORMIS*, *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 120, pl. xviii, figs. 1, 2.
 1865. — — *H. Coquand*. Mon. Aptien de l'Espagne, p. 144.
 1869. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 86, pl. clvi, fig. 1.
 1871. *GERVILLEA* — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 399.

Description.—Shell thick, large, much inflated, triangular or rhombic, oblique.

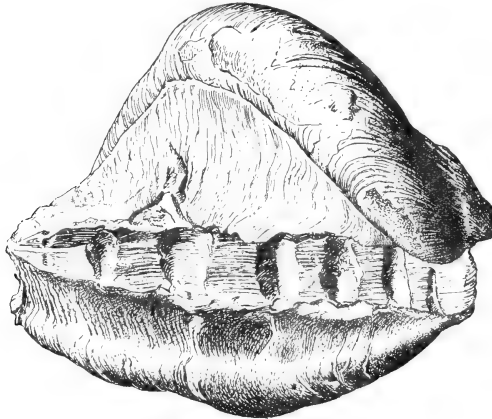


FIG. 9.—*Gervillia aleformis* (Sowerby). Lower Greensand (Crackers), Atherfield. Sedgwick Museum. Dorsal view, showing the ligament area of the right valve. Natural size.

Anterior parts of both valves more or less nearly vertical to the plane of the valves. Around the byssal opening the marginal parts of the valves are sometimes concave. Umbones near the anterior extremity. Hinge-area large with large ligament pits—usually five or six. Numerous narrow transverse teeth.

Left valve larger and more inflated than the right, with its umbo strongly incurved. A very prominent, convex portion extends from the umbo to the rounded postero-ventral extremity; dorsally it bends anteriorly; ventrally it has a slight posterior curvature. This convex part is separated by a shallow depres-

sion from a small anterior portion, and by a linear depression from a very large triangular posterior portion, which is flattened in small specimens but moderately convex in older examples. This posterior portion has a wing-like projection in young specimens, but in older forms its posterior border is nearly straight and forms an obtuse angle with the hinge-line.

Right valve similar to the left, but smaller, less convex, with the posterior portion more flattened, and with the umbo not incurved.

Ornamentation in the adult shell consists of numerous growth-lamellæ. On the earlier part of the shell, and in young examples, there are a few rather strong, broad, rounded radial ribs with a few smaller ribs between.

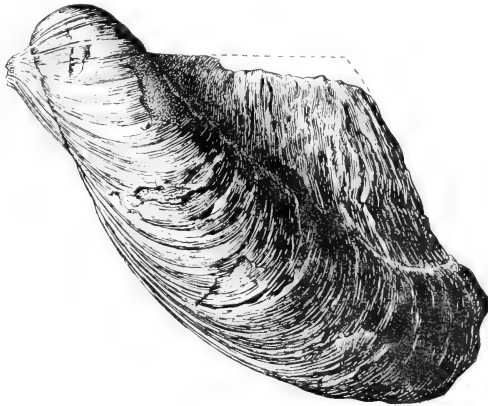


FIG. 10.—*Gervillia alaxformis* (Sowerby). Left valve of specimen shown in Fig. 9. $\times \frac{1}{2}$.

Measurements :

| | | | |
|------------------------|-----------------------------|-----|--------|
| | (1) | (2) | (3) |
| Length of hinge . . . | 97 | 90 | 85 mm. |
| Height (oblique) . . . | 122 | 130 | 116 „ |
| | (1—3) Crackers, Atherfield. | | |

Affinities.—This species presents some resemblance to *G. allaudiensis* (Matheron¹) but is more inflated, less inequivalve, and less oblique.

Pietet and Campiche regarded the form figured as *G. alaxformis* by d'Orbigny as distinct from Sowerby's *G. alaxformis*, and they believed that the former was limited to the Neocomian whereas the latter occurs in the Aptian. Some specimens from the *Perna*-bed of Atherfield agree almost exactly with d'Orbigny's figure, and I

¹ 'Catal. Foss. des Bouches-du-Rhône' (1842), p. 175, pl. xxvi, fig. 1; Pietet and Campiche, 'Terr. Crét. Ste. Croix' (1869), p. 81, pl. clv, fig. 1.

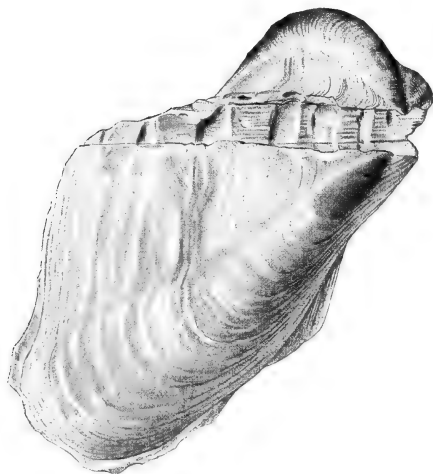
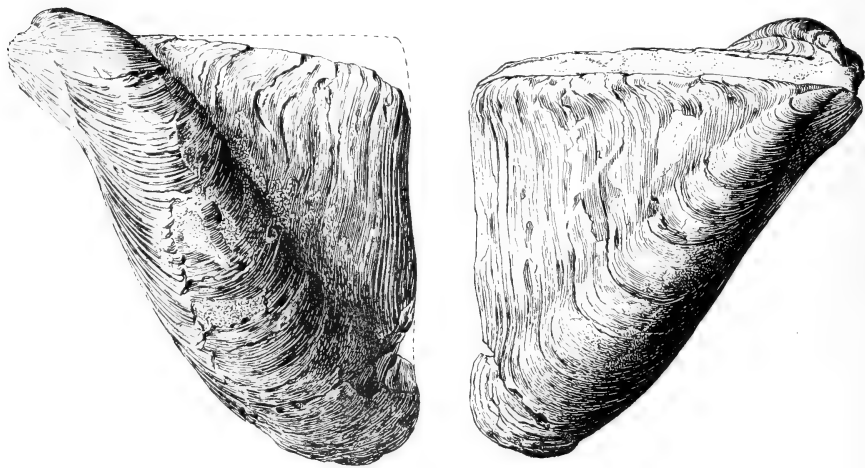


FIG. 11.—*Gervillia alaformis* (Sowerby). Right valve, and umbo and ligament area of the left valve of the specimen shown in figs. 9, 10. $\times \frac{1}{4}$.



FIGS. 12, 13.—*Gervillia alaformis* (Sowerby). Lower Greensand (Crackers), Atherfield. Sedgwick Museum. 12. Left valve. 13. Right valve. $\times \frac{1}{4}$.

cannot regard them as more than a variety in which the central convex part is rather narrower and more elevated than usual (fig. 14).

Remarks.—*G. alæformis* belongs to Frech's¹ 'Group of *Gervillia Hartmanni*,' in which the shell is obliquely rhombic and has numerous small teeth.

Young specimens of *G. alæformis* differ from older examples in having well-marked radial ribs, in the valves being less inflated, and in the occurrence of a wing-like projection on the posterior ear. They resemble the form described by d'Orbigny as *Avicula Cottaldina*, but in the latter the radial ornamentation and well-marked posterior wing are retained in the adult state, whereas they soon become obsolete in *G. alæformis*. I am not acquainted with the character of the hinge of *Avicula Cottaldina*.

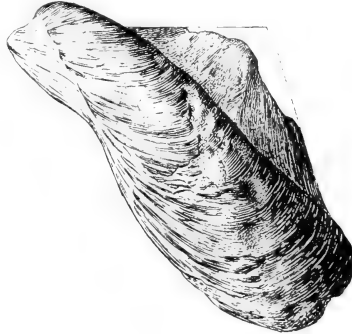


FIG. 14.—*Gervillia alæformis* (Sowerby). Lower Greensand (*Perna*-bed), Atherfield. Sedgwick Museum.
Left valve of a narrow variety. $\times \frac{1}{4}$.

Type.—The type cannot be found; it came from the Lower Greensand (probably the *Perna*-bed) of Sandown, Isle of Wight.

Distribution.—*Perna*-bed of Atherfield and Sandown. Crackers and Bed 11 (of Fitton) of Atherfield. Atherfield Clay of Haslemere. Hythe Beds of Hythe and Lymgne.

GERVILLIA ROSTRATA (Sowerby), 1836. Plate XI, figs. 12 *a, b*, 13–23.

1836. *PERNA ROSTRATA*, *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol. iv., pp. 241, 342, pl. xvii, fig. 17.
 1846. *AVICULA CENOMANENSIS*, *A. d'Orbigny*. Pal. Franç. Terr. Cret., vol. iii, p. 476, pl. cccxci, figs. 11–13.
 1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 167.

¹ 'Centralb. für Min.,' etc. (1902), p. 613.

1850. *PERNA ROSTRATA*, d'Orbigny. Ibid., p. 168.
 1854. *GERVILLIA* — J. Morris. Cat. Brit. Foss., ed. 2, p. 168.
 1871. *MELINA* — F. Stoliczka. Palæont. Indica, Cret. Fauna S. India,
 vol. iii, p. 400.
 ? 1895. *AVICULA cf. CENOMANENSIS*, E. Tiessen. Zeitschr. d. deutsch. geol. Gesellsch.,
 vol. xlvii, p. 479.

Description.—Shell rather small, of moderate convexity, often very oblique, triangular. Ventral and posterior margins rounded. Hinge-line long.

Left valve more convex than the right, with the umbo moderately incurved. The large, central, very convex portion is indistinctly separated from the large, anterior, triangular, wing-like ear and from a narrow, flattened, obtusely triangular posterior part.

Right valve similar to the left but less convex and with the umbo only slightly incurved, and with the anterior ear more distinctly limited.

Surface of valves with narrow, regular growth-layers.

Measurements :

| | (1) | (2) | (3) | (4) | (5) |
|--------------------|-----|-----|-----|-----|--------|
| Length of hinge . | 21 | 20 | 20 | 18 | 15 mm. |
| Height (oblique) . | 25 | 28 | 24 | 20 | 17 „ |

(1—5) Greensand, Blackdown.

Affinities.—*Avicula cenomanensis*, d'Orbigny, from the Cenomanian of Le Mans, appears to be identical with *G. rostrata*. In all the specimens of the latter which I have seen, the terminal portion of the posterior wing is more or less imperfect, but the growth-lines show that the posterior margin must have had the same form as in d'Orbigny's fig. 11.

Gervillia rostrata presents some resemblance to the young forms of *G. alæformis* (p. 79) but is more oblique and without radial ribs, also the central convex portion is less sharply marked off from the lateral parts, and the anterior ear is larger.

G. rostrata is allied to *G. tenuicostata*, Pietet and Campiche (see below), but the right valve is less flattened, and the concentric ornamentation appears to be less developed—this, however, may be due to difference of preservation, since some of the Blackdown specimens are nearly smooth whereas others show distinct concentric ridges.

Remarks.—This species is moderately common at Blackdown but is usually imperfectly preserved. An example from the Gault of Folkestone, recorded by Price as *Avicula cenomanensis*, is probably referable to this species, but the greater part of the shell has disappeared, leaving a mould of the right valve; the specimen is now in the Museum of Practical Geology (No. 1624).

The examples of *G. rostrata* show a considerable amount of variation in obliquity,

and some of the less oblique specimens (Plate XI, figs. 17, 18) appear at first sight to be distinct from the more abundant oblique forms, but there is a complete transition between the extremes.

Distribution.—Upper Greensand (zone of *Schambachia rostrata*) of Blackdown, Haldon, and ? Devizes. ? Upper Gault (zone xi) of Folkestone.

GERVILLIA, sp. Plate XI, figs. 24, 25.

Specimens from the Ferruginous Sands of Shanklin, which were collected by the late C. J. A. Meyer and are now in the Sedgwick Museum, resemble closely *G. rostrata* and *G. tenuicostata* (Pictet and Campiche),¹ but the material at present available is hardly sufficient to justify a definite conclusion as to their relationship. The specimen from the Lower Greensand of Upware figured by Keeping² as *Perna* sp. nov. resembles still more closely some examples of *G. rostrata*; the original is in the collection of Mr. J. F. Walker.

GERVILLIA FORBESIANA, *d'Orbigny*, 1846. Plate XI, figs. 26, 27. Plate XII, figs. 1–5.

- | | | | |
|-------|-----------------------|----------------------------------|---|
| 1826. | GERVILLIA SOLENOIDES, | <i>J. de C. Sowerby.</i> | Min. Conch., vol. vi, p. 14, pl. dx, figs. 1–3 (not 4). |
| 1845. | — | — | <i>E. Forbes.</i> Quart. Journ. Geol. Soc., vol. i, p. 246. |
| 1846. | — | FORBESIANA, <i>A. d'Orbigny.</i> | Pal. Franç. Terr. Crét., vol. iii, p. 486, pl. ccxcvi, figs. 5, 6. |
| 1850. | — | — | <i>d'Orbigny.</i> Prodr. de Pal., vol. ii, p. 119. |
| 1854. | — | SOLENOIDES, <i>J. Morris.</i> | Cat. Brit. Foss., ed. 2, p. 168 (<i>partim</i>). |
| 1897. | — | FORBESIANA, <i>R. B. Newton.</i> | Proc. Dorset. Nat. Hist. and Antiq. Field Club, vol. xviii, p. 87. |

Description.—Shell compressed, slender, greatly elongated, sabre-shaped, tapering posteriorly to a rounded or subtruncate extremity. Dorsal margin slightly concave; ventral margin convex, with a rather greater curvature than the dorsal margin. Near the dorsal margin the valves are compressed rather abruptly, but ventrally to this they are compressed gradually, giving rise to a knife-like edge. Umbones terminal, acute. Posterior ear large, triangular, with its dorsal margin straight or very slightly concave and its posterior margin curving backwards so as to form an acute angle with the dorsal margin of the valve. The ear is marked by fine growth-lines parallel with its posterior border.

¹ 'Terr. Crét. Ste. Croix' (1869), p. 88, pl. clvi, figs. 4, 5.

² 'Foss. Neoc. Upware and Brickhill' (1883), p. 109, pl. v, fig. 3.

Surface of valves smooth except for growth-ridges, of which the curved portions near the dorsal margin are more distinct than the other portions.

Hinge with small transverse teeth at the anterior end and six or seven long narrow oblique teeth near the posterior end—the latter decreasing in length posteriorly.

Measurements :

| | (1) | (2) | (3) | (4) |
|---------------------|-----|-----|-----|-------|
| Height ¹ | 31 | 24 | 15 | 8 mm. |
| Length ² | 182 | 125 | 74 | 35 „ |

(1—4) Gault, Folkestone.

Affinities.—This species belongs to Frech's³ 'Group of *Gervillia solenoides*.'

The only localities given for *G. Forbesiana* by d'Orbigny are Shanklin and Atherfield, and apparently his figured specimen came from the latter place. All the examples from Shanklin are in the form of casts of which the posterior part is usually missing; it is consequently difficult to make out their real characters, but they probably belong to this species.

The examples found in the Gault and Upper Greensand differ somewhat from the specimen figured by d'Orbigny. In the former the shell is less slender and tapers more quickly posteriorly; the posterior ear, however, agrees with d'Orbigny's figure.

A considerable number of examples of *Gervillia* from different localities and horizons have been referred by various writers⁴ to *G. solenoides*, DeFrance,⁵ but without seeing a large collection of those forms it is impossible to determine their relationship to one another and to the examples here described. The figures given by DeFrance do not enable us to form a satisfactory idea of the characters of the species; in his original account (1820) he gave "Ile d'Aix" as the locality, but in his later remarks (1824) he states that the specimens came from the department of Le Manche.

The Senonian specimens figured by d'Orbigny⁶ as *G. aviculoides* (non *G.*

¹ From posterior end of hinge-line to opposite margin of valve.

² From umbo to posterior extremity.

³ 'Centralb. für Min.,' etc. (1902), p. 615.

⁴ Sowerby (1826), Goldfuss (1836), Reuss (1846), Müller (1847), d'Orbigny (1847), Alth (1850), Zittel (1866), Favre (1869), Stoliczka (1871), Geinitz (1873), Brauns (1876), Fritsch (1877-93), Nötling (1885), Griepenkerl (1889), Holzapfel (1889), Lündgren (1894), Vogel (1895), Müller (1898), *G. oblonga*, Böhm (1885).

⁵ 'Dict. Sci. nat.,' vol. xviii (1820), p. 503; vol. xxxii (1824), p. 316, pl. lxxxvi, fig. 6.

⁶ 'Pal. Franç. Terr. Crét.,' vol. iii (1846), p. 489, pl. ccxcvii, fig. 2 (and perhaps fig. 1). Prof. M. Boule informs me that the original of fig. 1 cannot be found in the d'Orbigny collection, and that the original of fig. 2 comes from Valognes (Manche).

aviculoides, Sowerby) were afterwards¹ referred by that writer to *G. solenoides*, DeFrance, whilst the Cenomanian forms from Le Mans, also figured as *G. solenoides*, were named² *G. subaviculoides*.

The examples of *G. solenoides* from the Senonian of Aachen figured by Holzapfel³ differ from our specimens of *G. Forbesiana* in the greater height of the posterior ear and in its indistinct separation from the rest of the valve, also in having a larger apical angle.

Types.—Two of the specimens figured as *G. solenoides* by Sowerby (figs. 2, 3) are in the British Museum and came from Shanklin. Another specimen figured by Sowerby (fig. 1), from the Upper Greensand of Lyme Regis, is in the Museum of the Geological Society of London (No. 1555), but is not recorded in Mr. Blake's "List of Types." D'Orbigny's type of *G. Forbesiana* apparently came from the Crackers of Atherfield, but Professor Boule informs me that the specimen cannot now be found in the d'Orbigny Collection.

Distribution.—*Perna*-bed, Atherfield Clay, and Crackers of Atherfield. Fitton's Bed 36 of Blackgang. Ferruginous Sands of Shanklin. Atherfield Beds of Peasmarsh. Hythe Beds of Pulborough. Sandgate Beds of Parham Park.

Gault (zones iii to vii, and viii) of Folkestone. Zone of *Hoplites interruptus* of Okeford Fitzpaine (Dorset). Cambridge Greensand (derived). Upper Greensand of Blackdown.

Genus—PERNA, *J. G. Bruguière*, 1789.

(*Eneye. Méthod., Vers.*, vol. i, p. xiii.)

PERNA MULLETI, *Deshayes*, 1842. Text-figure 15.

1842. PERNA MULLETI, *Deshayes* in *A. Leymerie*. *Mém. Soc. géol. de France*, ser. 2, vol. v, p. 8, pl. xi, figs. 1—3.
1845. — — *E. Forbes*. *Quart. Journ. Geol. Soc.*, vol. i, p. 246, pl. i, figs. 1—4.
1846. — MULLETI, *A. d'Orbigny*. *Pal. Franç. Terr. Crét.*, vol. iii, p. 496, pls. cccc, cccci, figs. 1—3.
1848. — MULLETI, *C. L. Koch*. *Palaontographica*, vol. i, p. 171, pl. xxiv, figs. 14—17.

¹ 'Prodr. de Pal.', vol. ii, 1850, p. 250.

² *Ibid.*, vol. iii (1852), p. 72 (index); d'Orbigny, 'Pal. Franç. Terr. Crét.', vol. iii (1846), p. 489, pl. cccxxvii, figs. 3, 4, 5. Prof. Boule informs me that these are from Le Mans, and are now in the d'Orbigny collection.

³ 'Mollusk. Aachen. Kreide' (1889), p. 223, pl. xxiv, figs. 11, 12.

1850. Perna MULETTI, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 82.
 1854. — MULETTI, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 179.
 1855. — MULETTI, *G. Cotteau*. Moll. Foss. de l'Yonne, p. 106.
 1869. — MULETTI, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix
 (Matér. Pal. Suisse, ser.
 5), p. 97, pl. clviii.
 — — FORBESI, *Pictet and Campiche*. Ibid., p. 99, pl. clix.
 1871. MELINA MULETTI, *F. Stoliczka*. Palæont. Indica, Crét. Fauna S. India,
 vol. iii, p. 400.
 1883. Perna MULETTI, *W. Keeping*. Foss. etc., Neoc. Upware and Brickhill,
 p. 150.
 1884. — — *O. Weerth*. Die Fauna des Neocom. im Teutoburg. Wald.
 (Palæont. Abhandl., vol. ii), p. 49.
 1886. — (MULETTIA) MULETTI, *P. Fischer*. Manuel de Conch., p. 956,
 fig. 725.
 1895. — MULETTI, *F. Vogel*. Holländisch. Kreide, p. 55.
 — — — *G. Maas*. Zeitschr. der deutsch. geol. Gesellsch., vol.
 xlvii, p. 267.
 1896. — — — *A. Wollemann*. Ibid., vol. xlvi, p. 843.
 1900. — — — Die Biv. u. Gastrop. d. deutsch. u. hol-
 länd. Neocom. (Abhandl. d. k. preus-
 sisch. geol. Land., N. F., pt. 31), p. 60.

Description.—Shell large, thick, compressed, more or less quadrilateral, with unequal angles. Hinge-line long. Umbones almost terminal. Anterior part of the shell sharply bent, and more or less nearly perpendicular to the plane of the two valves; anterior marginal part more or less deeply concave. From the umbo start two strong, broad, rounded folds; the anterior of these is near the anterior margin and curves anteriorly, its extremity forming the antero-ventral angle; the posterior fold at first curves ventrally and afterwards posteriorly, and its termination forms the postero-ventral angle. The part of the shell behind the posterior fold is compressed and flattened and produced into a wing of varying length. The junction of the two valves is sinuous, the anterior, the ventral, and the posterior margins (between the angles) being concave on the right valve and convex on the left.

The shell is ornamented with distinct growth ridges which bend ventrally in passing over the folds and form a semicircular or semi-oval curve near the hinge-line.

Measurements :

| | (1) | (2) | (3) |
|--|-----|-----|--------|
| Length of hinge-line . . . | 128 | 120 | 95 mm. |
| Height (from umbo to postero- ventral angle). | 114 | 135 | 130 „ |

(1—3) *Perna*-bed, Atherfield.

Affinities.—The forms found in the Lower Greensand of England which had been referred to *Perna Mulleti* by earlier writers were regarded as distinct by Pictet and Campiche, and were named by them *Perna Forbesi*. They considered that the latter were distinguished by the more prominent folds, the shorter and more deeply concave anterior margin, and the longer posterior wing. An examination of a number of specimens shows that these characters are variable, and I am led to agree with Wollemann in thinking that the forms described by Pictet and Campiche cannot be regarded as more than varieties of a variable species.



FIG. 15.—*Perna Mulleti*, Deshayes. Lower Greensand (*Perna-bed*), Sandown. Sedgwick Museum. Left valve $\times \frac{1}{3}$. (The posterior wing is broken. Forbes gives a figure of a specimen in which the wing is perfectly preserved.)

Perna Mulleti is the type of Fischer's section *Mulletia*.

Type.—From the Neocomian of Vendeuve. I have not seen the specimens figured by Forbes.

Distribution.—*Perna-bed* of Atherfield and Sandown. Atherfield Beds of Haslemere, Peasmarsh, Shalford, Redhill, Sevenoaks, and Hythe. Hythe Beds of Hythe (*vide* Topley). Lower Greensand of Potton and Upware. Tealby Limestone (zone of *B. brunsvicensis*) of North Willingham. Speeton Clay of Speeton.

PERNA RICORDEANA, *d'Orbigny*, 1846. Text-figures 16–18.

1846. PERNA RICORDEANA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 494, pl. ccxcix, figs. 1–3.
1850. — — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 82.
1854. — — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 179.
1855. — — — *G. Colteau*. Moll. Foss. de l'Yonne, p. 107.
1858. — — — *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 125.
1869. — — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 93, pl. clvii, fig. 1.
1869. — FITTONI, *Pictet and Campiche*. Ibid., p. 95, pl. clvii, fig. 2.
1883. — RICORDIANA, *W. Keeping*. Foss., etc., Neoc. Upware and Brickhill, p. 150.
1900. — RICORDEANA, *A. Wollemann*. Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 61.

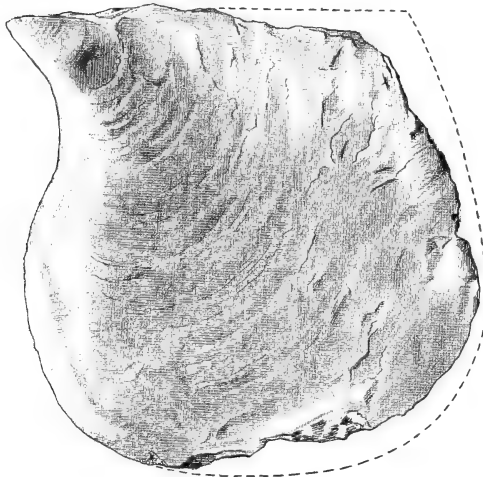


FIG. 16.—*Perna Ricordeana*, *d'Orbigny*. Lower Greensand (*Perna*-bed), Atherfield. Museum of Practical Geology, No. 12351. Left valve. $\times \frac{1}{3}$.

Description.—Shell large, thick, sub-quadrate, compressed; left valve more convex than the right. Posterior margin slightly convex or nearly straight and forming with the hinge-line an angle which is rather greater than a right-angle.

Ventral margin curved regularly. Dorsal part of anterior margin concave. Valves moderately convex near the anterior margin, but flattened elsewhere. Dorsal half or more of the anterior marginal parts concave and depressed. Umbones sharp, close together, projecting beyond the rest of the anterior margin of the valves.

Surface with growth-lamellæ at more or less regular intervals.

Measurements :

| | | | |
|---------------------------|-----|-----|--------|
| | (1) | (2) | (3) |
| Length of hinge | 105 | 91 | 75 mm. |
| Height of valve | 140 | 106 | 101 „ |

(1—3) *Perna*-bed, Atherfield.



FIG. 17.—*Perna Ricordeana*, d'Orbigny. Lower Greensand (*Perna*-bed), Atherfield. Sedgwick Museum. Right valve and anterior view of both valves. $\times \frac{1}{4}$.

Affinities.—Examples of this species from the Lower Greensand of the Isle of Wight were regarded by Pictet and Campiche as distinct from *P. Ricordeana* and were described as *Perna Fittoni*. According to those writers the former is distinguished from the latter chiefly by the wide separation of the umbones; this separation, however, seems to me to be due to the thickening of the valves in old age, such as may be seen not infrequently in *Gervillia* and other allied forms. The postero-dorsal angle of the valve, according to d'Orbigny's figure, appears to be rather smaller in *P. Ricordeana* than in *P. Fittoni*, but the difference is not great, and moreover, the outline of the shell and the size of this angle vary in different specimens of *P. Fittoni*. *P. Germani*, Pictet and Campiche, is very closely allied to *P. Ricordeana*.

Types.—From the Neocomian of Seignelay, near Auxerre. The type of *P. Fittoni* is from the *Perna*-bed of the Isle of Wight.

Distribution.—Lower Greensand (*Perna*-bed) of Atherfield. Tealby Limestone (zone of *Belemnites brunsvicensis*) of North Willingham.

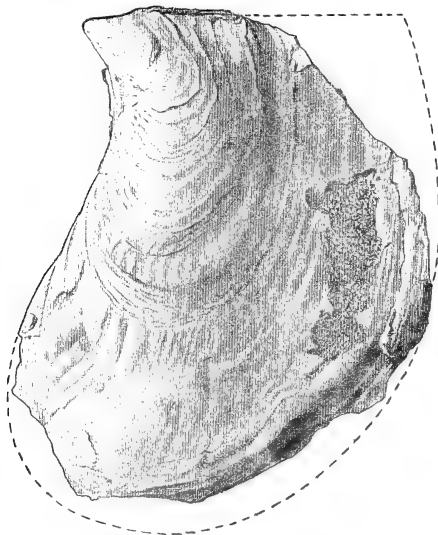


FIG. 18.—*Perna Ricordeana*, d'Orbigny. Tealby Limestone, North Willingham. Sedgwick Museum. Left valve. $\times \frac{2}{3}$.

PERNA RAULINIANA, d'Orbigny, 1846. Plate XII, figs. 6, 7a, b, 8, 9.

| | | |
|-------|---|---|
| 1846. | <i>PERNA RAULINIANA</i> , A. d'Orbigny. | Pal. Franç. Terr. Crét., vol. iii, p. 497, pl. cecci, figs. 4, 5. |
| 1850. | — — | d'Orbigny. Prodr. de Pal., vol. ii, p. 138. |
| 1852. | — — | F. J. Pictet and W. Roux. Moll. Foss. Grès verts de Genève, p. 497, pl. xli, fig. 4. |
| 1854. | — — | J. Morris. Cat. Brit. Foss., ed. 2, p. 179. |
| 1855. | — — | G. Colteau. Moll. Foss. de l'Yonne, p. 107. |
| 1869. | — — | F. J. Pictet and G. Campiche. Foss. Terr. Crét. Ste. Croix (Matúr. Pal. Suisse, ser. 5), p. 100, pl. clx, figs. 1, 2. |

Description.—Shell of moderate convexity, valves nearly equal, compressed posteriorly, sub-rhomboidal, oblique, much higher than long; postero-ventral margin rounded, anterior margin slightly concave, posterior margin slightly convex,

forming an obtuse angle with the hinge-line. Umbonal portion angular. Apical angle small. Surface with growth-lines.

Measurements :¹

| | (1) | (2) | (3) | (4) | (5) |
|--------------|-----|-----|-----|-----|--------|
| Length . . . | 35 | 34 | 24 | 23 | 11 mm. |
| Height . . . | 73 | 69 | 49 | 40 | 22 „ |

(1—3, 5) Cambridge Greensand.

(4) Lower Gault, Folkestone.

Affinities.—This species is closely allied to *P. Ricordeana* (see above), but appears to differ (1) in being relatively shorter and higher; (2) in its more obtuse postero-dorsal angle; (3) in the less prominent umbones; (4) in the anterior marginal parts (near the byssal opening) being less depressed; (5) in the smaller size of the shell.

Remarks.—This species occurs commonly in the Cambridge Greensand in the form of internal casts; these differ in outline from specimens with the shell preserved on account of the fact that the postero-dorsal part is missing—probably owing to the two valves being in contact or almost in contact at this part. Even when the shell is preserved, as in specimens from the Gault, some portion of the postero-dorsal margin is frequently missing.

Types.—From the Albian of Avocourt (Meuse) and Eseragnolles.

Distribution.—Cambridge Greensand (derived, internal casts). Lower Gault of Folkestone.

PERNA OBLONGA, *Seeley*, 1861. Text-figure 19 A.

1861. PERNA OBLONGA, *H. G. Seeley*. *Ann. Mag. Nat. Hist.*, ser. 3, vol. vii, p. 121, pl. vi, fig. 6.

Remarks.—This species is known only from internal casts, and apparently differs from *P. Rauliniana* in having a larger apical angle and in the smaller angle formed by the hinge-line and the posterior margin. Some of the specimens, however, agree very closely with the figure of a cast of *P. Rauliniana* given by Pietet and Campiche (pl. clx, fig. 2).

Seeley compared *P. oblonga* with *P. subspathulata*, *Reuss*,² and *P. lanceolata*, *Geinitz* (see below). It is distinguished from the former by its relatively greater height, and from the latter by its larger apical angle.

¹ The height in this case is measured from the umbo to the postero-ventral margin, and the length is taken at right angles to the height.

² 'Die Verstein. der böhm. Kreideformat.,' pt. ii (1846), p. 24, pl. xxxii, figs. 16, 17.

Rounded depressions which are found commonly on the casts of this and some other species of *Perna* from the Cambridge Greensand are regarded by Seeley as evidence of the occurrence of pearls.

A specimen from the Gault (Plate XII, fig. 10) resembles *P. oblonga*, but is more convex between the umbo and the postero-ventral extremity.

Type.—In the Sedgwick Museum.

Distribution.—Cambridge Greensand (derived).

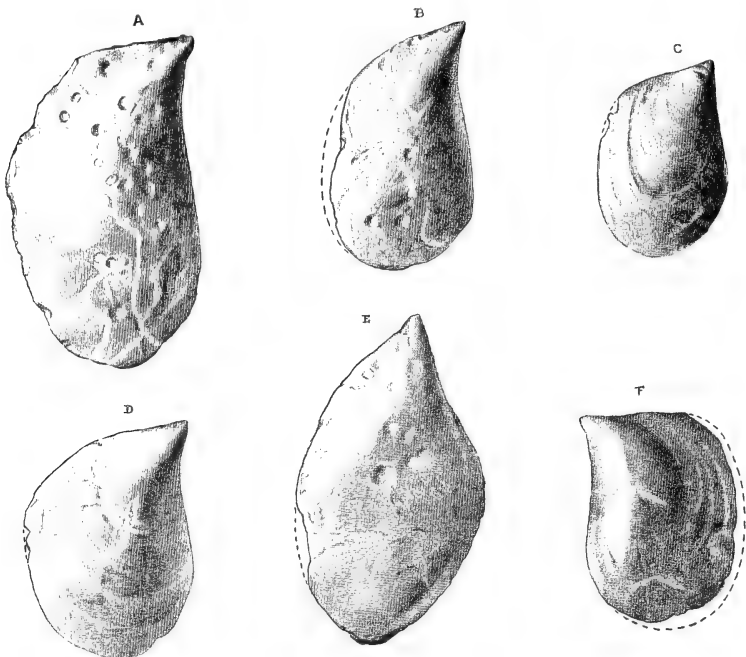


FIG. 19.—*Perna*. Cambridge Greensand (derived). Internal casts. Sedgwick Museum. Natural size, except fig. E.—A, *Perna oblonga*, Seeley. The Type.—B, C, *Perna*, sp. (referred to *P. lanceolata*, Geinitz, by Seeley).—D, *Perna semielliptica*, Seeley. The Type.—E, *Perna*, sp. (regarded by Seeley as a variety of *P. lanceolata*, Geinitz) $\times \frac{1}{2}$.—F, *Perna*, sp. (referred to *P. subspathulata*, Reuss, by Seeley).

PERNA SEMIELLIPTICA, Seeley, 1861. Text-figure 19 D.

1861. *PERNA SEMIELLIPTICA*, H. G. Seeley. Ann. Mag. Nat. Hist., ser. 3, vol. vii, p. 121, pl. vi, fig. 7.

Remarks.—This is distinguished from *P. Rauliniana* (p. 92) by its relatively greater length, larger apical angle, and more rounded outline.

Measurements :

| | (1) | (2) | (3) |
|------------------|-----|-----|--------|
| Length | 58 | 46 | 32 mm. |
| Height | 87 | 70 | 47 „ |

(1-3) Cambridge Greensand.

Type.—From the Cambridge Greensand. In the Sedgwick Museum, Cambridge.*Distribution*.—Cambridge Greensand (derived, internal casts).

PERNA, sp. Text-figures 19, B C.

1861. PERNA LANCEOLATA, *H. G. Seeley*. *Ann. Mag. Nat. Hist.*, ser. 3, vol. vii, p. 122.

Remarks.—This species (figs. 19 B, C) was referred by Professor Seeley to *Perna lanceolata*, Geinitz,¹ and it presents a general resemblance to the examples figured by Reuss and by d'Orbigny, but is less oblique. No satisfactory comparison, however, can be made, since the specimens from the Cambridge Greensand are in the form of internal casts.

Some examples (fig. 19 E) were named *Perna lanceolata*, var., by Seeley; they differ from Geinitz's species in the postero-ventral part being more produced and less rounded, so that the outline of the valve becomes more distinctly quadrate. By this quadrilateral outline they are distinguished from *P. Rauliniana*.

Distribution.—Cambridge Greensand (derived, internal casts).

PERNA, sp. Text-figure 19 F.

1861. PERNA SUBSPATHULATA, *H. G. Seeley*. *Ann. Mag. Nat. Hist.*, ser. 3, vol. vii, p. 124.

Remarks.—Internal casts were regarded by Professor Seeley as examples of *P. subspathulata*, Reuss,² but they appear to differ from the latter in their greater convexity. The height is less and the length greater than in *P. oblonga*.

Distribution.—Cambridge Greensand (derived).³

¹ 'Das Elbthalgeb. in Sachsen,' pt. i (1873), p. 210, pl. xlvi, fig. 8. References to other figures are given by Geinitz.

² 'Die Verstein. der böhm. Kreideformat.,' pt. ii (1846), p. 24, pl. xxxii, figs. 16, 17.

³ *Avicula cuneata*, Seeley, may be a *Perna*. *Perna lissa*, *P. plana*, and *P. transversa*, Seeley, appear to be *Inocerami*. All four come from the Red Limestone of Hunstanton. Seeley, 'Ann. Mag. Nat. Hist.,' ser. 3, vol. xiv (1864), p. 277, and vol. xvii (1866), pp. 178, 179.

Family—PINNIDÆ, Gray.

Genus—PINNA, Linnæus, 1758.

('Syst. Nat.,' ed. 10, p. 707.)

PINNA ROBINALDINA, *d'Orbigny*, 1844, Plate XII, figs. 11–15; Plate XIII, fig. 1.

1839. PINNA RUGOSA, *F. A. Römer*. Die Verstein. d. nord-deutsch. Oolith.-geb. Nachtrag., p. 32, pl. xviii, fig. 37 (non *rugosa*, Schlotheim).
1841. — — *F. A. Römer*. Die Verstein. d. nord-deutsch. Kreidegeb., p. 65.
1844. — ROBINALDINA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 251, pl. cccxxx, figs. 1–3.
1845. — RESTITUTA, *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 248.
1850. — ROBINALDINA, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 80.
- — SUBRUGOSA, *d'Orbigny*. Ibid., p. 80.
1854. — SULCIFERA, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 180.
1855. — ROBINALDINA, *G. Coiteau*. Moll. Foss. de l'Yonne, p. 89.
1858. — — *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 117, pl. xvi, fig. 5.
- — — *J. Villanova-y-Piera*. Mem. geog.-agric. de Castellon, pl. iii, fig. 17.
1865. — — *H. Coquand*. Mon. Aptien de l'Espagne, p. 143.
1867. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 532, pl. cxxxix, figs. 3–6.
- ? 1882. — — *P. de Loriol*. Gault de Cosne, p. 82, pl. x, figs. 3–5.
1883. — — *W. Keeping*. Foss., etc., Neoc. Upware and Brickhill, p. 110.
1884. — — *O. Weerth*. Die Fauna des Neocom. im Teutoburg. Walde (Palæont. Abhandl., vol. ii), p. 48.
- ? 1892. — — *O. Behrensden*. Zeitschr. der deutsch. geol. Gesellsch., vol. xlv, p. 25.
- ? 1895. — — *F. Vogel*. Holländisch. Kreide, p. 55.
1896. — — *A. Wollemann*. Zeitschr. der deutsch. geol. Gesellsch., vol. xlviii, p. 845.
1899. — — *G. Maas*. Zeitschr. der deutsch. geol. Gesellsch., vol. li, p. 248.
1900. — — *A. Wollemann*. Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 70.

PLATE VIII.

Genus—PTERIA, *Scopoli*.

Sub-Genus—OXYTOMA, *Meek*.

Figs.

- 1—7. *P. (Oxytoma) Cornueliana* (d'Orb.). 1—6. Speeton Series (D, 1), Speeton. 7. Claxby Ironstone, Claxby. (P. 57.)
1. Sedgwick Museum. Left valve.
 2. York Museum. Left valve.
 3. Sedgwick Museum. *a*, left valve; *b*, postero-ventral portion $\times 3$.
 4. Mr. Lamplugh's Collection. Left valve, portion near ventral margin $\times 3$.
 5. Mr. Lamplugh's Collection. Right valve.
 6. York Museum. Right valve.
 7. Sedgwick Museum. Right valve.
- 8—14. *P. (Oxytoma) pectinata* (Sow.). (P. 59.)
- 8—10. Folkestone Beds, Folkestone. Sedgwick Museum. Left valves, 8 *a*, $\times 1\frac{1}{2}$; 8 *b*, portion of 8 *a* $\times 6$. 10 *a*, $\times 2$; 10 *b*, portion of 10 *a* $\times 8$.
 - 11, 12. Hythe Beds (Bargate Stone), Busbridge. Sedgwick Museum. Right valves. $\times 1\frac{1}{2}$.
 - 13, 14. Gault, Folkestone. British Museum, No. L, 4926. 13, left valve. 14 *a*, right valve; 14 *b*, portion of 14 *a* $\times 8$.
15. *P. (Oxytoma) sp.* Totternhoe Stone, Hitchin. Left valve. Museum of Practical Geology, No. 2338. 15 *a* $\times 3$; 15 *b*, portion $\times 9$. (P. 60.)
16. *P. (Oxytoma) dubia* (Eth.). Totternhoe Stone, Burwell. Sedgwick Museum. One of the Types. Exterior (*a*) and interior (*b*) of right valve. $\times 2$. (P. 60.)
- 17—23. *P. (Oxytoma) tenuicostata* (Römer). Upper Chalk. (P. 61.)
- 17, 18. *A. quadratus* zone, West Harnham. Dr. Blackmore's Collection. 17 *a*, left valve; *b*, portion near mid-ventral margin $\times 4$; *c*, interior; *d*, hinge $\times 3$. 18, left valve $\times 2$.
 - 19, 20. Coddendam. Museum of Practical Geology, Nos. 10788, 12620. 19 *a*, left valve; *b*, portion near the mid-ventral margin $\times 6$. 20 *a*, left valve; *b*, posterior ear $\times 2$.
 - 21—23. Wells. Norwich Museum. Nos. 3249, 3250, 3251. 21 *a*, left valve; 21 *b*, portion near mid-ventral margin $\times 3$. 22, left valve. 23, right valve and interior of the marginal part of the left valve.

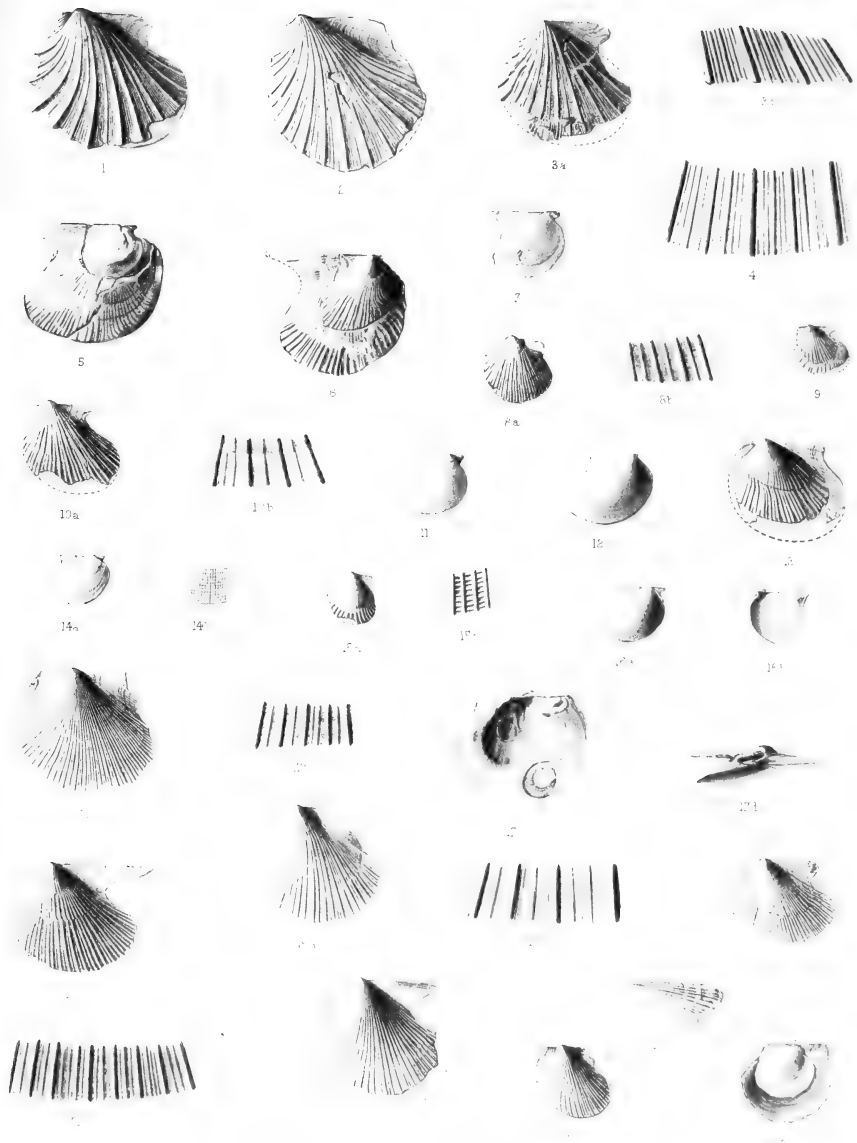


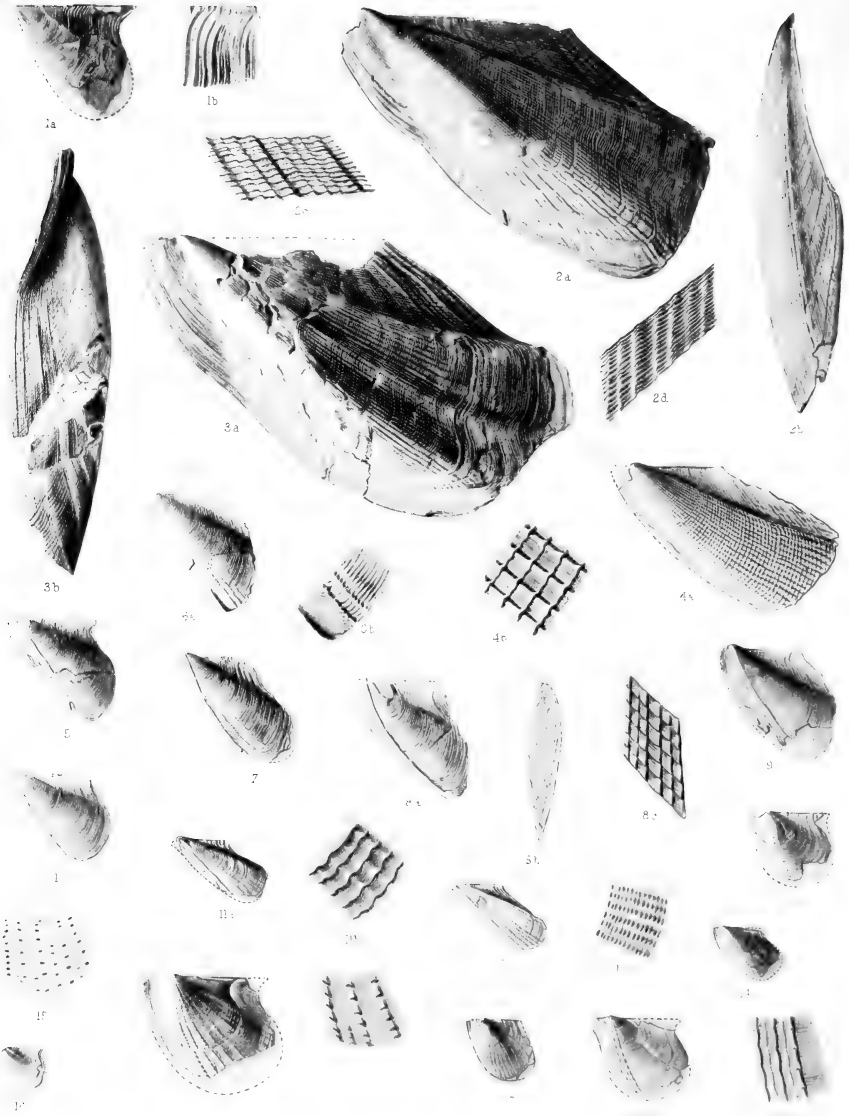
PLATE IX.

PTERIA (*continued*).

Sub-Genus—PSEUDOPTERA, *Meek*.

FIGS.

1. *P. (Pseudoptera) subdepressa* (d'Orb.). Lower Greensand (Crackers), Atherfield. The Type. Museum of the Geological Society, No. 2050. *a*, left valve; *b*, portion of posterior ear $\times 4$. (P. 63.)
- 2—4. *P. (Pseudoptera) anomala* (Sow). Upper Greensand. 2, 3, Blackdown. 4, Haldon. (P. 64.)
 2. The Type. Bristol Museum. *a*, left valve; *b*, postero-dorsal view; *c*, portion of ridge $\times 4$; *d*, portion of posterior ear $\times 4$.
 3. British Museum, No. L, 16876. *a*, left valve; *b*, antero-ventral view.
 4. British Museum, No. L, 16869. *a*, left valve $\times 2$; *b*, portion near the middle of the valve $\times 8$.
- 5—10. *P. (Pseudoptera) haldonensis*, Woods. Upper Greensand, Haldon. Left valves. (P. 66.)
 5. British Museum, No. L, 16800.
 - 6 *a*. " " " L, 16759; *b*, ventral portion $\times 3$.
 7. " " " L, 16868.
 - 8 *a*. " " " L, 16868; *b*, antero-ventral view; *c*, middle part of antero-ventral side $\times 6$.
 9. Sedgwick Museum, Cambridge.
 10. British Museum, No. L, 16805. $\times 2$.
- 11, 12. *P. (Pseudoptera) gaultina*, Woods. Gault, Black Ven. Left valves. (P. 67.)
 - 11 *a*. Museum of Practical Geology, No. 10780; 11 *b*, median portion $\times 6$.
 - 12 *a*. Sedgwick Museum; 12 *b*, median portion $\times 3$.
- 13—19. *P. (Pseudoptera) caerulescens* (Nilsson). Upper Chalk. Left valves. (P. 67.)
 - 13—15. Zone of *A. quadratus*, East Harnham. Dr. Blackmore's collection. 13 $\times 1\frac{1}{2}$. 15, median part $\times 4$.
 16. Zone of *B. mucronata*, Clarendon. Dr. Blackmore's collection.
 - 17—19. Zone of *B. mucronata*, Norwich. Norwich Museum. 17 *a* $\times 2$; 17 *b*, median portion $\times 6$. 19 *a*, $\times 1\frac{1}{2}$; 19 *b*, portion with ribs $\times 4$.



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PLATE X.

Genus—AUCELLA, *Keyserling*.

FIGS.

- 1, 2. *A. volgensis*, Lahus. Spilsby Sandstone, Donnington. Sedgwick Museum. (The specimens figured by Pavlow.) 1 *a*, left valve; 1 *b*, anterior view; 1 *c*, right valve. 2 *a*, left valve; 2 *b*, right valve; 2 *c*, posterior view. (P. 69.)
- 3—5. *A. Keyserlingiana*, Trautsch. Claxby Ironstone, Claxby. Sedgwick Museum. 3 *a*, left valve; 3 *b*, right valve; 3 *c*, posterior view; 3 *d*, anterior ear and umbo of right valve $\times 3$. 4 *a*, left valve; 4 *b*, right valve. 5, left valve. (P. 70.)

Genus—AUCELLINA, *Pompeckj*.

- 6—13. *A. gryphæoides* (Sow.). Cambridge Greensand, except figs. 11, 12, 13. Sedgwick Museum. (P. 72.)
6. *a*, left valve; *b*, posterior view; *c*, right valve; *d*, part of right valve $\times 4$.
7. *a*, left valve; *b*, right valve; *c*, dorsal view.
8. *a*, left valve; *b*, right valve.
9. *a*, umbo and anterior ear of left valve $\times 3$; *b*, dorsal view showing areas, etc. $\times 3$; *c*, area of right valve $\times 3$.
10. Anterior ear of right valve $\times 3$.
11. Lower Chalk, near Cambridge. Right valve $\times 1\frac{1}{2}$.
12. Lower Chalk, Reach. Portion near the middle of the right valve $\times 6$.
13. Red Limestone, Speaton. Left valve.

Genus—GERVILLIA, *DeFrance*.

- 14—16. *G. sublanceolata* (d'Orb.). Lower Greensand (Crackers), Atherfield. Sedgwick Museum. (P. 74.)
14. Right valve of a young individual.
15. Left valve of a young individual with only three ligament pits.
16. Left valve of an immature specimen.



PLATE XI.

GERVILLIA (*continued*).

FIGS.

1. *G. sublancoolata* (d'Orb). Upper Greensand, Blackdown. Sedgwick Museum. Interior of part of a right valve. (P. 74.)
- 2—8. *G. linguloides*, Forbes. Lower Greensand (Crackers), Atherfield. Figs. 2—4, 6—8, Sedgwick Museum; fig. 5, York Museum. (P. 78.)
 2. Left valve $\times 1\frac{1}{2}$.
 3. Hinge of left valve $\times 3$.
 4. Right valve $\times 1\frac{1}{2}$.
 5. Left valve $\times 1\frac{1}{2}$.
 - 6—8. Left valves.
- 9—11. *G. alæformis* (Sow.). Lower Greensand (Crackers), Atherfield. Sedgwick Museum. Figs. 9, 10, young specimens. (P. 79.)
 - 9 *a*, left valve; *b*, portion near umbo $\times 3$; *c*, right valve; *d*, dorsal view.
 - 10 *a*, left valve $\times 1\frac{1}{2}$; *b*, ribs near the middle of the left valve $\times 3$; *c*, hinge of same valve $\times 3$; *d*, area and ligament pits of right valve of the same specimen $\times 3$.
 11. Hinge of adult specimen. *Perna*-bed, Atherfield.
- 12—23. *G. rostrata* (Sow.). Upper Greensand, Blackdown. 12—19, left valves. 20—22, right valves. Sedgwick Museum, except figs. 13, 15, 22, 23. (P. 83.)
 - 12 *b*, interior of 12 *a*, $\times 1\frac{1}{2}$.
 13. Museum of Practical Geology, No. 10784.
 15. British Museum, No. L, 16872.
 19. Hinge $\times 2$.
 22. Haldon. Museum of Practical Geology, No. 10783.
 23. Dorsal view of the Type. Bristol Museum.
- 24, 25. *G.*, sp. Lower Greensand (Ferruginous Sands), Shanklin. Sedgwick Museum. Left valves. 24 $\times 1\frac{1}{2}$. (P. 85.)
- 26, 27. *G. Forbesiana*, d'Orb. Right valves. Sedgwick Museum. (P. 85.)
 26. Lower Greensand (Crackers), Atherfield.
 27. Gault, Folkestone.



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OF THE

BRITISH CARBONIFEROUS
LAMELLIBRANCHIATA.

BY

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INDEX TO VOLUME II.

| | PAGE | | PAGE |
|------------------------------|---------|-------------------------------|---------|
| Actinopteria | 22 | Avicula tessellata | 63 |
| — fluctuosa | 25 | — Thompsoni | 17 |
| — persulcata | 23 | — tumida | 126 |
| — sulcata | 26 | — Valenciennesiana | 65 |
| Allorisma Ansticei | 165 | Aviculopecten | 66, 165 |
| Anusium | 121 | — anisotus | 104 |
| — concentricum | 122 | — blandus | 57 |
| — (?) deornatum | 100 | — Bosquetianus | 55 |
| — planicostatum | 123 | — Bouei | 94 |
| — Sowerbii | 118 | — Cairnsii | 106 |
| — tenue | 123 | — cancellatulus | 90 |
| Ancylus Vinti | 144 | — Carrolli | 97 |
| Anomia antiqua | 126 | — clathratus | 82 |
| — corrugata | 30 | — cœlatus | 70 |
| Anthracomya calcifera | 146 | — concavus | 54 |
| Anthracosia robusta | 150 | — concentrico-costatus | 108 |
| Avicula angusta | 11 | — constans | 130 |
| — Bosquetiana | 55 | — decussatus | 79 |
| — Buchiana | 126 | — deornatus | 100 |
| — cycloptera | 64 | — dissimilis | 70 |
| — gibbosa | 16 | — docens | 69 |
| — hemispherica | 45 | — Dumontianus | 65 |
| — informis | 11 | — dupliciradiatus | 39 |
| — laminosa | 14 | — ellipticus | 103 |
| — levigata | 11, 126 | — Eskdalensis | 74 |
| — lunulata | 11 | — eximius | 59 |
| — papyracea | 51 | — fallax | 75 |
| — plicata | 73 | — fibrillosus | 86, 106 |
| — radiata | 55 | — fimbriatus | 93 |
| — recta | 11 | — flexuosus | 165 |
| — Samueli | 54 | — Forbesii | 83 |
| — simplex | 39 | — gentilis | 86 |
| — squamosa | 16 | — granosus | 57 |
| — sublobata | 110 | — hemisphæricus | 45 |

INDEX TO VOLUME II.

| | PAGE | | PAGE |
|------------------------------|---------|-------------------------------|---------|
| Actinopteria | 22 | Avicula tessellata | 63 |
| — fluctuosa | 25 | — Thompsoni | 17 |
| — persulcata | 23 | — tumida | 126 |
| — sulcata | 26 | — Valenciennesiana | 65 |
| Allorisma Ansticei | 165 | Aviculopecten... .. | 66, 165 |
| Anusium | 121 | — anisotus | 104 |
| — concentricum | 122 | — blandus | 57 |
| — (?) deornatus | 100 | — Bosquetianus | 55 |
| — planicostatum | 123 | — Bouei | 94 |
| — Sowerbii | 118 | — Cairnsii | 106 |
| — tenue | 123 | — cancellatulus | 90 |
| Ancylus Vinti | 144 | — Carroli | 97 |
| Anomia antiqua | 126 | — clathratus | 82 |
| — corrugata | 30 | — celatus | 70 |
| Anthracomya calcifera | 146 | — concavus | 54 |
| Anthracosia robusta | 150 | — concentrico-costatus | 108 |
| Avicula angusta | 11 | — constans | 130 |
| — Bosquetiana | 55 | — decussatus | 79 |
| — Buchiana | 126 | — deornatus | 100 |
| — cycloptera | 64 | — dissimilis | 70 |
| — gibbosa | 16 | — docens... .. | 69 |
| — hemisphaerica | 45 | — Dumontianus | 65 |
| — informis | 11 | — dupliciradiatus | 39 |
| — laminosa | 14 | — ellipticus | 103 |
| — levigata | 11, 126 | — Eskdalensis | 74 |
| — lunulata | 11 | — eximius | 59 |
| — papyracea | 51 | — fallax | 75 |
| — plicata | 73 | — fibrillosus | 86, 106 |
| — radiata | 55 | — fimbriatus | 93 |
| — recta | 11 | — flexuosus | 165 |
| — Samuelsei | 54 | — Forbesii | 83 |
| — simplex | 39 | — gentilis | 86 |
| — squamosa | 16 | — granosus | 57 |
| — sublobata | 110 | — hemisphaericus | 45 |

| | PAGE | | PAGE |
|---|---------|--|----------|
| Aviculopecten illegalis | 69, 89 | British Palæozoic Fossils, M'Coy | 172 |
| — incassatus | 89 | Camptonectes... .. | 102 |
| — inequalis | 99 | Carbonicola Vinti | 144 |
| — ingratus | 88 | Cardiomorpha Nysti... .. | 164 |
| — interlineatus | 101 | — obliqua | 164 |
| — intermedius | 81 | — radiata | 131 |
| — interstitialis | 94 | Clidophorus | 158 |
| — Jonesii | 129 | Conchylolithus | 1 |
| — Knockonniensis | 84 | — flabelliformis | 1 |
| — lævigatus | 48 | — nudus | 1 |
| — Losseni | 80 | Crenipecten | 112 |
| — macrotis | 84 | — semicircularis | 113 |
| — megalotis | 89 | Ctenodonta | 141 |
| — Mosensis | 52 | — Halli | 140 |
| — Murchisoni | 98 | — lævirostris | 164 |
| — nobilis | 90 | — lirata | 143 |
| — nodulosus | 57 | — pentonensis | 139 |
| — ornatus | 50 | — sinuosa | 164 |
| — papyraceus | 52 | Cypriocardia | 153 |
| — pera | 78, 84 | — cylindrica | 154 |
| — perplicatus | 92 | — oblonga | 131 |
| — perradiatus | 87 | — socialis | 154 |
| — planoclathratus | 91 | Distribution | 173 |
| — planoradiatus... .. | 67, 165 | Edmondia acuta | 151 |
| — plicatus | 73 | — amæna | 150 |
| — proteus | 122 | — Lyellii | 164 |
| — quinquelineatus | 93 | — oblonga | 164 |
| — Ruthveni | 97 | — punctatella | 147 |
| — Sedgwicki | 101 | — senilis | 151 |
| — segregatus | 94 | — truncata | 149 |
| — semicostatus | 69, 165 | Entolium | 116 |
| — Sowerbii | 118 | — aviculatum | 118 |
| — stellaris | 88, 131 | — Sowerbii | 118, 122 |
| — subconoideus | 76 | — tenue | 123 |
| — sublobatus | 110 | Estheria punctatella | 147 |
| — tabulatus | 67, 165 | Euchondria | 67 |
| — tenuilineatus | 91 | Eumicrotis | 43 |
| — tessellatus | 63 | — hemisphæricus | 45 |
| — textilis | 70 | — ovalis | 46 |
| — villanus | 88 | Fleming, History of British Animals | 166 |
| Aviculopinna | 5 | Geology of Coalbrookdale, Prestwich | 167 |
| — d'Orbigny | 4 | | |
| — spatula | 4 | | |
| Axinus obovatus | 143 | | |
| Belgium, Carboniferous Limestone fossils of | 190 | | |

| | PAGE | | PAGE |
|--------------------------------------|--------|--|---------|
| Geology of Londonderry, Portlock ... | 168 | <i>Lucina antiqua</i> | 163 |
| — of Yorkshire, pt. ii, Phillips | 166 | — <i>du Noyeri</i> | 163 |
| <i>Gervillia lammosa</i> | 14, 17 | <i>Lyriopecten</i> | 61 |
| — <i>lunulata</i> | 11 | — <i>orbiculatus</i> | 61 |
| — <i>squamosa</i> | 16 | <i>Macrodon</i> | 164 |
| <i>Grammatodon</i> | 164 | <i>Malleus orbicularis</i> | 60 |
| History of British Animals, Fleming | 166 | <i>Martin, Petrefacta Derbiensia</i> | 165 |
| <i>Inoceramus auriculatus</i> | 108 | <i>M'Coy, British Palæozoic Fossils</i> | 172 |
| <i>Isodietic line</i> | 176 | — <i>Synopsis of the Carboniferous Fossils</i> | |
| <i>Jenkinson, E.</i> | 209 | — of Ireland | 168 |
| <i>Lanistes obtusus</i> | 21 | <i>Megambonia</i> | 133 |
| — <i>rugosus</i> | 23 | — <i>carbonifera</i> | 133 |
| <i>Leda</i> | 140 | <i>Meleagrina lævigata</i> | 48 |
| <i>Leiopteria</i> | 9 | — <i>rigida</i> | 60 |
| — <i>divisa</i> | 22 | — <i>tessellata</i> | 63 |
| — <i>emaciata</i> | 17 | <i>Mineral Conchology, Sowerby</i> | 165 |
| — <i>grandis</i> | 19 | <i>Modiola Macadamii</i> | 164 |
| — <i>hirundo</i> | 13 | — <i>megaloba</i> | 164 |
| — <i>laminosa</i> | 14 | — <i>obtusa</i> | 21 |
| — <i>longirostris</i> | 20 | — <i>radiata</i> | 131 |
| — <i>lunulata</i> | 11 | — <i>rostrata</i> | 20 |
| — <i>modiolaris</i> | 17 | — <i>Wrightii</i> | 132 |
| — <i>obtusa</i> | 21 | <i>Mytilomorpha angulata</i> | 164 |
| — <i>rostrata</i> | 14 | <i>Mytilus Koninckianus</i> | 131 |
| — <i>squamosa</i> | 16 | <i>Nothamusium</i> | 159 |
| — <i>Thompsoni</i> | 17 | — <i>radiatum</i> | 160 |
| — <i>trigonalis</i> | 17 | — <i>transversum</i> | 161 |
| <i>Leptodesma</i> | 9 | <i>Nucula cuneata</i> | 139 |
| Life-zones | 212 | — <i>lævirostris</i> | 164 |
| <i>Lima alternata</i> | 37 | — <i>lunulata</i> | 164 |
| — <i>concinna</i> | 79 | <i>Nuculites</i> | 140 |
| — <i>decussata</i> | 79 | <i>Obliquipecten</i> | 114 |
| — <i>lævigata</i> | 108 | — <i>lævis</i> | 115 |
| — <i>obliqua</i> | 104 | <i>Orthis umbraculum</i> | 60 |
| — <i>prisca</i> | 37 | <i>Ostrea nobilissima</i> | 126 |
| <i>Limatulina</i> | 35, 38 | <i>Pachypteria</i> | 125 |
| — <i>alternata</i> | 37 | — <i>nobilissima</i> | 126 |
| — <i>desquamata</i> | 37 | <i>Palæolima</i> | 38 |
| — <i>radula</i> | 39 | — <i>Buchiana</i> | 126 |
| — <i>scotica</i> | 36 | — <i>lævis</i> | 40, 127 |
| — <i>selecta</i> | 94 | — <i>obliquiradiata</i> | 40 |
| <i>Lucina</i> | 162 | — <i>simplex</i> | 39 |

| | PAGE | | PAGE |
|-------------------------------|--------|---|----------|
| Palæoneilo | 140 | Pecten interstitialis | 94 |
| — carbonifera | 142 | — Jonesii | 129 |
| — lirata | 143 | — Knockonniensis | 84 |
| Paraclydas | 162 | — Kokcharofi | 94 |
| — du Noyeri | 163 | — lineatus | 80 |
| Parallelodon | 164 | — Losseni | 80 |
| — angustus | 137 | — macrotis | 84 |
| — divisus | 22 | — meleagrinoïdes | 62 |
| — elegans | 135 | — micropterus | 73 |
| — elongatus | 138 | — Murchisoni | 98 |
| — Haimeanus | 136 | — nobilis | 90 |
| — normalis | 136 | — orbiculatus | 83 |
| Pecten æqualis | 90 | — ottonis... .. | 70 |
| — anisotus | 104 | — ovatus | 98 |
| — arenosus | 70 | — papyraceus | 51 |
| — Bathus | 118 | — pera | 78 |
| — bellis | 84 | — Phillipsianus | 90 |
| — Bouei | 94 | — planicostatus | 123 |
| — cancellatulus | 90 | — planoclathratus | 91 |
| — cingendus | 108 | — plicatus | 69, 73 |
| — clathratus | 82 | — prætenuis | 106 |
| — celatus | 70 | — quinquelineatus | 93 |
| — cognatus | 90 | — rugulosus | 70 |
| — concavus | 54 | — scalaris | 86 |
| — concentrico-striatus | 70 | — Sedgwicki | 101 |
| — conoideus | 37 | — segregatus | 94 |
| — consimilis | 104 | — semicircularis... .. | 113 |
| — deornatus | 100 | — semicostatus | 69 |
| — depilis | 103 | — sibericus | 104 |
| — dissimilis | 70 | — simplex | 39 |
| — Dumontianus | 65 | — Sowerbii | 118 |
| — ellipticus | 103 | — stellaris | 88 |
| — elongatus | 103 | — subfimbriatus | 70 |
| — fallax | 75 | — subpapyracea | 51 |
| — filatus | 103 | — tabulatus | 67, 165 |
| — fimbriatus | 93 | — tripartitus | 79 |
| — flexuosus | 69 | — undulatus | 70 |
| — Forbesii | 83 | — Valdaicus | 118 |
| — gentilis | 86 | — variabilis | 104 |
| — gibbosus | 106 | — villanus | 88 |
| — granosus | 57, 97 | Pernopecten | 112, 117 |
| — Hardingi | 84 | Petrefacta Derbiensia, Martin | 165 |
| — hemisphæricus | 45 | Phillips, Geology of Yorkshire, pt. ii | 166 |
| — hians | 73 | Pinna | 1 |
| — incrassatus | 89 | — costata | 1 |
| — intercostatus | 82 | — flabelliformis | 1 |

| | PAGE | | PAGE |
|--|------|------------------------|----------|
| Pinna flabelliformis, var. inæquicostata ... | 1 | Pterinea Thompsoni ... | 17 |
| — flexicostata ... | 2 | Pterinopecten ... | 51 |
| — inæquicostata ... | 2 | — carbonarius ... | 128 |
| — Ivaniskiana ... | 4 | — concavus ... | 54 |
| — mutica ... | 4 | — cyclopterus ... | 64 |
| — spatula ... | 2, 4 | — Dumontianus ... | 65 |
| — subspatula ... | 4 | — eximius ... | 59 |
| Pinnites ... | 1 | — granosus ... | 57 |
| — flabelliformis ... | 1 | — meleagrinoïdes ... | 62 |
| Pleuonecites prætenuis ... | 106 | — papyraceus ... | 51 |
| Portlock, Geology of Londonderry ... | 168 | — pustulosus ... | 128 |
| Posidonia ... | 26 | — radiatus ... | 55 |
| — Becheri ... | 27 | — rigidus ... | 60 |
| — — var. tuberculata ... | 28 | — tessellatus ... | 63 |
| — lateralis ... | 27 | Pteronites ... | 5, 22 |
| — similis ... | 28 | — angustatus ... | 7 |
| — tuberculata ... | 27 | — fluctuosus ... | 25 |
| Posidoniella sulcata ... | 134 | — latus ... | 8 |
| Posidonomya ... | 26 | — naviformis ... | 7 |
| — Becheri ... | 27 | — persulcatus ... | 23 |
| — corrugata ... | 30 | — regularis ... | 23 |
| — hemisphærica ... | 45 | — subventricosus ... | 7 |
| — lamellosa ... | 34 | — sulcatus ... | 26 |
| — lateralis ... | 27 | Pullastra elegans ... | 135 |
| — membranacea ... | 33 | Rutotia ... | 43 |
| — obliqua ... | 34 | — hemisphærica ... | 45 |
| — punctatella ... | 147 | — lenticularis ... | 164 |
| — radiata ... | 31 | — ornithocephala ... | 46 |
| — similis ... | 28 | — ovalis ... | 46 |
| — tuberculata ... | 28 | Sanguinolites ... | 153 |
| Prestwich, Geology of Coalbrookdale ... | 167 | — angulatus ... | 164 |
| Protoschizodus magnus ... | 164 | — contortus ... | 165 |
| Pseudamusium ... | 102 | — hibernicus ... | 165 |
| — anisotum ... | 104 | — monensis ... | 155 |
| — auriculatum ... | 108 | — plicatus ... | 155 |
| — Bathus ... | 118 | — vexillum ... | 156 |
| — concentrico-lineatum ... | 111 | Scaudia minuta ... | 152 |
| — ellipticum ... | 103 | Schizodus obovatus ... | 143 |
| — fibrillosum ... | 106 | Smith, John ... | 202 |
| — gibbosum ... | 106 | Solen ... | 157 |
| — Redesdalense ... | 109 | Solenomorpha ... | 157, 165 |
| — sublobatum ... | 110 | — major ... | 158 |
| Pterinea desquamata ... | 37 | — minor ... | 159 |
| — intermedia ... | 81 | Solenopsis ... | 158, 165 |
| — lævigata ... | 11 | | |
| — lunulata ... | 11 | | |

| | PAGE | | PAGE |
|--|------|--|-----------------------|
| Sowerby, Mineral Conchology | 165 | Streblopteria ornata | 50 |
| Sowerby, J. de C., in Prestwich's Geology of | | prælineata | 45 |
| Coalbrookdale | 167 | — Renardi | 104 |
| Spathella | 153 | Syncyclonema | 116 |
| — cylindrica | 154 | — carboniferum | 120 |
| — tumida | 155 | — Sowerbyi | 118 |
| Streblopteria | 47 | — Witryi | 120 |
| — Buchiana | 127 | Synopsis of the Carboniferous Fossils of | |
| — concentrica | 127 | | Ireland, M'Coy |
| — elongata | 103 | Tait, D. | 192 |
| — lævigata | 48 | | |

ERRATA.

Page 168, line 23, right-hand column, for *Spathella* read *Paracyclas*.

Plate IV, line 12, for Killalu read Killala.

Plate IX, line 5, omit "of the last figure."

Plate XXIII, lines 9, 10, omit "and Redesdale, Northumberland."

Palæontographical Society, 1905.

A MONOGRAPH

ON THE

INFERIOR OOLITE AMMONITES

OF

THE BRITISH ISLANDS.

BY

S. S. BUCKMAN, F.G.S.,

HONORARY MEMBER OF THE YORKSHIRE PHILOSOPHICAL SOCIETY.

PART XIII.

SUPPLEMENT.

PAGES clxix—ccviii; PLATES XX—XXIV.

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II. REVISION OF, AND ADDITIONS TO, THE POLYMORPHIDÆ.

Family—POLYMORPHIDÆ, *Haug.*1891. POLYMORPHIDÆ, This Monogr., pp. 231, *et seq.*

The principal character which distinguishes the members of this family from the Hildoceratidæ is the suture line, with its inner lobes pointing obliquely across the whorl towards the periphery. There are cases, however, in which this character fails—for example, in degenerate species of *Dumortieria*, and in the genera *Catulloceras* and *Tmetoceras*. In style of ribbing most of the members of this family may be distinguished from the Hildoceratidæ—the ribs run straight, or nearly straight, across the whorl, having little of that lateral bend which is often so conspicuous in the Hildoceratidæ, and little of the ventral projection (rostration) which is sometimes so marked in that family.

The manner of phyletic development, however, is the chief point to be noticed. Whereas the Hildoceratidæ attain to a marked tuberculate stage with a well-developed carina—*e. g.* *Lillia*, *Haugia*, *Dreckmannia*, *Chartronia*, *Kilania*, etc.—and then show the stages of decline through a costate to a smooth stage, the Polymorphidæ only attain to a parvituberculate stage when the carina has not been developed, or is only feeble; examples, *Tmetoceras*, no carina, sulcate periphery; *Uptonia*, costate periphery; *Acanthopleuroceras* (*Cycloceras*), feeble carina; while in *Dumortieria* and *Catulloceras* there is no evidence of a tuberculate stage having been attained: it seems as if the anagenetic costate stage passed direct into the catagenetic, and the carina is a feature developed in the catagenetic costate stage. But in the Hildoceratidæ, on the evidence of ontogeny and analogy with the Arietidæ, the carina is developed even before the anagenetic costate stage commences.

When the members of this family were described in the body of the work, only a few localities were known to yield the principal genera—*Dumortieria* and *Catulloceras*; and the examples were mostly poor. Much addition has been made since. Mr. Charles Upton found in Penn Wood, near Stroud, a rich fauna of *Dumortieria*. This locality, and Buckholt Wood, near Frocester, have yielded to him and to myself many good specimens. Dursley also afforded me a good series in nice condition—mostly from the *Moorei* beds. The late Mr. E. Wilson, F.G.S., and Dr. Vaughan, F.G.S., have sent me various species from the neighbourhood of Bath and Bristol. Mr. Bloomfield showed me two localities in the Yeovil Sands, just out of Yeovil, rich in *Dumortieria* and *Catulloceras*—mostly of a type distinct

from those of the Cotteswolds: they are apparently earlier biogenetically, if not geologically. Of course all this additional material has yielded many new forms; but only a few of the more conspicuous and important of them can be dealt with now.

I. *Genus*—*TMETOCERAS*, *S. Buckman*.

1892. *TMETOCERAS*, This Monogr., p. 269.

Remarks.—Species of this easily recognised genus mark, with one exception, a well-known horizon—the strata of the *scissi* hemera—from the Dorset coast to Northamptonshire. The exception is *Tm. Hollandæ*, the date of which is *Murchisonæ* hemera.

At Burton Bradstock and Chideock Quarry Hill, on the Dorset coast, species of *Tmetoceras* are found in the stratum capping the “Sands”—the bed with *Liocerata* (see p. xxxv).

In Gloucestershire, in the Cotteswolds around Stroud, at Robinswood Hill (Mr. L. Richardson), at Andoversford, species of the genus have been found in the “Sandy Ferruginous Beds.”

The “Northampton Sands” of Northamptonshire have yielded specimens which I have verified: they are doubtless the *Am. niortensis* mentioned by Sharpe.

The Paving Bed of Bradford Abbas (date *Murchisonæ* η) has yielded two species: one, *Tm. Hollandæ*, is indigenous; the other, aff. *Tm. circulare*, is derived presumably—the matrix in the whorls differs from that enclosing the specimen.

There are specimens in my cabinet from Italy and Normandy, and the genus has been found in South America (Gottsche).

1. *TMETOCERAS CIRCULARE*, *S. Buckman*. Plate XLVIII, figs. 1—3.

1892. *TMETOCERAS SCISSUM*, This Monogr., Pl. xlviii, figs. 1—3; p. 273 (pars).

Description.—Substeno- (on the line, 50 per cent.) subpachygyral; perlatumbilicate; costate; periphery sulcate, the sulcus interrupting the costæ, of which each one terminates in a tubercle on the edge of the sulcus.

Distinction.—Very like *A. scissus*, Benecke, in proportions and appearance, but the whorl is rounder, and more inflated.

2. *TMETOCERAS SCISSUM* (*Benecke*). Plate XLVIII, figs. 4—7.

1892. *TMETOCERAS SCISSUM*, This Monogr., Pl. xlviii, figs. 4—7; p. 273 (pars).

3. *TMETOCERAS REGLEYI* (*Thiollière*). Plate XLVIII, figs. 8—10.

1892. *TMETOCERAS SCISSUM*, This Monogr., Pl. xlviii, figs. 8—10; p. 273 (pars).

Note.—Place here the reference to Dumortier, and with a query that to Gottsche.

Remarks.—The stout whorls, and general characters show close agreement with Dumortier's delineation. These features separate this form from the others.

Localities and Strata.—Dorset: Broad Windsor. Gloucestershire: Penn Wood, near Stroud, top of Sandy Ferruginous Beds. Foreign: Normandy; Feuguerolles, "Murchisonæ," from Dr. L. Brasil.

Date of Existence.—For the Penn Wood specimen, *scissi* hemera; and this is probably the correct date for the other examples—the strata of the *scissi* hemera having been often reckoned as base of *Murchisonæ* zone.

II. *Genus*—CATULLOCERAS, *Gemmellaro*.

1892. *CATULLOCERAS*, This Monogr., p. 276.

1. *CATULLOCERAS LEESBERGI* (*Branco*). Plate XXXIX, figs. 10, 11.

1891. *CATULLOCERAS LEESBERGI*, This Monogr., Pl. xxxix, figs. 10, 11; 1892, p. 279.

Remarks.—A good specimen of this rare and distinct species was found by Dr. A. Vaughan, at the tunnel shaft, Sodbury, Gloucestershire. It is larger than the example figured. I desire to thank him for adding it to my collection.

Note.—The want of carina in the specimen figured is due partly to ill preservation.

2. *CATULLOCERAS PSAMMINUM*, *S. Buckman*. Plate XLI, figs. 7, 8.

1891. *DUMORTIERIA RADIANS*, This Monogr., Pl. xli, figs. 7, 8.

Description.—Subplaty-subleptogyral; latumbilicate; spissicostate; periphery convex, paracarinata.

Distinction.—From *Catull. Leesbergi*, fewer whorls and a smaller umbilicus.

From *Dumortieria radians*, stouter whorls, a flatter periphery, a less definite carina.

Remarks.—The absence of the paucicostate stage (the evidence is furnished by other specimens), which is so noticeable in *Dumortieria*, even when more degenerate than this species, and the association of spissicostation with quadrate whorls and an open umbilicus, suggest that the generic position is *Catulloceras*.

Localities and Stratum.—Dorset: neighbourhood of Bradford Abbas, Yeovil Sands. Somerset: Furzey Knaps, near Yeovil, in the same beds, associated with several new allied species.

In the following species the periphery shows more or less definite furrows beside the carina. Place here also *Ammonites Perrouli*, Dumortier et Fontannes, and *Catull. aratum*, S. Buckm.

3. CATULLOCERAS SUBARATUM, *Brasil*. Plate XXXIX, figs. 1, 2.

1891. DUMORTIERIA ARATA, This Monogr., Pl. xxxix, figs. 1, 2.

1892. CATULLOCERAS ARATUM, This Monogr., p. 280 (pars).

1895. CATULLOCERAS SUBARATUM, *Brasil*, Ceph. nouv., Bull. Soc. Géol. Normandie, vol. xvi, Pl. iv, figs. 1, 2.

Remarks.—Dr. L. Brasil has found this species in Normandy, and has rightly corrected me by separating this from the compressed form under a distinct name.

III. Genus—DUMORTIERIA, *Haug*.

1891. DUMORTIERIA, This Monogr., p. 231.

RECTIRADIATE.

Paucicostate.

1. DUMORTIERIA PRISCA, *S. Buckman*. Plate XXXVII, figs. 9—11.

1891. DUMORTIERIA PRISCA, This Monogr., Pl. xxxvii, figs. 9—11, p. 236.

Localities and Strata.—Somerset: Hendford Hill, Yeovil, in “the Sands.” Gloucestershire: Penn Wood, Cephalopoda Bed, middle (“*Dumortieria* Beds”). This specimen, 68 mm. in diameter, has last whorl sparsicostate to smooth, failure of costation beginning about 55 mm. in diameter.

Date of Existence.—*Dumortieria*.

2. DUMORTIERIA NOVATA, *S. Buckman*. Suppl., Fig. 163 in text.

1885. AMMONITES FALCOFILA SPAESICOSTA, *Quenst.*, *Amm. Schwab. Jura*, Pl. liv.
fig. 29 (not 35).

1895. DUMORTIERIA PRISCA, *Brasil*, *Ceph. nouv.*, *Bull. Soc. Géol. Normandie*,
vol. xvi, Pl. ii, fig. 3.

Distinction.—From *D. prisca*, the costæ in the early whorls are less coarse and less distant, the umbilicus is smaller, degenerative changes begin earlier.

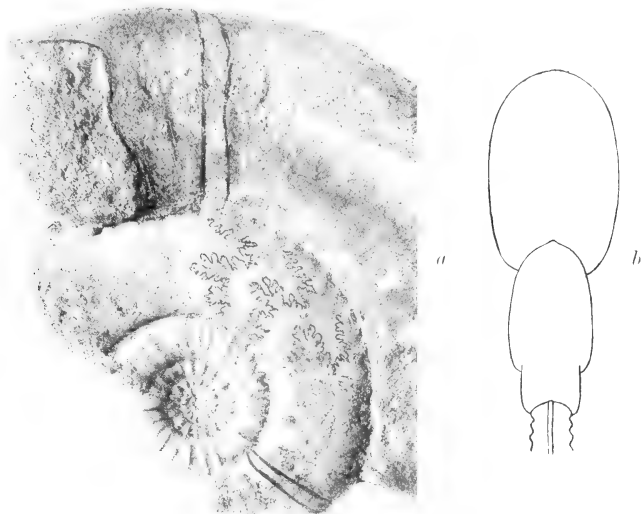


FIG. 163.—*Dumortieria novata*.

Description.—(Young) Subplatysubpachygyral, latumbilicate, paucicostate to costate; (adult) subplatyleptogyral, perlatumbilicate, costate to lævigate; subpauciseptate, sublongi-subangustilobate; periphery penetabulate, parvicarinate, degenerating to convex, obsoletecarinate.

This seems to be one of the forms which Quenstedt called *A. falcofila sparsicosta*; but Haug, considering that form as identical with a species he figured, used the name *sparsicosta* for that species—his *Dumortieria sparsicosta* (*q. v.*, p. 239). But this form, Quenstedt's fig. 29 of Plate LIV, has thicker whorls and a broader, more convex, periphery than Haug's species.

Localities and Strata.—Gloucestershire: Penn Wood, Cephalopod Bed, middle ("Dumortieria Beds"), several young specimens; Wotton-under-Edge, similar

position; Cam Down. Normandy: Tilly-sur-Seulles, two specimens in my collection from Mr. Brasil. He says (p. 7) it is abundant at Tilly-sur-Seulles and at Fontenay-le-Pesnel in the upper part of the zone of *Lytoceras jurense*, associated with species of *Dumortieria*, which he names; it occurs in England in similar association.

Date of Existence.—*Dumortieria* hemera.

3. DUMORTIERIA FALCOFILA (*Quenstedt*). Fig. 164 in text.

1885. AMMONITES FALCOFILA, *Quenstedt*, *Amm. Schwäb. Jura*, Pl. liv, fig. 31, and ? fig. 28.

Remarks.—*Quenstedt* figured a series of species as *A. falcofila*, *A. falcofila sparsicosta*, and *A. falcofila macer* (Plate LIV, figs. 28—35). Of these Fig. 31 agrees exactly with our English example, Fig. 28 is near, but may be a thinner form, Fig. 30 is a form allied to *Dumortieria pseudoradiosa* (v. p. 246); of Figs. 29, 35, *falcofila sparsicosta*, Fig. 29, is *D. novata*, sp. nov. (p. clxxiii), Fig. 35 is allied to *D. Munieri* (v. p. clxxv); of Figs. 32—34, *falcofila macer*, Figs. 32, 34, appear to be *Catullocceras* aff. *Dumortieri*, and might therefore be inscribed *Catullocceras macrum*; Fig. 33 is a smooth species upon which I venture no opinion.



FIG. 164.—*Dumortieria falcofila*, *Quenstedt*.

Distinction.—Shows little of the coarse distant ribbing characteristic of the early whorls of the two preceding species. Is stouter whorled than *D. novata*.

Localities and Strata.—Somerset: Furzey Knaps, near Yeovil, "Sands." Foreign; Normandy: Tilly-sur-Seulles, "Jurense zone," from Mr. L. Brasil.

Date of Existence.—*Dumortieria* hemera.

4. DUMORTIERIA SUB SOLARIS, *S. Buckman*. Pl. XXXVII, figs. 6—8.

1831. AMMONITES SOLARIS? *Zieten*, *Verst. Württ.*, Pl. xiv, fig. 7 (non *solaris*, Phillips).

1891. DUMORTIERIA LEVESQUEI, *This Monogr.*, Pl. xxxvii, figs. 6—8.

1902. DUMORTIERIA SOLARIS, *S. Buckman*, *Emend. Amm. Nom.*, p. 6.

Distinction.—From *A. Levesquei*, d'Orbigny, costæ less definite, closer together, less persistent; whorl more compressed; periphery narrower, more acute.

Remarks.—Is *Am. solaris*, *Zieten*, but not Phillips ('*Geol. Yorkshire*,' Pl. IV,

fig. 29), which belongs to a different genus and a different family. As Zieten's name is a synonym, it cannot be used in the present case.

5. *DUMORTIERIA PAUCISEPTATA*, *S. Buckman*. Fig. 165 in text.

Description.—Subplatysubleptogyral; sublaturumbilicate; pauciseptate, sublongi-subangustilobate; subpaucicostate to subcostate; periphery subfastigate, parvicarinate.

Distinction.—From young *D. novata*, the more compressed whorl, the narrower periphery, the less paucicostate character. From *D. sparsicosta*, more definitely costate; the septa more distant, their lobes larger.

Locality and Stratum.—Gloucestershire: Bowcott Wood, near Dursley, in the Cephalopod Bed.

Date of Existence.—*Moorei* hemera.

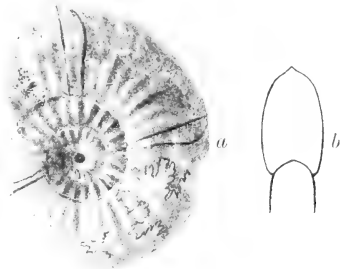


FIG. 165.—*Dumortieria pauciseptata*.

7. *DUMORTIERIA COSTULA* (*Reinecke*). Pl. XXXVII, figs. 12, 13, 18, 19; Suppl., Fig. 166, p. cxvii.

1818. NAUTILUS COSTULA, *Reinecke*, *Maris prot.*, figs. 33, 34.

1891. DUMORTIERIA COSTULA, *This Monogr.*, Pl. xxxvii, figs. 12, 13 only.

1891. DUMORTIERIA, sp., *Ibid.*, Pl. xxxvii, figs. 18, 19.

Notes.—At a little larger size than that of the specimen figured in Pl. XXXVII, figs. 18, 19, the ribs degenerate rapidly, becoming close-set but sub-obsolete, somewhat after style of those in Plate XL, fig. 7.

Localities and Strata.—Gloucestershire: Cam Down, Buckholt Wood, Bowcott Wood, etc., Cephalopod Bed, upper part ("Moorei Beds"). Somerset: Stoford, Yeovil Sands.

Date of Existence.—*Moorei* hemera.

8. *DUMORTIERIA MUNIERI* (*Haug*). Plate XXXVII, figs. 14, 15. Suppl., Fig. 167.

1884. HARPOCERAS MUNIERI, *Haug*, *Nouv. Ann. du Lias sup.*, *Bull. Soc. Géol. France*, 3 Sér., vol. xii, Pl. xiii, fig. 3.

1885. AMMONITES STRIATULOCOSTATUS, *Quenstedt*, *Amm. Schwab. Jura*, Pl. lii, fig. 8.

1891. DUMORTIERIA COSTULA, *This Monogr.*, Pl. xxxvii, figs. 14, 15.

Note.—The example which I have figured has great resemblance to Haug's type, both in general proportion and in manner of costation. It only differs in degree of costation, being more strongly ribbed, especially in the umbilical whorls.

9. *DUMORTIERIA* sp. Plate XLV, figs. 15, 16.

1891. *DUMORTIERIA* LEVESQUEI, This Monogr., p. 241, 1892, Pl. xlv, figs. 15, 16.

Remarks.—Not much can be said about this fragment. The umbilicus is not large enough for *A. Levesquei* (d'Orbigny). It seems to have some likeness to *D. Munieri*.

Paucicostate to Costate.

The inner whorls show more or less of the paucicostate or *D. prisca* stage, but the costate stage and decline of that stage are the chief characters in this series of species.

10. *DUMORTIERIA* MULTICOSTATA, *S. Buckman*. Suppl., Fig. 168 in text.

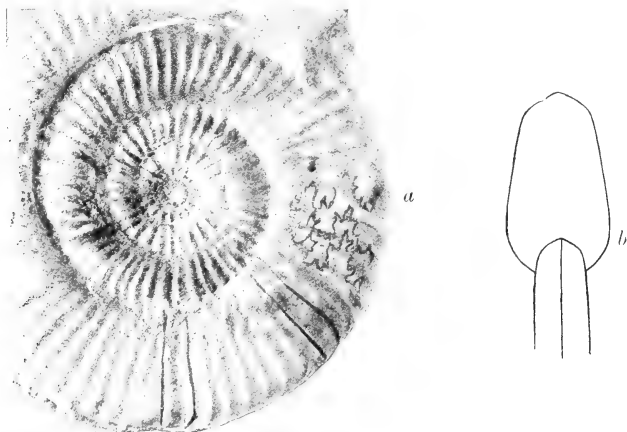


FIG. 168.—*Dumortieria multicostata*.

Description.—Subplatyleptogyral, lat-, almost perlatumbilicate, densiseptate; subbrevisubangustilobate; subpaucicostate to costate; periphery subtabulate, parvicarinate.

Remarks.—The *D. prisca* stage is evident in the inner whorls. The later development is much more definitely costate than in *D. novata*. Quenstedt figured

a series of species under the name *striatulocostatus*.¹ To one of these the present species has much likeness, but it cannot be exactly identified therewith. The coiling of the umbilicus does not correspond; the ribs of the present species are more pronounced, more approximate, and more persistent; and apparently the whole shell is stouter.

Locality and Stratum.—Gloucestershire: Penn Wood, near Stroud, in the middle part of the Cephalopod Bed.

Date of Existence.—*Dumortieria* hemera.

11. DUMORTIERIA EXTERNICOSTATA (*Branco*). Plate XL, figs. 1, 2. Suppl., Fig. 169, p. cxevi.

1879. HARPOCERAS SUBUNDULATUM, var. EXTERNE COSTATUM, *Branco*, Unt. Dogger, Abh. Geol. Spez. Karte Elsass-Lothringen, Bd. ii, Pl. iii, fig. 3 only.

1891. DUMORTIERIA STRIATULOCOSTATA, This Monogr., Pl. xl, figs. 1, 2.

1902. — EXTERNICOSTATA, *S. Buckman*, Emend. Anm. Nom., p. 5.

Note.—Smaller umbilicus and finer costation than *D. striatulocostata*, as now defined.

12. DUMORTIERIA MUTANS, *S. Buckman*. Plate XL, figs. 3—8. Suppl., Fig. 170, p. cxevi.

1891. DUMORTIERIA STRIATULOCOSTATA, This Monogr., Pl. xl, figs. 3—8, p. 243.

Description.—Sublumbilicate; costate declining to obscuricostate; periphery narrow, fastigate, parvicarinate.

Distinction.—From *Am. striatulocostatus*, Quenstedt,² smaller umbilicus and less coarsely costate. From *Harp. externicostata*, *Branco*, thinner, with earlier degeneration of costae.

13. DUMORTIERIA DECLINANS, *S. Buckman*. Plate XL, figs. 10—12. Suppl., Fig. 171, p. cxevi.

1891. DUMORTIERIA STRIATULOCOSTATA, This Monogr., Pl. xl, figs. 10—12.

1902. — DECLINANS, Emend. Anm. Nom., p. 5.

Description.—Sublumbilicate; subcostate declining to almost striate; periphery narrow, subtabulate, parvicarinate.

¹ Anm. Schwäb. Jura, Pl. lii, fig. 7; taken as type, see this Monogr., p. 244.

² Anm. Schwäb. Jura, Pl. lii, fig. 7.

Distinction.—From *Dum. mutans*, costæ in umbilicus less coarse, and not declining so rapidly, a more distinct carina on a more definite periphery.

Localities and Stratum.—Gloucestershire: Penn Wood, Buckholt Wood, Cephalopod Bed, Middle (*Dumortieria* Beds). Largest specimen 113 mm. in diameter, with last half-whorl smooth.

14. DUMORTIERIA YEOVILENSIS, *S. Buckman*. Plate XXXVII, figs. 16, 17. Suppl., Fig. 172, p. excvi.

1891. DUMORTIERIA STRIATULOCOSTATA, This Monogr., Pl. xxxvii, figs. 16, 17.

1902. — YEOVILENSIS, Emend. Ann. Nom., p. 6.

Description.—Sublatumbilicate; costate changing to sublevigate; periphery fastigate, subcarinate.

Distinction.—More strongly costate and with a more acute periphery than either *D. mutans* or *D. declinans*.

Locality and Stratum.—Dorset-Somerset border, Yeovil Junction, Sands (Mr. D. Stephens). One specimen measures 114 mm. in diameter.

15. DUMORTIERIA METITA, *S. Buckman*. Plate XLII, figs. 11, 12. Suppl., Fig. 173, p. excvi.

1874. AMMONITES RADIOSUS, *Dumortier* (non *Seebach*), Pal. Bassin Rhone, vol. iv, Pl. xiv, fig. 2 only.

1891. DUMORTIERIA RADIANS, This Monogr., Pl. xlii, figs. 11, 12.

1902. — METITA, Emend. Ann. Nom., p. 5.

Description.—Subplaty-subleptogyral; latumbilicate; subpauciparvicostate periphery convex to fastigate, parvicarinate.

Localities and Strata.—Gloucestershire: Cam Down, Penn Wood, Cephalopod Bed, middle part (*Dumortieria* Beds). Foreign: France, "Le Bernard (Vendée) Lias supérieur" (Mr. L. Chartron).

Date of Existence.—*Dumortieria* hemera.

16. DUMORTIERIA REGULARIS, *S. Buckman*. Plate XLI, figs. 4—6. Suppl., Fig. 174, p. excvi.

1890. DUMORTIERIA RADIANS, This Monogr., Pl. xli, figs. 4—6.

Description.—Subplatysubleptogyral; latumbilicate; spissiparvicostate; periphery subtabulate, parvicarinate.

*Costate to Spissicostate.*17. DUMORTIERIA RHODANICA, *Haug*.

1874. AMMONITES RADIOSUS, *Dumortier* (non *Seebach*), *Depôts Jurassiques*, vol. iv, Pl. xiv, figs. 3, 4 only.

1887. DUMORTIERIA RHODANICA, *Haug*, *POLYMORPH.*, N. Jahrb. f. Mineral, etc., Bd. ii, p. 138.

Remarks.—*Dumortier* figured two specimens under the name of *Am. radiosus*; one he called “compressed variety,” the other “the stout form.” To both of these *Haug* subsequently gave the name *Dumortieria rhodanica*. As *Dumortier* called the latter the commoner form it is advisable to take it as the type.

The combination of stout whorls with numerous costæ brings this form nearest to *D. pseudoradiosa*, but the whorls are thinner and the costæ are more numerous in the present species.

Distinction.—From *D. regularis*, stouter whorls, more numerous smaller costæ, larger umbilicus.

Locality and Stratum.—Gloucestershire: Penn Wood, near Stroud, in the middle part of the Cephalopod Bed, where several examples have been obtained by Mr. C. Upton and myself.

Date of Existence.—*Dumortieria* hemera.

18. DUMORTIERIA RADIANS (*Reinecke*). Plate XLII, figs. 8–10; woodcut, fig. 2, p. 187. Suppl., Plate XXII, figs. 31–33; Fig. 175, p. xcvi.

1891. DUMORTIERIA RADIANS, *This Monogr.*, Pl. xlii, figs. 8–10; p. 248 (pars).

Description.—Sublatumbilicate; subspissiparvicostate; periphery subtabulate, carinate.

Remarks.—The example figured in the present Supplement, Pl. XXII, figs. 31–33, has closer agreement with *Reinecke*’s original delineation than any other specimen. It will form a basis from which to work in understanding this species.

Localities and Strata.—Gloucestershire: Penn Wood, near Stroud, and Cam Down, near Dursley, Cephalopod Bed, *Dumortieria* horizon; Somerset: Maes Knoll (Dundry) (*L. Richardson*), presumably from clays of hill flank.

Date of Existence.—*Dumortieria* hemera.

19. DUMORTIERIA SIGNATA, *S. Buckman*. Plate XLII, figs. 6, 7. Suppl., Fig. 176, p. xcvi.

1891. DUMORTIERIA RADIANS, *This Monogr.*, Pl. xlii, figs. 6, 7 only.

1902. DUMORTIERIA SIGNATA, *Emend. Ann. Nom.*, p. 6.

Description.—Sublatumbilicate; subplaty-subleptogyral; spissiparvicostate; periphery fastigate, subcarinate.

Distinction.—From *Dum. radians*, thinner whorls; more acute, less carinate periphery; finer smaller costæ.

Localities and Strata.—Gloucestershire: Cam Down, near Dursley, Cephalopod Bed, *Dumortieria* horizon. Foreign: France, Le Bernard (Vendée), Lias supérieur (submitted by Mr. Chartron).

Date of Existence.—*Dumortieria* hemera.

Costate to Striate.

The costate stage is sometimes omitted altogether.

20. *DUMORTIERIA DIPHYES*, *S. Buckman*. Plate XLIII, figs. 5, 6 (Type), fig. 7. Plate XLII, figs. 13, 14.

1891. *DUMORTIERIA RADIOSA*, This Monogr., Pl. xlii, figs. 13, 14; Pl. xliii, figs. 5—7.

Description.—Subplatyleptogyral, latumbilicate; costate declining to striate; periphery convexifastigate, parvicarinate.

Distinction.—From *Am. radiosus*, v. Seebach. Mr. E. Mascke, Assistant at Göttingen Museum, who is making a special study of Inferior Oolite Ammonites, has very kindly compared my figures with Seebach's original specimen, which is in that collection. He writes: "The identification of *Dumortieria radiososa* appears to me not to agree, for there is a whole series of differences."¹ He gives a table of comparative measurements which show that Seebach's shell has stouter whorls and a smaller umbilicus.

21. *DUMORTIERIA INCLUSA*, *S. Buckman*. Plate XLV, figs. 13, 14.

1891. *DUMORTIERIA RADIOSA*, var. *GUNDERSHOFENSIS*, This Monogr., p. 254 (pars); 1892, Pl. xlv, figs. 13, 14.

Description.—Platysubleptogyral; subangustumbilicate; spissicostate to striate to spissiparvicostate; periphery subtabulate, carinate.

Distinction.—From *D. radiososa*, var. *gundershofensis*, the umbilicus being costate and not showing the tendency to expand noticeable in Haug's figure.

22. *DUMORTIERIA* sp. Plate XLII, figs. 1, 2.

1891. *DUMORTIERIA RADIANIS*, This Monogr., Pl. xlii, figs. 1, 2.

¹ In litt., August 29th, 1902.

23. DUMORTIERIA PENEXIGUA, *S. Buckman*. Plate XLII, figs. 3—5.

1891. DUMORTIERIA RADIANI, This Monogr., Pl. xlii, figs. 3—5 only.

1902. „ PENEXIGUA, Emend. Ann. Nom., p. 5.

Description.—Subplatysubleptogyral; sublatumbilicate; striate; periphery subtabulate; subcarinate.

Distinction.—From *D. signata*, much finer ornament; slightly stouter whorls, broader, flatter periphery.

24. DUMORTIERIA EXTERNICOMPTA (*Branco*).

1879. HARPOCERAS SUBUNDULATUM, var. EXTERNE COMPTUM, *Branco*, Unt. Dogger, Abh. Geol. Spez. Karte Elsass-Lothringen, Bd. ii, Pl. iii, fig. 5 only.

Remarks.—This species has in the inner whorls rather coarse distant ribs, which change rapidly to fine striæ; these are slightly bunched towards the inner margin. The umbilicus is smaller and the whorl broader than in *D. diphyes*.

Localities and Stratum.—Gloucestershire: Bowcott Wood, Cephalopoda Bed, upper portion (*Moorei* Beds); Buckholt Wood.

Date of Existence.—*Moorei* hemera.

25. DUMORTIERIA SUBFASCIATA, *S. Buckman*. Plate XXX, fig. 18. Suppl., Fig. 177, p. cxevi, and Fig. 178 in text.

1890. DUMORTIERIA RADIOSA, This Monogr., Pl. xxx, fig. 18.

1891. — — var. GUNDERSHOFENSIS, p. 254 (pars).

Description.—Platysubleptogyral, sublatumbilicate, the umbilicus bordered by definite margin; striate, with tendency to more prominent distant striation at about 30 mm. diameter. Periphery convexifastigate, carinate.

Note.—The striæ are irregular along the inner edge of the whorl, as if gathered into small bunches. This character suggests the trivial name.

Distinction.—From *D. gundershofensis*, Haug, thinner, more finely striate, with a less tabulate periphery.

Localities and Stratum.—Gloucestershire: Frocester Hill and Buckholt Wood, in the Cephalopod Bed.

Date of Existence.—*Moorei* hemera.



FIG. 178.—*Dumortieria subfasciata*. Section of whorl.

26. DUMORTIERIA MOOREI (*Lycett*), *Wright*. Plate XLIV, fig. 9. Fig. 179 in text.

1857. AMMONITES MOOREI, *Lycett*, Cotteswold Hills, p. 122, description partly, and dimensions (Pl. i, fig. 2 a¹ †).

1883. HARPOCERAS AALENSE, *Wright* (non *Zieten*), *Lias Amm.* (Pal. Soc.), Pl. lxxx, figs. 1, 2.

Remarks.—The evidence about the type-specimen and *Wright*'s figure is given in p. 255. One piece of evidence about the Jermyn Street example has been overlooked. *Lycett* in the explanation of his plate speaks of his figured example as a "small specimen." This is against the Jermyn Street fossil being the type. But

Lycett's figure looks like an adult specimen, reduced, and *Wright* says: "the large shell which . . . Dr. *Lycett* figured in his handbook" (p. 459).

Under the circumstances it is best to take *Wright*'s figure as representing the type. That agrees so closely with the specimen referred to by *Lycett* as the largest example—of which he gives dimensions (p. 122); it is probably a figure of the same shell, which is most likely the Jermyn Street specimen, and that has always been considered as *Lycett*'s type.

I have given a figure of another example here for two reasons—to illustrate the species better, and to emphasize the remarkable deceptions of homœomorphy. This figure

should be compared with that of *Cotteswoldia bifax*, p. cxxxvi, and the difference in the radial line noted. The two fossils are in the same stage of decline—from costate to striate—and show about the same amount of costate umbilicus; in fact, they are in every way most similar. Such differences as they present might be regarded as individual variation were it not for the differences in radial line, which differences they share with their respective allies.

This is a good example of the trouble in Ammonite identification.

27. DUMORTIERIA SUBEXCENTRICA, *S. Buckman*. Plate XXX, fig. 19, Plate XLIV, figs. 7, 8. Suppl., Fig. 180, p. cxcvi.

cf. 1851. AMMONITES OPALINUS, *Bayle and Coquand* (see p. 255).

1890. DUMORTIERIA MOOREI, This Monogr., Pl. xxx, fig. 19; 1891, Pl. xlv, figs. 7, 8, p. 255 (pars).

1902. — SUBEXCENTRICA, *Emend. Amm. Nom.*, p. 6.

¹ Two pieces of body-chamber, making another half-whorl, belong to this specimen, but *C. bifax* is complete.

Description.—Subexcentrumbilicate; striate (a small costate stage in inner whorls); periphery fastigate, parvicarinate.

Distinction.—From *D. Moorei*, the earlier loss of costæ and the peculiar umbilicus.

Remarks.—This species seems to have great likeness to the Chili fossil figured by Bayle and Coquand; but in face of what is known about homœomorphy it would be hazardous to suggest identity.

28. DUMORTIERIA LINEARIS, *S. Buckman*. Plate XXX, figs. 15—17. Suppl., Fig. 181, p. cxevi.

1890. DUMORTIERIA MOOREI, This Monogr., Pl. xxx, figs. 15—17.

Description.—Subplatyleptogyral, sublumbilicate, with definite inner margin; striate; periphery fastigate, parvicarinate.

Distinction.—From *D. Moorei*, the want of a costate stage; the definite inner margin (Lycet says of his species “inner border of whorls not truncated,” p. 122). From *D. subexcentrica*, the want of costæ in the umbilicus, the more definite periphery and carina.

Localities and Strata.—Dorset: Bradford Abbas, Yeovil Sands, upper part; Chideock Quarry Hill, Bridport Sands—specimens at a fossiliferous horizon 50 feet from top of sands and from where opalinoid Ammonites occur, 110 feet from base of sands, and 180 feet from first appearance of *Dumortieria* in so-called Upper Lias clay.

The strata on Dorset coast (sands and clay) which yield *Dumortieria* are about 200 feet in thickness.

Date of Existence.—*Moorei* hemera.

29. DUMORTIERIA sp. Plate XLIV, figs. 4—6. Suppl., Fig. 182, p. cxevi.

1891. DUMORTIERIA MOOREI, This Monogr., Pl. xlv, figs. 4—6.

Remarks.—This form lacks the costate umbilicus of *D. Moorei*, the excentrumbilicus of *D. subexcentrica*; the definite inner margin of *D. linearis*. It has also a less definite periphery than the typical *D. linearis*, a slightly larger umbilicus, and is thinner.

Widely umbilicate species.

Compare with *D. subsolaris* for the costate ally.

30. DUMORTIERIA LATA, *S. Buckman*. Plate XLIV, figs. 1—3. Suppl. Fig. 183, p. cxevi.

1885. AMMONITES cf. RADIAN, *Quenstedt*, Amm. Schwäb. Jura, Pl. liv, fig. 19.

1891. DUMORTIERIA RADIAN, var. EXIGUA, This Monogr., Pl. xlv, figs. 1—3 only.

Description.—Subplatyleptogyral; latumbilicate; spissiparvicostate; periphery subacutifastigate, parvicarinate.

Distinction.—From *Dum. signata*, the larger umbilicus, as mentioned in p. 252. The costæ are also rather more distant and distinct.

31. DUMORTIERIA EXIGUA, *S. Buckman*. Plate XLIII, figs. 11, 12. Suppl., Fig. 184, p. cxvii.

1891. DUMORTIERIA RADIANS, *var. EXIGUA*, This Monogr., Pl. xliii, figs. 11, 12.

Description.—Subplaty-subleptogyral; latumbilicate; spissiparvicostate to striate; periphery fastigate, parvicarinate.

32. DUMORTIERIA sp. Plate XLIII, figs. 1—4.

1891. DUMORTIERIA RADIANS, This Monogr., Pl. xliii, figs. 1—4.

Remarks.—A young example depicted to show the ontogeny. It has a larger umbilicus than the last species.

SUBFLEXIRADIATE.

In this group the radial line has a slight curve on the lateral area; the umbilicus is large, and considerable compression is attained even while a strongly costate stage is present. These are all factors of distinction from true *Dumortieria*, where the radial line is straight, at least until the striate stage is well advanced, where the umbilicus tends to contract as soon as compression commences, and where such compression does not become pronounced until costal degeneration has nearly attained the striate stage.

The comparative development may be expressed somewhat in this way: In the flexicostate series the *prisca* style of distant ribbing and wide umbilication are found persisting until considerable whorl compression has been reached. So in the reticostate series the *prisca* style of ribbing is associated with circular whorls, in the flexicostate series with compressed elliptical whorls.

The present group admits of division into two series, but only in regard to size:

(1) *Latescens* series, large forms. *Dum. latescens*, *Dum. arenaria*, which is perhaps young of a larger form, and the species called *Dum. subundulata*, *var. striatolocostata* by Haug in 'Polymorphidæ,' N. Jahrbuch f. Mineral., 1887, Bd. II, Pl. V, fig. 4.

(2) *Subundulata* series, all seem to be dwarf forms, *Dum. subundulata* and its allies.

A. *The Latescens series.*

33. DUMORTIERIA LATESCENS, *S. Buckman*. Plate XLIII, figs. 8—10. Suppl., Fig. 185, p. cxcvi.

1890. DUMORTIERIA SUBUNDULATA, *This Monogr.*, Pl. xliii, figs. 8—10.

1902. — LATESCENS, *Emend. Ann. Nom.*, p. 5.

Description.—Subplatyleptogyral; latumbilicate; parvicostate (with an intermediate striate stage) passing to somewhat smooth (with irregular obscure ribs). Periphery subacutifastigate to convex, parci- to obsoletecarinate.

Remarks.—In other specimens the intermediate striate stage is more pronounced.

Localities and Strata.—Somerset: Stoford, shelly beds of Yeovil Sands; North Stoke, near Bath (Cotteswold district) sandy strata in Cephalopod Bed, collected by the late E. Wilson, F.G.S.

Date of Existence.—*Moorei*, or *Dumortieriæ* hemera.

34. DUMORTIERIA ARENARIA, *S. Buckman*. Suppl., Plate XXII, figs. 34—36.

Description.—Subplatyleptogyral; latumbilicate; costate declining to parvicostate and to irregulari-subcostate; periphery acutifastigate, parvicarinate.

Distinction.—From *D. latescens*, coarser, more distant, costæ, sharper periphery.

Locality and Stratum.—Dorset: Bradford Abbas, in the Yeovil Sands.

Date of Existence.—*Moorei* hemera, presumably.

B. *The Subundulata (or dwarf) series.*

35. DUMORTIERIA TABULATA, *S. Buckman*. Suppl., Plate XXII, figs. 25—27.

Description.—Subplatysubleptogyral (almost subpachygyral); latumbilicate; costate; periphery tabulate, parvicarinate.

Locality and Stratum.—Gloucestershire: Penn Wood, Cephalopoda Bed (“*Dumortieria* Beds”), E. Wilson.

36. DUMORTIERIA EXPLANATA, *S. Buckman*. Suppl., Plate XXII, figs. 28—30.

Description.—Subplatysubleptogyral (almost leptogyral); latumbilicate; costate; periphery subtabulate, parvicarinate.

Distinction.—From *D. tabulata*, the thinner whorls, and less tabulate periphery.

Localities and Strata.—Gloucestershire: Penn Wood, Cephalopoda Bed (“*Dumortieria* Beds”); Cam Down, similarly.

Date of Existence.—*Dumortieria hemera*.

37. *DUMORTIERIA SUBUNDULATA* (*Branco*). Plate XLV, figs. 1—3.

1879. *HARPOCERAS SUBUNDULATUM*, *Branco*, Unt. Dogger, Abh. Geol. Spez. Karte Elsass-Lothringen, Bd. ii, Pl. iii, fig. 4 only.

1892. *DUMORTIERIA SUBUNDULATA*, This Monogr., Pl. xlv, figs. 1—3.

Distinction.—From *D. explanata*, the more acute periphery, the more distant ribs.

Localities and Strata.—Gloucestershire: Buckholt Wood, *Moorei* Beds; Bowcott Wood.

38. *DUMORTIERIA RUSTICA*, *S. Buckman*. Plate XLV, figs. 4, 5 (type), figs. 10—12.

1892. *DUMORTIERIA SUBUNDULATA*, This Monogr., Pl. xlv, figs. 4, 5, 10—12.

1902. — *RUSTICA*, Emend. Amm. Nom., p. 5.

Description.—Subplatysubleptogyral, latumbilicate; costate passing to spissiparvicostate; periphery fastigate, subcarinate.

Distinction.—From *D. subundulata*, more numerous and closer set costæ; thinner whorls. From *D. explanata*, decline to parvicostate stage, sharper periphery.

Localities and Strata.—Gloucestershire: Penn Wood, Cam Down, in the Cephalopod Bed.

39. *DUMORTIERIA MUNDA*, *S. Buckman*. Plate XLIV, figs. 10—12.

1891. *DUMORTIERIA SUBUNDULATA*, This Monogr., Pl. xlv, figs. 10—12 only.

1902. — *MUNDA*, Emend. Amm. Nom., p. 5.

Description.—Subplatysubleptogyral, sublumbilicate; subcostate passing to striate; fasciate; periphery fastigate, parvicarinate.

Distinction.—From *Dum. rustica*, the finer ornament, the smaller umbilicus.

40. *DUMORTIERIA BRANCOI*, *S. Buckman*. Plate XLV, figs. 8, 9.

1879. *HARPOCERAS PSEUDORADIOSUM*, *Branco*, Unt. Dogger, Abh. Geol. Spez. Karte Elsass-Lothringen, Bd. ii, Pl. ii, fig. 3 only.

1892. *DUMORTIERIA SUBUNDULATA*, This Monogr., Pl. xlv, figs. 8, 9.

1902. — *BRANCOI*, Emend. Amm. Nom., p. 5.

Description.—Subplatysubleptogyral, latumbilicate; spissiparvicostate; periphery fastigate, parvicarinate.

Distinction.—From *Dum. munda*, the costation, the larger umbilicus.

Localities and Strata.—Gloucestershire: Frocester Hill, Cephalopod Bed; Dorset: Chideock Hill, Bridport Sands with *D. linearis*.

41. DUMORTIERIA EXACTA, *S. Buckman*. Plate XLV, figs. 6, 7.

1892. DUMORTIERIA SUBUNDULATA, This Monogr., Pl. xlv, figs. 6, 7.

1902. — EXACTA, Emend. Ann. Nom., p. 5.

Description. — Subplatyleptogyral; latumbilicate; subspissi-subparvicostate; periphery subacutifastigate, subcarinate.

Distinction.—From *D. Brancoi*, more definite costation, thinner whorls, more acute periphery.

Localities and Strata.—Gloucestershire: Buckholt Wood, Cam Down, Penn Wood, Cephalopod Bed, upper part (“*Moorei* Beds”).

IV. Genus—FONTANNESIA¹, *S. Buckman*.

(Type: *Dumortieria grammoceroïdes*, Haug.).

1891. DUMORTIERIA, pars, This Monogr., p. 231.

1902. FONTANNESIA, Emend. Ann. Nom., p. 6.

Definition.—Subplatysubleptogyral; latumbilicate; subdensiseptate; sublongi-angusti-ornati-lobate; laterally subflexiradiate; peripherally latanguliradiate; convex, parvicarinate. (Radial line, fig. 186, p. cxcvi.)

Notes.—Such are the characters of the typical series, modifiable according to the degree of development. But there are other series which do not quite conform, even allowing for developmental variation. Thus a periphery convex and carinate is found, and a costation varying from subflexirursiradiate to subrectiversiradiate is shown.

Distinction.—From *Dumortieria*, the more ornate suture-line, and the longer peripheral projection of the radial line. The costae lack that annular appearance so noticeable in *Dumortieria*.

Remarks.—The species of this genus are interesting for the likeness in certain cases to species of *Sonninia*,² from which, however, they are separable by the suture-line with dependent inner portion. This suture-line is of the type of that

¹ In honour of F. Fontannes, collaborator with E. Dumortier.

² See p. 339, and footnote ¹, p. 340.

found in the family Polymorphidæ, but is more ornate than in other genera, except *Uptonia*. It has a certain likeness to that of *Hammatoceras*, and curiously enough certain species of this genus have some outward resemblance to certain, as yet undescribed, species of that genus which occur in the same bed: the species of *Fontannesia* may, however, be distinguished by lacking the pronounced carina, which is also a septicarina, of the species of *Hammatoceras*.

No foreign locality, so far as I am aware, has yielded any species of this genus. Hitherto nearly all the specimens have come from a small area within about two miles' radius of Bradford Abbas, Dorset; only one or two have come from places a little more distant. Much interest therefore belongs to a specimen of this genus found by Mr. J. W. Tutchter so far away as Dundry, Somerset, which is not only more than 30 miles from Bradford Abbas, but is separated therefrom by the Mendip axis.

The earliest species to be named was called *Harpoceras Boweri*; the next was designated *Dumortieria grammoceroïdes*, named by Dr. Haug from a British example of which he has very kindly sent me a plaster cast. Before this, species of the genus had long been known by the name *Am. Levesquei*.

Typical series.

1. FONTANNESIA EXPLANATA, *S. Buckman*. Plate XLVI, figs. 6, 7. Suppl., Fig. 187, p. cxcvi.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvi, figs. 6, 7.

1902. FONTANNESIA EXPLANATA, Emend. Amm. Nom., p. 6 (xlvii misprint).

Description.—Subplatysubleptogyral, latumbilicate; subpaucicostate; periphery fastigate, subcarinate.

Localities and Stratum.—Dorset: Bradford Abbas, Fossil Bed; Louse Hill, near Halfway House.

Date of Existence.—*Discitæ* hemera.

2. FONTANNESIA GRAMMOCEROIDES (*Haug*). Plate XLVI, figs. 1—3. Plate XLVII, figs. 15—17; Suppl., Fig. 186, p. cxcvi.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvi, figs. 1—3; Pl. xlvi, figs. 15—17, p. 262.

1902. FONTANNESIA — Emend. Amm. Nom., p. 6.

Distinction.—From *Font. explanata*, the broader, flatter periphery, also the somewhat smaller umbilicus and the rather stouter whorls.

3. FONTANNESIA LUCULENTA, *S. Buckman*. Plate XLVI, figs. 4, 5 (type), fig. 8.
Plate XLVII, figs. 10—12.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvi, figs. 4, 5, 8; Pl. xlvii, figs. 10—12.

1902. FONTANNESIA LUCULENTA, Emend. Ann. Nom., p. 6.

Description.—Sublatumbilicate; subspissi-subparvicostate; periphery subfastigate, subcarinate.

Distinction.—From *Font. grammoceroides*, the somewhat smaller umbilicus, the smaller, more closely set, costæ.

4. FONTANNESIA OBRUTA, *S. Buckman*. Suppl., Plate XXIV, figs. 8—11.

1892. DUMORTIERIA SP., This Monogr., p. 340, footnote.

Description.—Sublatumbilicate, parvi- to obsolete-costate; periphery subfastigate, parvicarinate.

Distinction.—From *Font. luculenta*, the more degenerate style of costation.

Locality and Stratum.—Dorset: Bradford Abbas, in the Fossil Bed.

Date of Existence.—*Discitæ* hemera, presumably (by matrix).

Carinate series.

5. FONTANNESIA CARINATA, *S. Buckman*. Plate XLVII, figs. 13, 14.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvii, figs. 13, 14.

1902. FONTANNESIA CARINATA, Emend. Ann. Nom., p. 6.

Description.—Rursi- and subcrassicostate; periphery rounded to subfastigate, subcarinate to carinate.

Remarks.—In the inner whorls of the specimen depicted in Plate XLVII, fig. 13, the ribs are not shown coarse enough.

Localities and Strata.—Dorset: Bradford Abbas, Fossil Bed; Halfway House, from equivalent bed.

Date of Existence.—*Discitæ* hemera, presumably.

Dwarf series.

- A. Rursicostate (with lateral auricles).

a. *Flexicostate.*

6. FONTANNESIA CURVATA, *S. Buckman*. Plate XLVII, figs. 1, 2 (type), figs. 3, 4, 5.
Plate LXV, Figs. 6, 7.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvii, figs. 1—5; Pl. lxxv, figs. 6, 7.

1902. FONTANNESIA CURVATA, Emend. Ann. Nom., p. 6.

Description.—Latumbilicate, flexi-rursi-costate: periphery rounded, practically non-carinate.

Remarks.—The figured specimens show lateral (mouth-border) lappets, or signs thereof, at 16, 32, 36 mm. diameter. Other examples show them at 28 mm. (two) and at 32 mm.

Localities and Stratum.—Dorset: Bradford Abbas, Fossil Bed; Somerset: Stoford. A not uncommon species.

Date of Existence.—*Discitæ* hemera.

b. Subflexicostate.

7. FONTANNESIA BOWERI (*J. Buckman*). Suppl., Plate XXIV, figs. 1—4 (type refigured).

- AMMONITES BOWERI. *J. Buckman*, MS.
 1883. HARPOCERAS BOWERI, *S. Buckman*, New Spp. Amm.; Proc. Dorset Club, vol. iv, p. 145, woodcut.
 1889. SONNINIA BOWERI (pars), This Monogr., p. 119.
 1902. FONTANNESIA BOWERI, Emend. Amm. Nom., p. 6.

Remarks.—This is a most noteworthy species. The type form was at one time thought to be the same as *Sonninia Zurcheri* (Douvillé), which, however, it precedes by two years; and so the name *Sonninia Boweri* was used. But it is not a *Sonninia*; the suture-line, which can be seen obscurely through the test, has a dependent inner portion. Also *Boweri* differs from *Zurcheri* in not having such flexed costæ, nor the sulci beside the carina, nor so distinct a carina.

The name was suggested by my father in honour of his friend the Rev. — Bower, of Closeworth, Somerset, a geologist.

Distinction.—From *F. luculenta*; a smaller umbilicus and less distinct costæ.

Locality and Stratum.—Dorset: Bradford Abbas, Fossil Bed.

Date of Existence.—*Discitæ* hemera.

c. Subrecticostate.

8. FONTANNESIA AURITA, *S. Buckman*. Suppl., Plate XXIV, fig. 7.

Description.—Sublatumbilicate; crassicostate; periphery rounded, parvicarinate, with area each side of carina slightly depressed.

Distinction.—From *F. Boweri*, more costate, more umbilicate, and thinner.

Locality and Stratum.—Dorset: Halfway House (Compton), near Sherborne, presumably from bed equivalent to the Bradford-Abbas Fossil Bed.

Date of Existence.—*Concavi* or *Discitæ* hemera, presumably.

9. FONTANNESIA CONCENTRICA, *S. Buckman*. Suppl., Plate XXIV, figs. 5, 6.

Description.—Subplatysubleptogyral; sublatumbilicate, concentrumbilicate; costate, periphery convex, parvicarinate.

Distinction.—From *F. awrita*, less strongly costate, and barely carinate.

Locality and Stratum.—Dorset: Louse Hill, near Halfway House (Compton), presumably from strata equivalent to Bradford-Abbas Fossil Bed.

Date of Existence.—*Concavi* or *Discitæ* hemera, presumably.

B. Versi- or prorsicostate (without lateral auricles, so far as evidence shows).

10. FONTANNESIA TORTIVA, *S. Buckman*. Plate XLVII, figs. 8, 9.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvii, figs. 8, 9.

1902. FONTANNESIA TORTIVA, Emend. Ann. N.ºm., p. 6 (figs. 6, 7 misprint).

Description.—Latumbilicate; subrectisubversi- (to subprorsi-) costate; periphery convex, parvicarinate.

Locality and Stratum.—Dorset: Bradford Abbas, upper part of Fossil Bed.

Date of Existence.—*Discitæ* hemera.

11. FONTANNESIA DESPECTA, *S. Buckman*. Plate XLVII, figs. 6, 7.

1892. DUMORTIERIA GRAMMOCEROIDES, This Monogr., Pl. xlvii, figs. 6, 7.

Description.—Subplatysubleptogyral; latumbilicate; subrecti- prorsi- parvicostate; periphery subtabulate, parvicarinate.

Distinction.—From *D. tortiva*, the more numerous, smaller costæ.

Remarks.—A common form at Bradford Abbas, but it seems always to be small. The largest of 16 specimens is 37 mm. in diameter.

Localities and Strata.—Dorset: Bradford Abbas, upper part of Fossil Bed; Somerset: Dundry (Mr. J. W. Tutchet), presumably from below the White Iron-shot.

Date of Existence.—*Discitæ* hemera.

NOTE.—Since the above articles were written, a specimen of this genus has been found in the Lower *Trigonia*-Grit (*discitæ* η) of the Cheltenham district. I have recorded it as *F. cf. tortiva* in 'Handbook Geol. Cheltenham,' by L. Richardson, 1904, p. 230.

III. REVISION OF, AND ADDITIONS TO, VARIOUS FAMILIES.

Family—AMALTHEIDÆ.

Sub-family—SONNININÆ.

Genus—ZURCHERIA, *Douvillé*.

ZURCHERIA PUGNAX (*Vacek*). *Suppl.*, Fig. 188 in text.

1892. ZURCHERIA PUGNAX, *This Monogr.*, p. 298.

1895. — PUGNAX, *Brasil*, *Ceph. Nouv.*; *Bull. Soc. Géol. Normandie*,
vol. xvi, Pl. ii, figs. 4, 5.

1902. — PUGNAX, *S. Buckm.*, *Emend. Amm. Nom.*, p. 7.

This was noticed as a foreign species at p. 298. It can now be recorded as British. A specimen in beautiful preservation, 53 mm. in diameter, was obtained by me from the workmen at Stoke Knap, Dorset, some years ago. It came evidently from the Building Stone, and by its matrix perhaps from the lower part ; that would make its date *Bradfordensis* hemera ; but it may be later.

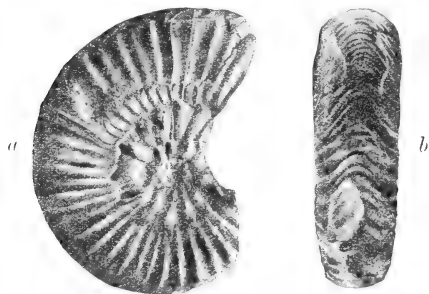


FIG. 188.—*Zurcheria pugnax*.

This example is a whorl larger than *Vacek's*, and shows on this whorl decline of the bispinous stage—in fact, the ornament on this whorl is just that of *Haplopleuroceras*. The periphery, however, is quite convex, shows no carina nor furrows ; but the small costæ pass over this periphery, making linguiform figures.

This specimen is most interesting in its bearing on my remarks as to the genealogy of *Haplopleuroceras*, p. 299. My thanks are due to Mr. J. W. Tutchter for the two photographs.

Genus—DORSETENSIA, *S. Buckman*.

DORSETENSIA LENNIERI, *Brasil*. Plate LII, figs. 1—3.

1892. DORSETENSIA SP., *This Monogr.*, Pl. lii, figs. 1—3, p. 304.

1895. — LENNIERI, *Brasil*, *Ceph. Nouv.*, *Bull. Soc. Géol. Normandie*,
vol. xvi, Pl. iii, figs. 10, 11, p. 10.

Found in Normandy by Mr. L. Brasil.

Genus—PÆCILOMORPHUS, *S. Buckman*.

This genus should be removed from the family Hildoceratidæ, and placed with the Sonnininæ. See the excellent remarks hereon by E. Haug, *Amm. Et. Moyens*, Bull. Soc. Géol. France, 3rd série, t. xx, p. 297, 1893.

Genus—SONNINIA, *Bayle*.

Dwarf *Sonniniæ*, series allied to the genus *Pæcilomorphus*.

SONNINIA SULCATA (*S. Buckman*). Plate XXII, figs. 32, 33; Plate XXIII, fig. 1.

1889. LILLIA SULCATA, This Monogr., Pl. xxii, figs. 32, 33, Pl. xxiii, fig. 1, p. 109.

1893. SONNINIA SULCATA, *Haug*, *Amm.*, Bull. Soc. Géol. France, ser. 3, vol. xx, p. 290.

Dr. Haug's correction is justified—the species certainly belongs to the Sonnininæ.

SONNINIA, aff. BUCKMANI, *Haug*. Plate XXIII, figs. 7, 8; Plate XXII, fig. 34, p. 107, 1889.

This species is closely allied to *Sonninia Buckmani*, *Haug*, *Amm. Et. Moy.*, Bull. Soc. Géol. France, sér. 3, vol. xx, Pl. IX, fig. 4, 1893.

SONNINIA DUNDRIENSIS, *S. Buckman*. Plate XXIII, figs. 5, 6.

1889. SONNINIA SP., This Monogr., Pl. xxiii, figs. 5, 6.

Description.—A compressed form with small but excentrically coiled umbilicus. Costæ falcate and connate, not much projected peripherally. Periphery with a small carina bordered by slight furrows.

Locality and Stratum.—Somerset: Dundry, Ironshot Oolite.

Date of Existence.—*Sauzei* hemera.

Note.—The three species just mentioned illustrate two series of dwarf Sonnininæ, whereof there are many undescribed forms. *Sonn. sulcata* and *Sonn. aff. Buckmani* belong to the stout-whorled series; while *Sonn. dundriensis* shows what are the characters of the compressed forms.

Genus—WITCHELLIA, *S. Buckman*.

WITCHELLIA sp. Plate XXIII, figs. 2—4.

1889. LUDWIGIA SP., This Monogr., Pl. xxiii, figs. 2—4, p. 107.

The present is most likely the more correct position—at any rate, it belongs to the Sonniniæ. Since it was described I have been able to work certain disused quarries around Sherborne, and I can therefore judge that the horizon of this species is probably *Witchellia* beds, certainly not *Murchisonæ* or *Concavus* beds. See Baj. Sherborne Dist., Quart. Journ. Geol. Soc, vol. xlix, p. 480.

Family—OPPELIDÆ.

Genus—ŒCOTRAUSTES, *Waagen*.

(Type: *Œcotraustes genicularis*, *Waagen*.)

1869. ŒCOTRAUSTES, *Waagen*, Formenreihe Am. subradiatus; Geol. Pal. Beiträge, Bd. ii, Heft ii, p. 251. Spelt "*Oecotraustes*" in explanation of Plates.

ŒCOTRAUSTES, AUCT.

That the Hectici were related to *Ludwigia* was the opinion of several palæontologists. The species called *Œcotraustes* were figured in Plates XX, XXI as being related to the Hectici, which is perhaps correct, and hence to *Ludwigia*. But before they were described the *Ludwigia* connexion was seen to be untenable; these species belonged to the Oppelidæ, though the idea that the Hectici were related to *Ludwigia* was still clung to. Bonarelli, however, considers that the Hectici belong to the Oppelidæ, and that seems to be most likely.

As the specimens of *Œcotraustes* that happened to be figured have not been described in the body of the work, it is advisable to consider them here.

ŒCOTRAUSTES RUGOSUS, *S. Buckman*. Plate XXI, figs. 1, 2. Suppl., Fig. 189, p. cxcvi.

1889. ŒCOTRAUSTES RUGOSUS, This Monogr., Pl. xxi, figs. 1, 2.

Description.—Subplatysubleptogyral; subangustumbilicate; costate; periphery subconvex, parvicarinate.

Note.—Plain costate stage until 29 mm. diameter, then begins a stage with nodate-ended costæ.

Locality and Stratum.—Somerset: East Coker, from the upper beds.

Date of Existence.—Probably hemera *Truelli*.

ŒCOTRAUSTES COSTIGER, *S. Buckman*. Plate XX, figs. 15—17. Suppl., Fig. 190, p. cxcvi.

1889. ŒCOTRAUSTES CONJUNGENS, This Monogr., Pl. xx, figs. 15—17.

Description.—Platysubleptogyral; excentrumbilicate; parvicostate, costæ quite

feeble on inner area; periphery subfastigate to convex, carina small to nearly obsolete.

Note.—The plain costate stage until 33 mm. diameter; stage with nodate-ended costæ to 39 mm. diameter; then relapse to plain costate stage.

There are three stages in last whorl:

(1) Costate, with nearly straight radial line.

(2) Nodate, costæ ending in blunt knobs near carina; radial line much curved.

(3) Post-nodate, the knobs have gone, the costæ are declining.

Stages 1, 2 are carinate; in stage 3 the periphery is rounded, the whorl swollen, the inner margin receding from centre.

Distinction.—From *Oec. rugosus*, the smaller costæ, the umbilicus, and the general proportions.

Locality and Stratum.—Dorset: Bradford Abbas, from the White Beds.

Date of Existence.—Probably *hemera fuscæ*.

ŒCOTRAUSTES NODIFER, *S. Buckman*. Plate XX, figs. 13, 14. Suppl., Fig. 191, p. cxcvi.

1889. ŒCOTRAUSTES CONJUNGENS, *This Monogr.*, Pl. xx, figs. 13, 14.

And compare

1869. ŒCOTRAUSTES CONJUNGENS, *Waagen* (non *Mayer*), *Formenreihe Am. subradiatus*, *Geol. Pal. Beiträge*, Ed. ii, Heft ii, Pl. xx, fig. 5.

Description.—Platygyral; excentrumbilicate; semicostate, the inner area nearly smooth; nodi when developed, strong; periphery subfastigate, parvicarinate.

Note.—Plain costate stage to 27 mm. diameter; then follows the stage with costæ ending in nodi.

Distinction.—From *Am. conjungens*, *Mayer*,¹ smaller umbilicus, more distinct ornament, more definite carina. From *Oec. costiger*, the smooth inner area, the greater excentricity of umbilicus, the more definite carina and nodi on the periphery.

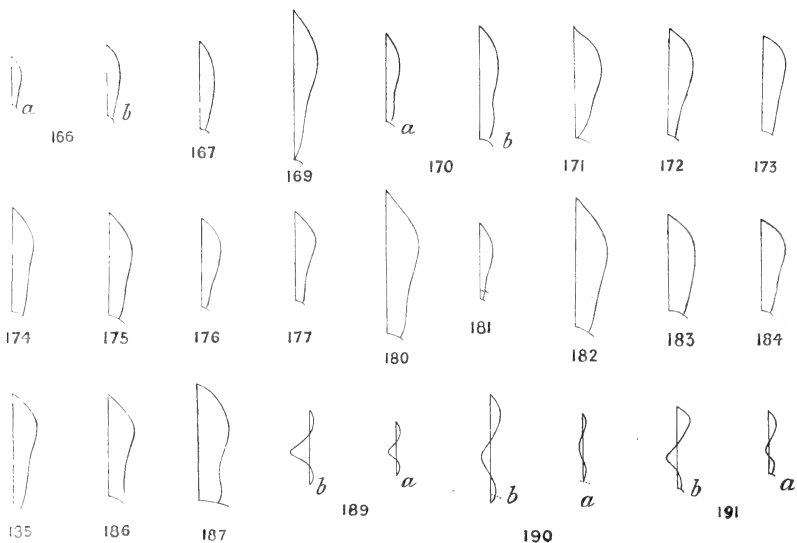
Localities and Strata.—Dorset: Bradford Abbas, from the White Beds; Burton Bradstock, from the Upper Beds.

Date of Existence.—Probably *hemera fuscæ*.

¹ 'Journ. Conchyliologie,' vol. xiii, Pl. viii, fig. 6, p. 322, 1865.

SUPPLEMENT, TABLE IV.

Radial lines.—POLYMORPHIDÆ, OPPELIDÆ.



- Fig. 166.—*Dumortieria costula*, p. clxxv. (a, from specimen figured in Pl. XXXVII, figs. 12, 13; b, from that in Pl. XXXVII, figs. 18, 19.)
 Fig. 167.—*Dumortieria munieri*, p. clxxv. (From specimen in Pl. XXXVII, figs. 14, 15.)
 Fig. 169.—*Dumortieria externicostata*, p. clxxvii. (From specimen in Pl. XL, figs. 1, 2.)
 Fig. 170.—*Dumortieria mutans*, p. clxxvii. (From specimen in Pl. XL, figs. 3—9.)
 Fig. 171.—*Dumortieria declinans*, p. clxxvii. (From specimen depicted in Pl. XL, figs. 10—12, at two stages: a, subcostate; b, degenerate subcostate.)
 Fig. 172.—*Dumortieria yeovilensis*, p. clxxviii. (From example in Pl. XXXVII, figs. 16, 17.)
 Fig. 173.—*Dumortieria metita*, p. clxxviii. (From specimen shown in Pl. XLII, figs. 11, 12.)
 Fig. 174.—*Dumortieria regularis*, p. clxxviii. (From example in Pl. XLI, figs. 4—6.)
 Fig. 175.—*Dumortieria radians*, p. clxxix. (From example in Pl. XLII, figs. 8—10.)
 Fig. 176.—*Dumortieria signata*, p. clxxix. (From specimen in Pl. XLII, figs. 6, 7.)
 Fig. 177.—*Dumortieria subfasciata*, p. clxxxi. (From specimen depicted in Pl. XXX, fig. 18.)
 Fig. 180.—*Dumortieria subexcentrica*, p. clxxxii. (From example figured in Pl. XXX, fig. 19, and Pl. XLIV, figs. 7, 8.)
 Fig. 181.—*Dumortieria linearis*, p. clxxxiii. (From specimen shown in Pl. XXX, figs. 15—17.)
 Fig. 182.—*Dumortieria*, sp., p. clxxxiii. (From specimen figured in Pl. XLIV, figs. 5, 6.)
 Fig. 183.—*Dumortieria lata*, p. clxxxiii. (From example drawn in Pl. XLIV, figs. 1—3.)
 Fig. 184.—*Dumortieria exigua*, p. clxxxiv. (From specimen in Pl. XLIII, figs. 11, 12.)
 Fig. 185.—*Dumortieria latescens*, p. clxxxv. (From specimen in Pl. XLIII, figs. 8—10.)
 Fig. 186.—*Fontannesia graminoceroidea*, p. clxxxviii. (From a plaster cast of Dr. E. Haug's holotype.)
 Fig. 187.—*Fontannesia explanata*, p. clxxxviii. (From the specimen in Pl. XLVI, figs. 6, 7.)
 Fig. 189.—*Æcolraustes rugosus*, p. cxcv. (From example depicted in Pl. XXI, figs. 1, 2; a, costate stage; b, middle of nodate stage.)
 Fig. 190.—*Æcolraustes costiger*, p. cxcv. (From specimen in Pl. XX, figs. 15—17; a, costate stage; b, end of nodate stage.)
 Fig. 191.—*Æcolraustes nodifer*, p. cxcv. (From example in Pl. XX, figs. 13, 14; a, costate stage; b, end of nodate stage.)

IV. CONCERNING TECHNICAL TERMS.

In order to secure, so far as possible, a uniform value for the terms descriptive of the dimensions of whorl and umbilicus, it has been found advisable to use some definite standard of proportion. Such a standard is furnished by the radius—the length from the centre to the periphery. This being taken as 100, the percentage of other dimensions may be approximately stated as follows :

| | | | |
|-------------------|--|-------------------|---|
| To 17 per cent. | $\left\{ \begin{array}{l} \text{Perstenogyral,} \\ \text{Perleptogyral,} \\ \text{Perangustumbilicate.} \end{array} \right.$ | From 50 per cent. | $\left\{ \begin{array}{l} \text{Subplatygyral,} \\ \text{Subpachygyral,} \\ \text{Sublatumbilicate.} \end{array} \right.$ |
| | | to 66 per cent. | |
| From 17 per cent. | $\left\{ \begin{array}{l} \text{Stenogyral,} \\ \text{Leptogyral,} \\ \text{Angustumbilicate.} \end{array} \right.$ | From 66 per cent. | $\left\{ \begin{array}{l} \text{Platygyral,} \\ \text{Pachygyral,} \\ \text{Latumbilicate.} \end{array} \right.$ |
| to 34 per cent. | | to 83 per cent. | |
| From 34 per cent. | $\left\{ \begin{array}{l} \text{Substenogyral,} \\ \text{Subleptogyral,} \\ \text{Subangustumbilicate.} \end{array} \right.$ | From 83 per cent. | $\left\{ \begin{array}{l} \text{Perplatygyral,} \\ \text{Perpachygyral,} \\ \text{Perlatumbilicate.} \end{array} \right.$ |
| to 50 per cent. | | to 100 per cent. | |

When the dimensions exceed 100 per cent. they may be denoted by affixing the word *extreme*-. Thus certain species might be *extremipachygyral*, or *extremilatumbilicate*, with further modification, when necessary, by *per*- and *sub*-.

There is a certain arbitrariness about the whole method, as when only a slight difference each side of a dividing line gives a different designation, while more difference, if falling at beginning and end of a division, does not give a different term, although it would be desirable in specific distinction. When a dimension falls on the dividing line, it seems advisable to take the lower denomination as the term. Proportional triangles, such as those given by P. Reynès in the frontispiece of his *Monograph*, are suitable for taking the measurements.

The descriptions from page lxxv onwards have been checked in accordance with this more exact scheme.

V. GENERIC CLASSIFICATION.

The following is a classification of the genera which have been described. They have been arranged in such order in their respective groups that, so far as possible, the sequence shall be from the least to the most modified form; and the sequence of the groups themselves is on the same basis.

Super-family—AMMONITACEA.

Family—ARIETIDÆ. *Hudlestonia*.

Family—HILDOCERATIDÆ.

Sub-family—HILDOCERATINÆ. *Hildoceras*, *Pseudohildoceras*, *Canavarella*, *Vacekia*,
Polyplectus.

Sub-family—GRAMMOCERATINÆ. *Grammoceras*, *Cotteswoldia*, *Pleydellia*, *Canavarina*,
Walkeria, *Phlyseogrammoceras*, *Pseudogrammo-*
ceras, *Asthenoceras*.

Sub-family—HAUGINÆ. *Chartronia*, *Lillia*, *Deuckmannia*, *Haugia*, *Phymatoceras*,
Bradoceras.

Sub-family—GRAPHOCERATINÆ. *Graphoceras*, *Pseudographoceras*, *Platygraphoceras*,
Braunsina, *Crickia*, *Rhæboceras*, *Ludwigella*,
Ludwigia, *Kiliania*, *Wiltshireia*, *Apedogyria*,
Ludwigina.

Sub-family—LUCYINÆ. *Lucya*, *Paquieria*, *Paineia*, *Cylicoceras*, *Depaoceras*, *Lioceras*,
Cyphohoceras, *Ancolhoceras*.

Sub-family—HYATTEINÆ.¹ *Strophogyria*, *Hyattina*, *Hyattia*, *Cosmogogyria*, *Welschia*,
Geyeria, *Manselia*, *Brasilina*, *Brasilia*.

Sub-family—DARELLEINÆ. *Braunsella*, *Reynesia*, *Darellina*, *Darellella*, *Reynesella*,
Edania, *Hugia*, *Lopadoceras*, *Darellia*, *Stokeia*,
Disseroceras, *Deltotoceras*, *Deltoidoceras*, *Tozohoceras*,
Hyperhoceras.

Family—AMALTHEIDÆ.

Sub-family—SONNININÆ. *Zurcheria*, *Hyplopleuroceras*, *Pæcilomorphus*, *Dorsetensia*,
Sonninia.

Family—POLYMORPHIDÆ. *Polymorphites*, *Tmetoceras*, *Catullocceras*, *Fontannesia*, *Dumortieria*.

VI. AMMONITE DEVELOPMENT.

For the better understanding of the revised system of Ammonite grouping now adopted, and in accordance with which this work has been revised, it may be desirable to recapitulate briefly certain phenomena of Ammonite development. Some reference has been made to them in various places in the body of the work

¹ Spelt thus not to conflict with *Hyattina*.

(pp. 133, 288); they have been fully stated by Hyatt in his 'Genesis of the Arietidæ,' while similar phenomena of development have been proved for Cephalopoda generally by A. Hyatt, for various Ammonites by J. P. Smith, for Pelecypoda by R. T. Jackson, for Brachiopoda by Beecher, by Schuchert, by Cumings and others, and in both zoological and botanical series generally by Jackson. In fact, they are the phenomena of bioplastology.

Such phenomena of development show a certain sequence—stages of elaboration (anagenesis) are followed by stages of simplification (catagenesis); and this applies not only to the ontogeny of the individual and the phylogeny of the race, but also to the ontogeny and phylogeny of the particular features or characters which distinguish one species, one genus, one race, from another. Variation in the characters themselves along their lines of progression or degeneration is a specific, but not a generic, distinction; variation in the relative development of characters is generic, so that in such associations as A, b, c; a, B, c; a, b, C, indicating the characters of three species, the generic distinctions are the relative development expressed as A to a, b to B, c to C respectively.

Working on such lines as these in regard to Ammonites, Hyatt made for the Arietidæ some six genera, which with better knowledge would be increased perhaps to 8 or 9; but in the Hildoceratidæ continued development has produced so much complication, that, by work on similar lines, the number of genera must be increased enormously. The fauna has, however, increased far more than proportionately in richness; in Ammonites, the numerical acme and what may be called the acme of pœcilomorphy—variety of form—is reached in the period called Inferior Oolite, so that the multitude of individuals and their great diversity of characters make the task of classification a matter of extreme complexity.

In Ammonites it may be seen that there are five characters to deal with; they may be stated as follows:

- (1) Whorl-shape.
- (2) Umbilication.
- (3) Suture-line.
- (4) Test ornament—transverse and longitudinal.
- (5) Radial curve, in which rostration plays so important a part.

Each of these characters has its definite ontogenetic and phylogenetic history. To each there is a stage of anagenesis and a stage of catagenesis, and between them an acme, or period of prime development. But the acmes of the various characters are by no means coincident; and it is this diversity of incidence which produces diversity of form. With five characters, to each of which may be given, say, five stages of anagenesis and five of catagenesis, the possible number of different combinations that may be produced thereby is almost innumerable.

Any approximate coincidence of the majority of acmes of characters does not

coincide with or produce the acme of a genetic series. For another factor comes in here—individual bulk. The period of attainment of the largest individual growth by a particular species of a genetic line must be regarded as the genetic acme; and although there is a certain relation between the acme of ornament-elaboration and the acme of bulk-development, yet they do not coincide. Rather the acme of ornament is reached before the acme of bulk—sometimes shortly, sometimes at a longer period, before—as if a certain economy in reduction of ornament were necessary and favourable to the attainment of greatest individual growth.

To take examples: *Vermiceras Conybearii* compared to *Coroniceras*, *Stepheoceras* compared to *Caloceras Blagdeni*, *Sonninia dominans* compared to *S. crassispinata*, are all cases where the acme of size comes shortly after the acme of ornament. In *Parkinsonia dorsetensis* (Wright), the giant of the Inferior Oolite, the acme of size is long after the acme of ornament—for that must be reckoned as *Caloceras-Blagdeni*-equivalent in this series—a stage from which *Park. dorsetensis* has travelled far: it only shows the morphic representation thereof in its brephic whorls. In the *Lytoceras*, too, the growth-acme is long after the ornament-acme; for *Lytoceras fimbriatum* is about in the acme of ornament in this series; but it is a small species beside such giants as *Lytoc. sigaloei*, *L. Wrighti*, *L. confusum*, which have left the ornament-acme so far behind that they only show, at a very youthful period, traces of a stage somewhat analogous to that of *L. fimbriatum*.

To consider the various characters and their morphogeny: In whorl-shape, inflation is anagenetic, and contraction is catagenetic. In suture-line, the greater elaboration and complication is anagenetic, the simplification is catagenetic. When suture-lines do not increase their complexity more than in proportion to the whorl-increase, but become more approximate—the individual becoming more densesept and less latisept—that must be regarded as a beginning of catagenesis.

In test-ornament, elaboration is anagenetic, and simplification is catagenetic. The transverse ornament may show the following successive stages of morphogeny: in anagenesis, striation, subcostation, costation, unituberculation, bituberculation, multituberculation; and, in catagenesis, the same stages in reverse order till all ornament is again lost, and smoothness is returned to. Or, after a period of decline, renewed elaboration may take place; thus a species which shows in its ontogeny catagenesis from tuberculate to subcostate may elaborate afresh anagenetic stages from subcostate to tuberculate: *Sonninia renovata* is a notable example.

Perhaps it would be correct to regard the tuberculate stage as due to the development of longitudinal ornament across the costate transverse ornament, so breaking up the costæ into a row of tubercles in the line of intersection, which often is an angular portion of the whorl area.

Longitudinal ornament is most frequently developed on the periphery where

transverse ornament is weak; then it shows normal development in the following stages somewhat analogous to those of transverse ornament: a slight line (periphery angulate), a rib (periphery carinate), ribs and furrows (periphery carinatisulcate), and when the transverse ornament becomes stronger, knotted ribs and furrows (*Paltopleuroceras*). If, however, the area be already costate, the development of longitudinal ornament produces tuberculation directly. This would make tuberculate peripheries analogous to tuberculate lateral areas—both produced by similar development, either transverse costation of a longitudinal rib, or longitudinal costation of a transverse fold—depending on whether the transverse or the longitudinal ornament has progressed the most before the other begins, in regard to any given area.

Examples of longitudinal ornament in its simple form on the lateral area are the longitudinal striæ in *Amaltheus*, *Strigoceras*, etc., and longitudinal costæ in *Strigoceras trifurcatum* and *Str. Truelli*; these developments take place when the transverse ornament is in advanced catagenesis.

In regard to the radial curve, one of the principal features is the degree of rostration—the greater projection thereof must be regarded as anagenetic and reduction as catagenetic. This rostration is the outward projection of the median portion of the periphery—a part which in *Nautilus* is curved inwards. In *Ammonites* the variation is from no projection at all (*Graphoceras*) to a very long forward projection (*Amaltheus*, *Harpoceras*, *Schloenbachia*). In a general way the greater projection is connected with greater development of the keel on the periphery; but this rule only holds good when allied genera are considered by themselves. There may be considerable development without any keel (*Zurcheria*); when a keel appears the development attained then becomes still more pronounced.

The projection of the rostrum is often associated with general catagenesis; and not until catagenesis is in a very advanced stage is reduction of the rostrum usually found. Then it accompanies another extreme catagenetic feature—excentrumbilication; *Ludwigia ambigua* is a good instance.

Lastly, with regard to umbilication it is difficult to say what is anagenetic and what catagenetic. It may be recognised that there are alternate stages of coiling in and coiling out. The former must, perhaps, be considered as anagenetic, though it usually occurs when the series is in general catagenetic—the character anagenetic when the series is catagenetic—which may be called morphoanagenesis in phylocatagenesis. This is very marked in regard to umbilication.

From *Orthoceras* through *Gyroceras* to *Nautilus clausus* are the various degrees of incoiling—a cone coiling more and more on itself until no umbilicus is left. The *Nautilus* style of coiling appears in *Cymbites*—a very simple Ammonoid; but from *Cymbites* to *Coroniceras* at its acme, or to *Echioceras* the process is reversed—coiling in passes to coiling out; the umbilicus constantly enlarges. In catagenetic series of Arietidæ, Hildoceratidæ, etc., coiling out changes to coiling in—the

umbilicus decreases; but sooner or later in catagenesis, depending on the series, the process changes—coiling in gives place to coiling out. When the change supervenes late, after considerable incoiling has produced angustumbilication, then the coiling out is often rapid—it produces the phenomenon which I have called excentrumbilication—*Hyperlioceras rudiliscites*, for example. When carried to excess, outcoiling produces *Ancylocceras*—a return to the Gyroceratan form. Carried to an extreme, it produces *Baculites*—a return to the *Orthoceras* mode. There is, therefore, a cycle of development—from straightness to extreme involution and back to straightness again; but in completing this cycle there are many periods of interruption—periods of renewed anagenesis¹—while return may begin long before umbilical closing is obtained, and many Ammonite stocks die out without completing the cycle.

It will be seen from the foregoing remarks how different are the times of development of the various characters—how different are the morphogenetic acmes. Thus elaboration of a suture-line (septal morphanagenesis) is frequently carried on till late phylocatagenesis. This is in obedience to mechanical necessities, which were discussed pp. 134, 138. Then development of longitudinal ornament on the periphery—the carina—may be early or late in a series, or it may be delayed altogether. And in regard to umbilication the morphanagenesis is so frequently associated with phylocatagenesis that one is inclined to look upon it as really a catagenetic feature.

From the phases of development of characters which have been detailed it will be seen what changes may be expected in the various genetic stocks, bearing in mind two principles, ontogenetic repetition of phylogeny, and earlier inheritance (tachygenesis). Taking the Hildoceratidæ which show phylocatagenesis from tuberculate to costate, to subcostate, to smooth, there will be shown in the ontogeny of each species this sequence of events carried on to a certain degree. The more catagenetic is a species, the further it will carry out the sequence. Correlated with these characters of ornament there will be catagenesis of whorl shape—from inflation to compression; anagenesis of suture-line, with possible catagenesis at last; anagenesis of rostration, also with possible catagenesis ultimately; catagenesis of such longitudinal ornament as carination,² with ultimate failure; anagenesis or closing of umbilicus, with, later, catagenesis or expansion of umbilicus (excentrumbilication), especially correlated with catagenesis of rostrum and disappearance of carina.

¹ Compare *Sphaeroceras* for stages of umbilical closing, and *Morphoceras*, a descendant of a Sphaeroceratoid, for stages of a closed umbilicus opening out more and more. In *Morph. dimorphum* the peculiar form is due to rapid umbilical catagenesis.

² Increased prominence of the carina gaining at the expense of compression of periphery can hardly be accounted anagenesis.

Numerically, anagenesis musters more than catagenesis: but the features which it affects are less important, and to the latter must be credited bulk-decline—a factor in which is whorl compression. For even if the same diameter should be attained, it is only gained by a great decrease in thickness.

It is now necessary to show what bearing these considerations have on the interpretation of the generic definitions and the specific descriptions.

The definition of the genus indicates the characters shown by a certain species, and by a particular specimen of that species, which is selected as the type of a certain genetic series. This type-species of the genus—the genotype—then becomes a kind of fixed point in the genetic line. The species leading up to the genotype—in a catagenetic series like the Hildoceratidæ—will show in the main more, and those leading from it less, accentuated characters than the genotype.¹ The ontogeny of the genotype, and of species of allied genera, will give evidence as to the course of development. If the genotype show a tuberculate stage in youth declining to costate and smooth stages in adult—expressed in the specific description, which must be read with the generic definition, as tuberculate, to costate, to levigate—then the species leading up to the genotype should show more of the tuberculate and less of the subsequent stages, while the species leading from the type should show less of the tuberculate and constantly more of the subsequent stages (compare *Sonninia* and the Hildoceratidæ, *passim*). If the type show inflated whorls in youth, becoming compressed in adult, the species leading up to it should show a longer persistence of inflated whorls, and little or none of the compression, the species leading from it constantly less of the inflated period and more of the compression. And so with other features. These are the phenomena of morphic prefiguration and representation (p. 315). Under circumstances such as these the specific descriptions may often seem to contradict the generic definitions; but they do not: they merely indicate the difference in the degree of development between the species and the type. The genotype of series X may be defined as sublaticumbilicate, that of Y as angustumbilicate; but a smooth species assigned to X may be described as angustumbilicate, indicating the change in the series; but the smooth species of Y would probably by then be perangustumbilicate unless excentrumbilication had commenced.

If, however, the definition of the genotype of X be sublaticumbilicate while a species assigned thereto be stated as laticumbilicate, it indicates that such species is in an earlier stage of development, it may be ontogenetic, it may be phylogenetic, but it will be found to be the morphic prefiguration of a younger stage in the ontogeny of the genotype. In the specific descriptions some such correlation as this would be found: X 1 spinous to costate, laticumbilicate, X 2 (the genotype) costate to levi-

¹ The opposite obtains in anagenesis. Compare *Arnioceras*.

gate, sublatumbilicate. At the same time specimens of X 2 smaller than the actula specimen described should show, but in a reduced form, characters approximating to X 1 (morphic representation), and specimens larger than the type should show, but at a later date, characters which would be expected to belong to X 3—in a catagenetic series—(morphic prefiguration).

There has been no space in the descriptions in this supplement to deal with the ontogeny of each genotype; but these rules will show what may be expected, and by placing series of allied genera side by side—in which one supplements stages lacking in another—the ontogeny and the phylogeny of the genotypes may be observed.

When, as types of genetic series, species in different stages of development have been taken, the definition may not only show the difference between them—it may express more or it may indicate less. X smooth is angustumbilicate, Y costate is the same. If smooth X and costate Y be taken as the genotypes, the characters of umbilication appear in the definition as the same, so that apparently the umbilication is not a character of distinction in this case. And yet it may be: the association in which the same umbilicus is found gives the distinction—in X angustumbilication is associated with the smooth stage, but in Y with the costate; the difference then is between X angustumbilicate + smooth, Y the same + costate, or, comparing morphic equivalents, which should always be done, between smooth X angustumbilicate and smooth Y perangustumbilicate.

These remarks, it is hoped, will make clear the methods which have guided the arrangement of this supplement, wherein an immense series of species had to be dealt with in a limited space. In conclusion, one great difference in the point of view concerning a genus may be brought to mind. Formerly the genus embraced a series of so many homœomorphous species, now the genus comprises what may be called the heteromorphous stages of a phylogenetic series. The difference is most important. In simpler language, once the genus had a horizontal range, now it has a vertical extension. Now the genus indicates a phylogenetic series; and what is the course of that series is determined by the ontogeny of any one species in it.

VII. GEOLOGICAL DETAILS.

The title under which this monograph has been issued is “Inferior Oolite Ammonites,” and yet in many cases the species are stated to come from the “Upper Lias.” This is not a contradiction; it only means that the investigations carried on during the progress of this work for the elucidation of the Ammonite horizons have shown the contemporaneity of certain so-called “Inferior Oolite” and certain so-called “Upper Lias” strata.

The title “Inferior Oolite” was taken in the first place to denote the Inferior

Oolite Limestones, and also the Inferior Oolite Sands as they had often been called. In other words, it comprehended what has been termed by various authors “the Inferior Oolite Series”—the strata which had been mapped by the Geological Survey as “Inferior Oolite (G 5)” and “Midford Sands (G 4).”

However, as the Ammonite-fauna of the various facies of the so-called “Midford Sands” became known, it was found that though certain developments of these Sands were rightly enough Inferior Oolite, yet other developments thereof were really contemporaneous with deposits termed “Upper Lias.” This accounts for the appearance in this work of many species which properly belong to the “Upper Lias” or what is termed the Toarcian stage. Strictly this work, though it deals with Ammonites from strata which have usually been called Inferior Oolite Limestone and Sands (or from their argillaceous equivalents) should be termed a monograph of the Ammonites of the Toarcian (pars), of the Aalenian, of the Bajocian, and of the Bathonian (pars) stages.

The following table will illustrate this, and it will also show the hemeral classification which gives the dates for their deposits.

| Stratigraphical Terms used by the Geol. Survey. | Hemeral Names. | Full Title of Distinctive Fossil. | Ages. | Stratigraphical Terms. | |
|---|--|---|--|---|-----------------------|
| Inferior Oolite Series. | Inferior Oolite, G. 5. | <i>disci</i> | <i>Oppelia</i> (?) <i>discus</i> | PARKINSONIAN AGE | Upper Inferior Oolite |
| | | <i>(coarctate)</i> | <i>Dictyothyris coarctata</i> | | |
| | | <i>(macillate)</i> | <i>Terebratula mazillata</i> | | |
| | | <i>subcontracti</i> | <i>Macrocephalites subcontractus</i> | | |
| | | <i>fusca</i> | <i>Oppelia fusca</i> | | |
| | | <i>zigzag</i> | <i>Zigzagoceras zigzag</i> | | |
| | | <i>Truelli</i> | <i>Strigoceras Truelli</i> | | |
| | | <i>Garantiani</i> | <i>Strenoceras Garantianum</i> | | |
| | | <i>niortensis</i> | <i>Strenoceras niortense</i> | | |
| | | <i>Blagdeni</i> | <i>Celoceras Blagdeni</i> | | |
| | <i>Sauzei</i> | <i>Emileia Sauzei</i> | | | |
| | <i>Witchellie</i> sp. | <i>Witchellia</i> sp. | | | |
| | <i>Sonninie</i> sp. | <i>Sonninia</i> sp. | LUDWIGIAN AGE | Lower Inferior Oolite | |
| | <i>discite</i> | <i>Hyperlioceras discites</i> | | | |
| | <i>concovi</i> | <i>Ludwigella concova</i> | HARPOCERATAN AGE | Upper Lias, <i>Sensu lato</i> = Upper Lias, Oppel, etc. | |
| | <i>bradfordensis</i> | <i>Brasilia bradfordensis</i> | | | |
| | <i>Murchisonæ</i> | <i>Ludwigia Murchisonæ</i> | | | |
| | <i>scissi</i> | <i>Tmetoceras scissum</i> | | | |
| | <i>opaliniformis</i> | <i>Cypholloceras opaliniforme</i> | | | |
| | <i>aalensis</i> | <i>Pleydellia aalensis</i> | | | |
| <i>Moorei</i> | <i>Dumortieria Moorei</i> | | | | |
| <i>Dumortierie</i> sp. | ” sp. | | | | |
| <i>dispansi</i> | <i>Phlyseogrammoceras dispansum</i> | | | | |
| <i>Struckmanni</i> | <i>Pseudogrammoceras Struckmanni</i> | | | | |
| <i>striatuli</i> | <i>Grammoceras striatulum</i> | | | | |
| <i>variabilis</i> | <i>Haugia variabilis</i> | | | | |
| <i>Lilli</i> | <i>Lillia Lilli</i> | | | | |
| <i>bifrontis</i> | <i>Hildoceras bifrons</i> | | | | |
| <i>falciferi</i> | <i>Harpoceras falciferu</i> | | | | |
| <i>acuti</i> | <i>Arietoceras</i> (?) <i>acutum</i> | | | | |

The next table is a guide to the localities mentioned in this work, and gives information concerning the correlation of the deposits, together with the distinctive names by which the strata may happen to be known. It will be a guide to the stratigraphical position of the beds which have been mentioned in the text.

| | | |
|-------------------|--|---|
| <i>Fusca</i> | DORSET: Bridport Bradford Abbas, Halfway House, etc. | "The scroff," a marly stone on top of limestones; and some of the overlying clay. The upper part of the white stone which is burnt for lime. |
| <i>Zigzag</i> | DORSET: Broad Windsor, Bridport Bradford Abbas, Halfway House, etc. SOMERSET: Crewkerne Station Dundry GLOUCESTERSHIRE: Cotteswolds NORMANDY: Port-en-Bessin | The upper limestones, or <i>zigzag</i> beds. The lower part of the white stone. The upper limestones. ? The strata at Barnes Batch. The Coralline Beds. ? Limestones above the <i>Clypeus</i> -grit. ? Upper part <i>Clypeus</i> -grit. Blue calcareous stone beds, about level of shore, east of the village. |
| <i>Truelli</i> | GLOUCESTERSHIRE: Cotteswolds SOMERSET: Dundry DORSET: Halfway House Bridport | The <i>Clypeus</i> -grit (? lower part only). The Freestone. The fossil-bed with <i>Strigoceras Truelli</i> and <i>Parkinsonia dorsetensis</i> . A hard, bluish limestone. |
| <i>Garantiani</i> | GLOUCESTERSHIRE: Cotteswolds SOMERSET: North Stoke, Midford Dundry DORSET: Sherborne Bradford Abbas, Halfway House, etc. | The Upper <i>Trigonia</i> -grit. The Upper <i>Trigonia</i> -grit. The Conglomerate-bed of Maes Knoll; the thin bed below the Freestone at other places. The Building Freestone. "Marl Bed" and adjacent strata. |
| <i>Niortensis</i> | DORSET: Osborne | The upper part of the roadstone. |
| <i>Blagdeni</i> | DORSET: Osborne | The lower part of the roadstone. |
| <i>Sauzei</i> | GLOUCESTERSHIRE: Cleeve Hill DORSET: Sandford Laune SOMERSET: Dundry | The <i>Phillipsiana</i> beds. The upper part of the Fossil bed. The Ironshot Oolite. |
| <i>Witchellii</i> | DORSET: Sandford Laune Chideock | The middle part of the Fossil bed. The upper part of the "Red beds." |

| | | |
|----------------------|---|--|
| | GLoucestershire: Cold Comfort, Cleeve Hill | An ironshot limestone, with <i>Terebr. Wrighti</i> and <i>Witchellia</i> . |
| | SOMERSET: Dundry | The Upper White Ironshot. |
| <i>Souniniae</i> | GLoucestershire: Cotteswolds | The Notgrove Freestone, and the <i>Gryphite-grit</i> of Leckhampton, etc. |
| | DORSET: Sandford Lane | The lower part of the Fossil bed. |
| | SOMERSET: Dundry. | The Lower White Ironshot—the <i>fissilobata-ovalis</i> horizon. |
| <i>Discite</i> | GLoucestershire: Cotteswolds | The <i>Bucknani-grit</i> , and the Lower <i>Trigonia-grit</i> . |
| | DORSET: Bradford Abbas | The upper part of the Fossil bed. |
| | Sandford Lane | Below the Fossil bed. |
| | Stoke Knap | Top of Building Stone. |
| | SOMERSET: Dundry. | The upper part of the Grey Limestone and Marl beds. |
| | Horethorne Down, Seven Sisters. | Bluish clay with Brachiopods. |
| <i>Concavi</i> | GLoucestershire: Cotteswolds | The Snowhill Clay, and the Harford Sands. |
| | SOMERSET: Dundry. | The lower part of the Grey Limestone and Marl beds. |
| | DORSET: Bradford Abbas | The lower part of the Fossil bed. |
| | Sandford Lane | A bluish sandy bed. |
| | Stoke Knap | Middle of Building Stone. |
| <i>Bradfordensis</i> | GLoucestershire: Cotteswolds | The Upper Freestone, and the Oolite Marl. |
| | DORSET: Bradford Abbas | A marl bed associated with the Paving bed. |
| | Halfway House, Louse Hill, Marston Road, etc. | The <i>Rhynchonella ringens</i> beds. |
| | Chideock | Ironshot stone above Wild bed. |
| | Stoke Knap | The base of the Building Stone. |
| | SOMERSET: near Corton | The <i>Rhyn. ringens</i> beds. |
| <i>Murchisonae</i> | GLoucestershire: Cotteswolds | The Lower Freestone, and the Pea-grit. |
| | SOMERSET: Dundry. | The hard, irony, massive beds. |
| | Misterton, Haselbury, etc. | The "lower beds." |
| | DORSET: Bradford Abbas | The Paving bed. |
| | Near Sherborne | Lower part of stone beds. |
| | Stoke Knap | The "bottom bed." |
| | Broad Windsor | The "lower beds." |
| | Chideock | The "Wild bed." |
| <i>Scissi</i> | GLoucestershire: Cotteswolds | The Sandy Ferruginous Beds, at Frocester Hill known as the Bug-stone. |
| | DORSET: Stoke Knap | The <i>Brachiopod</i> -beds in the Sands. |
| | Burton Bradstock | The bed below that with "Snuff-boxes." |
| | NORTHAMPTONSHIRE: Duston | Northampton Sands. |
| | OXFORDSHIRE: Otley Hill | <i>Rhynch. subdecorata</i> bed. |

- Opaliniformis* . GLOUCESTERSHIRE: Frocester and Haresfield district . Hard ironshot stone capping the *Cephalopod*-bed.
DORSET: Bridport and Chideock . Upper part of Sand beds.
- Aalensis* . GLOUCESTERSHIRE: Frocester and Haresfield district . Top of the *Cephalopod*-bed.
SOMERSET: Dundry A bluish clay stone.
DORSET: Chideock and Bridport . Towards upper part of Bridport Sands.
- Moorei* . GLOUCESTERSHIRE: Frocester district . A portion of *Cephalopod*-bed.
SOMERSET: Ham Hill Building stone.
Stoford Upper part of Yeovil Sands, with some building stone.
Yeovil Upper part of Sands.
DORSET: Bradford Abbas Upper part of Yeovil Sands, and the "Dew Bed."
Chideock Rather above middle part of Bridport Sands.
- Dumortierie* . GLOUCESTERSHIRE: Frocester district . The middle part of the *Cephalopod*-bed—brown ironshot marl, a very Ammonitiferous horizon at Penn Wood, Dursley, etc.
SOMERSET: Dundry The Upper Clay beds.
Ham Hill and Yeovil district . The Yellow Sands.
DORSET: Bradford Abbas district . Yellow and Blue Sands.
Chideock Blue clay ("Upper Lias") of Down Cliffs about 70 feet, and about 100 feet of yellow sand above.
Bridport Much of the Yellow Sands, cf. Chideock.
YORKSHIRE: Blea Wyke The Yellow and Grey Sands below Dogger.
- Dispani* . GLOUCESTERSHIRE: Frocester district . About middle of *Cephalopod*-bed.
SOMERSET: North Stoke A brown, ironshot, marly stone.
Near Cole, Somerset and Dorset Railway Yellow sands, with hard sandstone, yielding *Hammatocera*.
Ilminster district Top of "Upper Lias" clay, below Yeovil Sands.
- Struckmanni* . GLOUCESTERSHIRE: Frocester district . The lower part of the Cotteswold *Cephalopod*-bed.
SOMERSET: Bath The lower part of the Midford Sands.
Dundry Part of blue ironshot beds.
Cranmore P. 168.
- Striatuli* . GLOUCESTERSHIRE: Frocester district . The base of the Cotteswold *Cephalopod*-bed.
Sodbury Yellowish sand and hard sandstones.

SUPPLEMENT, PLATE XX.

Discitæ hemera.

Figs. 1—3.—*BRAUNSINA FASTIGATA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page c.)

Figs. 4—6.—*BRAUNSINA CORNIGERA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page c.)

Figs. 7—9.—*BRAUNSINA PROJECTA*, *S. Buckman*.
Dundry (Somerset), "Limestone and Marl Beds." From the late Mr. E. Wilson. (Page c.)

Figs. 10—12.—*BRAUNSINA?* *SUBQUADRATA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." Collection of Mr. Darell Stephens, F.G.S. (Page ci.)

Figs. 13—15.—*PSEUDOGRAPHOCERAS?* *CARINIFERUM*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." From my father's Collection. (Page xciii.)

Figs. 16—18.—*PLATYGRAPHOCERAS CARBATINUM*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page xciv.)

Figs. 19—21.—*PLATYGRAPHOCERAS LATUM*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page xciv.)

Figs. 22—24.—*GRAPHOCERAS DEBILE*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." Collection of Mr. D. Stephens, F.G.S. (Page xevi.)

Murchisonæ hemera?

Figs. 25—27.—*LUDWIGELLA GLEVENSIS*, *S. Buckman*.
Cheltenham neighbourhood. Pea-grit Series? From the Collection of the late Dr. Thomas Wright, F.R.S. (Page lxxxix.)

Bradfordensis hemera.

Figs. 28—30.—*LUDWIGELLA ARCUATA*, *S. Buckman*.
Stoke Knap (Dorset), "Building Stone." (Page lxxxix.)

Concavi hemera.

Figs. 31—33.—*LUDWIGELLA CASTA*, *S. Buckman*.
Stoke Knap (Dorset), "Building Stone." Collection of Mr. D. Stephens. (Page lxxxix.)

Bradfordensis hemera?

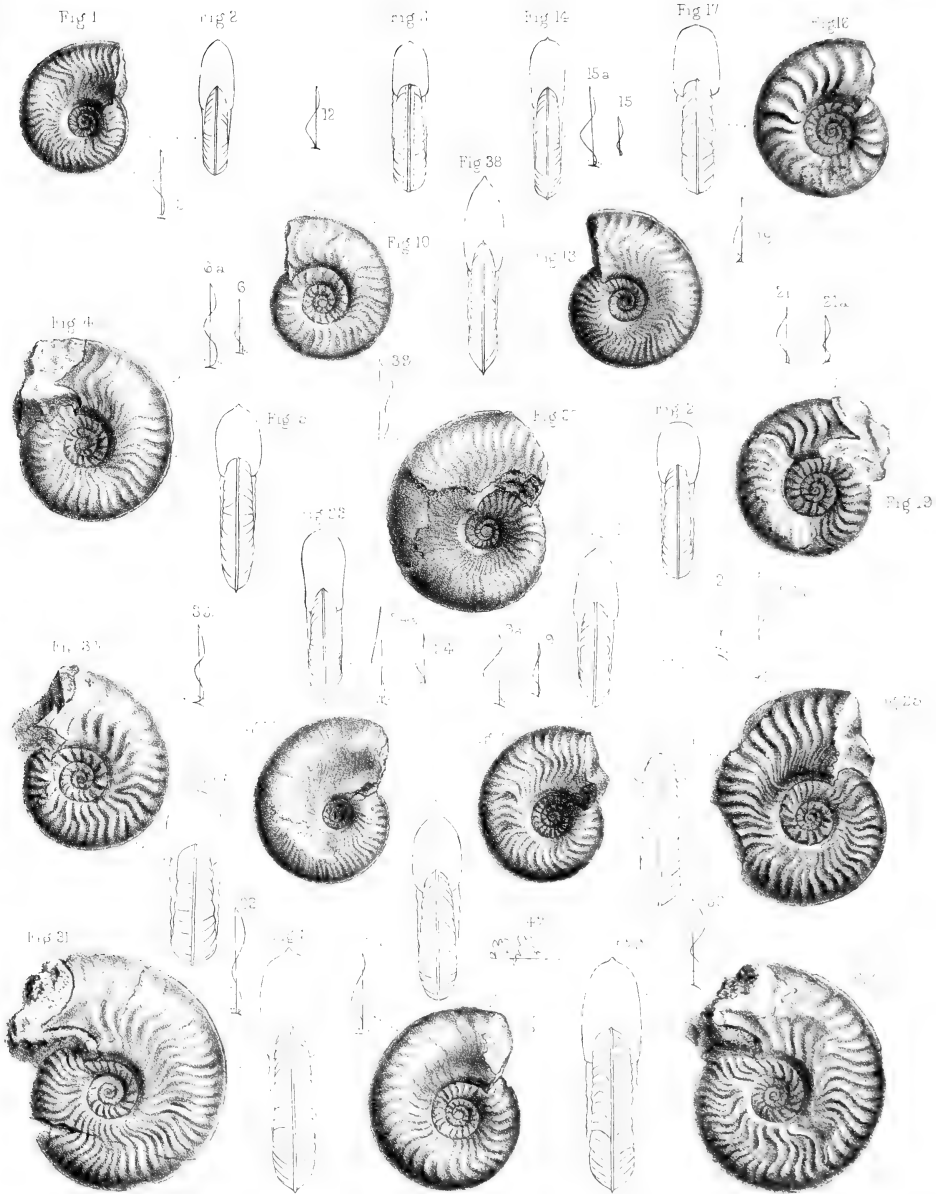
Figs. 34—36.—*LUDWIGELLA RUGOSA*, *S. Buckman*.
Stoke Knap, "Building Stone." (Page xc.)

Concavi hemera.

Figs. 37—39.—*LUDWIGELLA TENUIS*, *S. Buckman*.
Stoke Knap, "Building Stone." (Page lxxxvii.)

Discitæ hemera.

Figs. 40—42.—*REYNESIA AMENA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page ciii.)



SUPPLEMENT, PLATE XXI.

Discitæ hemera.

Figs. 1—3*a*.—*EDANIA FALCIGERA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cviii.)

Figs. 4—6.—*EDANIA LEPTA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cviii.)

Figs. 7—9*a*.—*EDANIA PARVICOSTATA*, *S. Buckman*.
Dundry [limestone and marl beds], from the late Mr. E. Wilson, F.G.S.
(Page cviii.)

Figs. 10—12.—*EDANIA DELICATA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cviii.)

Figs. 13—15.—*EDANIA INFLATA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cviii.)

Figs. 16—18.—*LOPADOCERAS FURCATUM*, *S. Buckman*.
Stoke Knap (Dorset), "Building Stone." (Page cxii.) Front view not stout
enough.

Figs. 19—21.—*LOPADOCERAS ARCUATUM*, *S. Buckman*.
Stoke Knap, "Building Stone." (Page cxii.)

Figs. 22—24.—*LOPADOCERAS EUIDES*, *S. Buckman*.
Stoke Knap, "Building Stone." (Page cxii.)

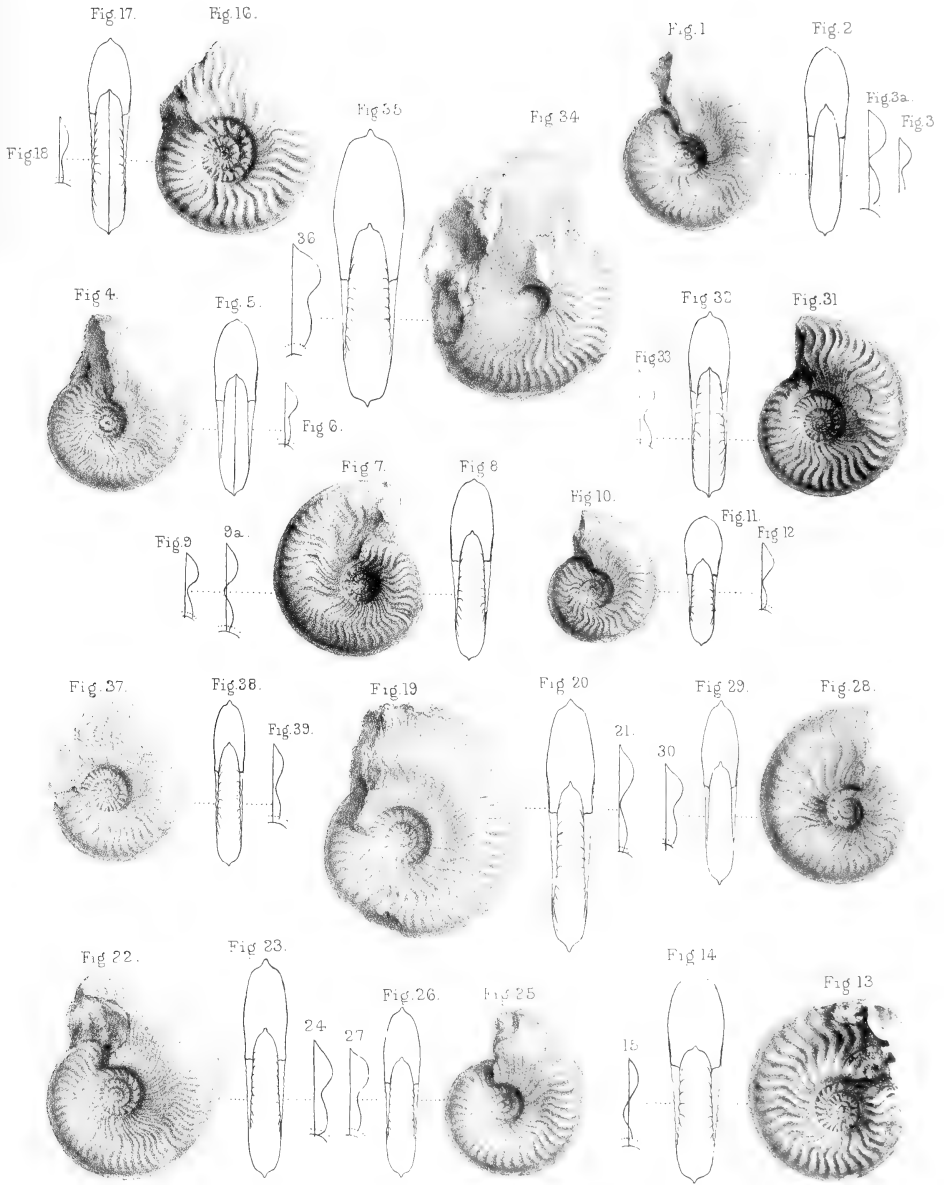
Figs. 25—27.—*HUGIA CURVA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cxi.)
(See Suppl. Pl. XVIII, figs. 19—21.)

Figs. 28—30.—*HUGIA MICCA*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cxi.)

Figs. 31—33.—*TOXOLIOCERAS INCISUM*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." Collection of Mr. Darell Stephens, F.G.S.
(Page cxxvi.)

Figs. 34—36.—*HYPERLIOCERAS? OCCLUSUM*, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cxxv.)

Figs. 37—39.—*REYNESELLA INOPS*, *S. Buckman*.
Stoke Knap, "Building Stone." (Page cx.)





SUPPLEMENT, PLATE XXII.

Discitæ hemera.

Figs. 1—3.—REYNESIA FURCILLATA, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page civ.)

Figs. 4—6.—DARELLINA ? DOCILIS, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cvii.)

Figs. 7—9.—DARELLINA PLANARIS, *S. Buckman*.
Bradford Abbas, "Fossil Bed." (Page cvi.)
(See Suppl. Plate XVII, figs. 22—24.)

Figs. 10—12.—REYNESIA BENIGNA, *S. Buckman*.
Bradford Abbas, "Fossil Bed." Collection of Mr. Darell Stephens, F.G.S.
(Page cv.)

Figs. 13—15.—STOKEIA MARMOREA, *S. Buckman*.
Stoke Knap, "Building Stone." (Page cxxviii.)

Opaliniformis hemera.

Figs. 16—18.—CANAVARELLA ? TOMA, *S. Buckman*.
Buckholt Wood (Frocester), Gloucester. Top of the "Cephalopod Bed."
(Page cxxix.)

Figs. 19—21.—CANAVARELLA ? SCELETA, *S. Buckman*.
Burton Bradstock [Bridport sands and ? near the top]. Collection of Mr. D.
Stephens, F.G.S. (Page cxxix.)

Scissi hemera.

Figs. 22—24.—CANAVARELLA BELOPHORA, *S. Buckman*.
Stoke Knap. Sandy Grits with *Terebratula infraoolithica*. (Page cxxix.)

Dumortieria hemera.

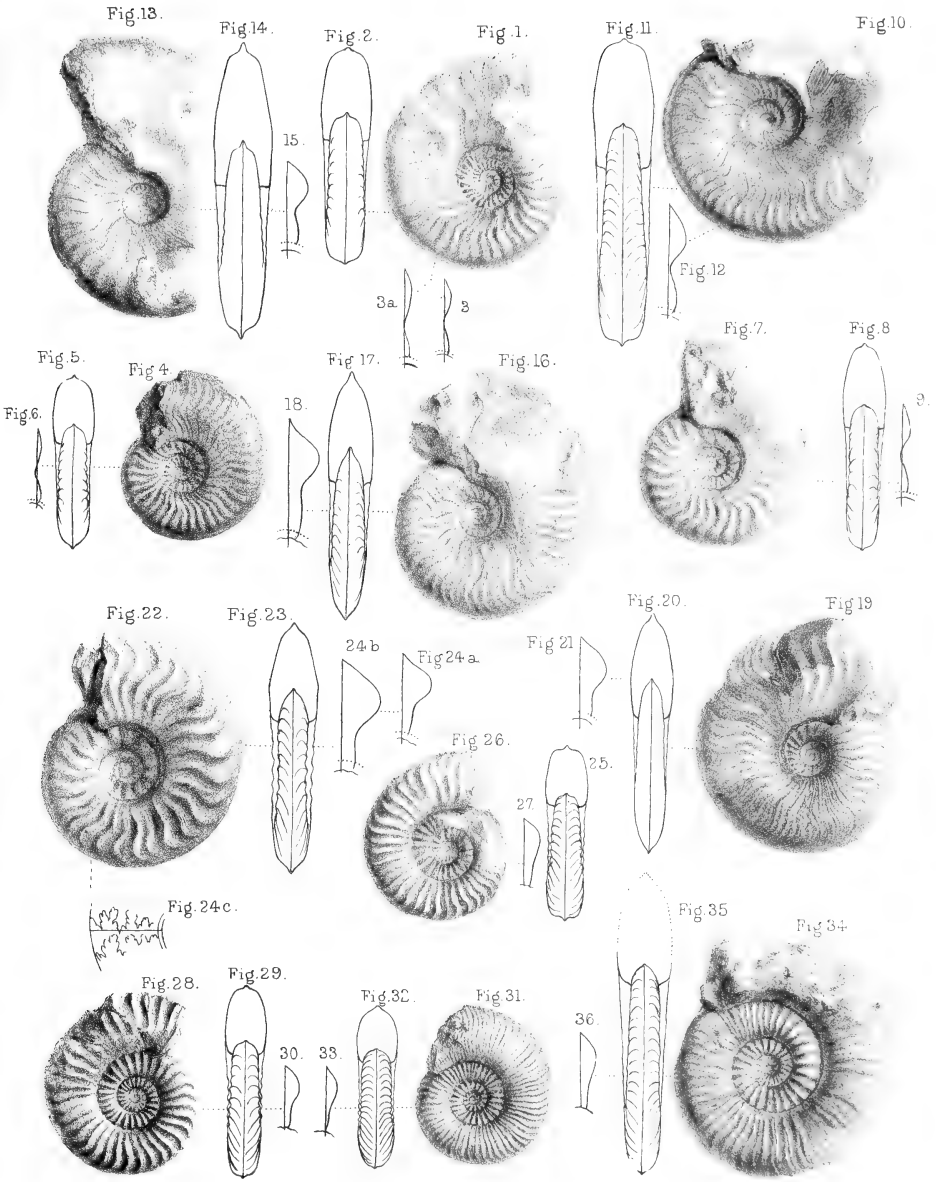
Figs. 25—27.—DUMORTIERIA TABULATA, *S. Buckman*.
Penn Wood (Stroud), Gloucestershire. From the late Mr. E. Wilson, F.G.S.
"Cephalopod Bed," *Dumortieria* horizon. (Page clxxxv.)

Figs. 28—30.—DUMORTIERIA EXPLANATA, *S. Buckman*.
Penn Wood (Stroud), "Cephalopod Bed." *Dumortieria* horizon. (Page
clxxxv.)

Figs. 31—33.—DUMORTIERIA RADIANS (*Reinecke*).
Penn Wood (Stroud), "Cephalopod Bed." *Dumortieria* horizon. (Page
clxxxix.)

Moorei hemera.

Figs. 34—36.—DUMORTIERIA ARENARIA, *S. Buckman*.
Bradford Abbas, Dorset, "Shelly Beds" of Yeovil Sands. (Page clxxxv.)





SUPPLEMENT, PLATE XXIII.

Moorei hemera.

Figs. 1—3 *a*.—*COTTESWOLDIA PAUCICOSTATA*, *S. Buckman*.

Fig. 1.—Side view of a fine specimen with test and body-chamber. (Page cxxxiii.)

Fig. 2.—Front view, outline. The periphery where it leaves the overlapping whorl and at bottom should be more fastigate, and at the top more rounded.

Fig. 3.—Suture-line. Fig. 3 *a*. Radial curve.

Figs. 5—7.—*COTTESWOLDIA PARTICOSTATA*, *S. Buckman*.

Fig. 5.—Side view, with test and complete body-chamber. (Page cxxxiii.)

Fig. 6.—Front view, outline. The periphery should be more rounded at top, the carina being almost obsolete.

Figs. 7, 7 *a*.—Radial curves.

Figs. 9—11.—*COTTESWOLDIA EGENA*, *S. Buckman*.

Fig. 9.—Side view of specimen with test and complete body-chamber, the border with lateral lappet. (Page cxxxiv.)

Fig. 10.—Front view, outline.

Fig. 11.—Radial curve.

Figs. 12—14.—*COTTESWOLDIA ATTRITA*, *S. Buckman*.

Fig. 12.—Side view, with test and the body-chamber almost complete. The costæ are rather too definite and distinct. (Page cxxxiv.)

Fig. 13.—Front view, outline.

Fig. 14.—Radial curve.

The above specimens were collected by myself from the *Moorei*-beds, a subdivision of the Cotteswold Cephalopod Bed, Buckholt Wood, near Frocester, Gloucestershire. For figures of allied species see Pls. XXX—XXXIII.

Figs. 4, 8.—Suture- and radial-lines.

Figs. 4, 4 *a*.—*COTTESWOLDIA COSTULATA* (*Zieten*).

Fig. 4.—Suture-lines. 4 *a*. Radial-lines of the specimen figured in Pl. XXXIII, figs. 3, 4 as *Grammoceras costulatum*. (Page cxxxiii.)

Fig. 8.—*COTTESWOLDIA DISTANS* (*S. Buckman*).

Fig. 8.—Radial-lines of the specimen figured in Pl. XXXIII, fig. 12, as *Grammoceras distans*. (Page cxxxvi.)

Fig. 1.

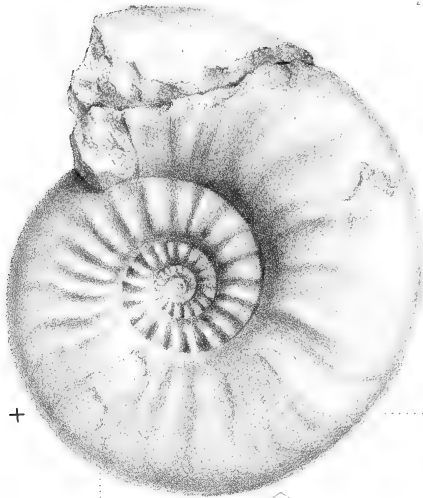


Fig. 2.



Fig. 9.

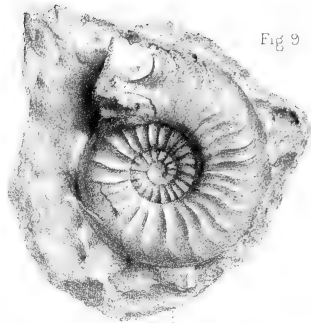


Fig. 11.



Fig. 10.



Fig. 4-a.



Fig. 4.



Fig. 7-a.

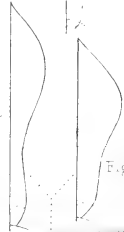


Fig. 6.



Fig. 5.



Fig. 7.

Fig. 13.



Fig. 14.



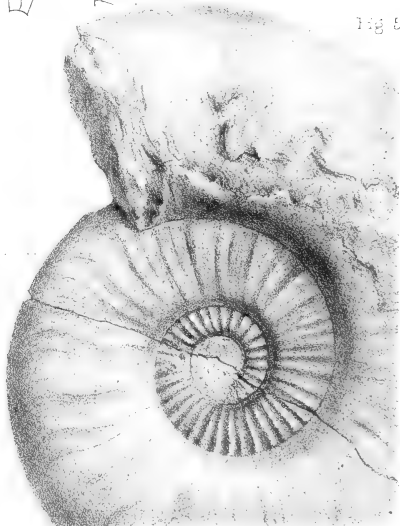
Fig. 3-a.



Fig. 12.



Fig. 8.



X



SUPPLEMENT, PLATE XXIV.

Discitæ hemera.

Figs. 1—4.—FONTANNESIA BOWERI (*J. Buckman*).

Fig. 1.—Side view of the type specimen refigured. From a heap of stones on the roadside, Babylon Hill (Anbury Quarry), Bradford Abbas, Dorset. Collected by the late Mr. Frank Monk, and kindly lent by his father to be figured in this work. The specimen is now in the British Museum—Natural History. (Page exc.)

Fig. 2.—The lateral auricle of the other side.

Fig. 3.—Apertural view.

Fig. 4.—Peripheral view.

Concavi or *Discitæ* hemera.

Figs. 5, 6.—FONTANNESIA CONCENTRICA, *S. Buckman*.

Fig. 5.—Side view, showing lateral auricle. Louse Hill, Halfway House (Compton), Dorset. (Page exci.)

Fig. 6.—Peripheral view.

Fig. 7.—FONTANNESIA AURITA, *S. Buckman*.

Fig. 7.—Side view, showing large auricle. Halfway House (Compton), Dorset. Collected by Mr. D. Stephens, F.G.S. (Page exc.)

Discitæ hemera.

Figs. 8—11.—FONTANNESIA OBRUTA, *S. Buckman*.

Fig. 8.—Side view of a wholly septate example. "Fossil Bed," Bradford Abbas, Dorset. Collected by Mr. Stephens. (Page clxxxix.)

Fig. 9.—Front view.

Figs. 10, 11.—Two suture lines—one to supplement the other. Fig. 11 is about the fifth line beyond fig. 10.

(For figures of allied species see Plates XLVI, XLVII, LXV.)

Fig. 6.



Fig. 1.

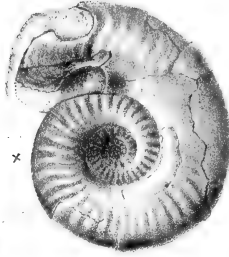


Fig. 4.



Fig. 2.



Fig. 5.



Fig. 11.



Fig. 7.

Fig. 10.



Fig. 9.



Fig. 3.





Palæontographical Society, 1905.

A MONOGRAPH

OF THE

FAUNA OF THE CORNBRAsh.

BY

REV. J. F. BLAKE, M.A., F.G.S.

PART I.

PAGES 1—100; PLATES I—IX.

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MONOGRAPH
OF THE
FAUNA OF THE CORNBRAsh.

INTRODUCTION.

THE rock known in this country as the *Cornbrash* is reckoned as the uppermost member of one of the subdivisions of the Jurassic rocks which are, as a whole, termed the Lower Oolites. This classification, which is still in vogue in England,¹ dates back to 1822, having been founded by Conybeare,² who writes as follows in his 'Outlines':

"The system of formations occupying the interval [between the Ironsand and the Red Marl] may be generally described as consisting of a series of oolitic limestones, of calcareous sands and sandstone and of argillaceous and argillo-calcareous beds alternating together and generally repeated in the same order, *i. e.* a formation consisting of many beds of oolitic limestone, resting upon one of calcareo-siliceous sand and that again upon an argillo-calcareous formation. Three of these systems comprehend all the beds. Each is based on an argillo-calcareous formation of much thickness. Hence we may give a hypothetical view of the whole series as divided into the Upper, Middle, and Lower Systems."

This system is, therefore, founded on local lithology, and is characteristic only in the South-West of England, where it originated.

On the other hand, Mr. H. B. Woodward, who at the present day holds an unrivalled knowledge of the Cornbrash in its stratigraphical bearings, states definitely that "the Cornbrash belongs to the zone of *Ammonites macrocephalus*. . . . The zone may be said to extend upwards into the Lower Oxfordian strata."³ Here is indicated a definite connection with the so-called Middle Oolites. This is so clearly the fact and comes out so definitely when the fauna is studied, as will subsequently be seen, that it must not be mistaken for a Lower Jurassic horizon—a view which is only accepted as an "hypothesis" by Conybeare.

¹ See Marr, 'Principles of Stratigraphical Geology,' 1898, p. 230; Watts, 'Geology for Beginners,' 1898, p. 271.

² 'Outlines of the Geology of England and Wales,' 1822.

³ 'Jurassic Rocks of Britain,' vol. iv, 1894, p. 434.

Dr. A. Oppel, in 1856-8, subdivided the "Juraformation" into zones, but his observations on the Cornbrash were not very numerous, and he observed it only in Wiltshire, where it and the underlying strata are very similar and with difficulty distinguished except by the fauna. Thus he made the following statement: "The Forest Marble and the Cornbrash I join in one zone and name them after one of the most important fossils—the beds of *Terebratula lagenalis*."¹ But neither Davidson in the study (α) nor H. B. Woodward in the field knows of any example of *Waldheimia* ("Terebratula") *lagenalis* in the Forest Marble (β). It may be taken therefore as unknown at that horizon. On the other hand, Oppel, finding no *Ammonites macrocephalus* at Stanton, Wilts, concluded that there were none anywhere in the Cornbrash (p. 456), and assigned the beds in which they were already known to occur in Yorkshire to the Kelloway Rock (p. 509). These misunderstandings have long since been rectified in this country, but, through the influence of Oppel and our own classification according to lithology rather than to palæontology, the English Cornbrash has long been supposed on the Continent to occupy a position below the zone of *Ammonites macrocephalus*; or rather, the strata below that zone have been identified with the Cornbrash of England.²

As it happens, the zone of *Macrocephalites macrocephalus*, as it is now called, is a very important one, and occupies a peculiar situation in the series of Jurassic rocks. As Neumayr explained some twenty years ago in a paper on "Die Geographische Verbreitung der Juraformation,"³ the whole series may be divided according to their geographic distribution into two parts—the Lower and the Upper. The map which illustrates that paper shows the rocks which are referred to the Lower Jurassic from the Lias to the Bathonian inclusive, as occurring only in parts of Europe, the North of Africa, and the Caucasus range; but those referred to the Upper Jurassic from the Callovian to the Tithonic, as transgressing beyond these limits to Russia, eastwards to Cutch, the Salt Range, the Himalayahs, and northwards to Siberia. This is a result, confirmed as it is by deposits still further removed in the Arctic regions, in Western Australia, and in South America, of world-wide significance. In both these cases the lower strata of the subdivision are the most widely distributed. Each series commences with a maximum and is gradually reduced to a minimum. *The Upper Jurassic Series commences with the Macrocephalites beds* represented by its various forms, as in Russia,⁴ Cutch,⁵ Franz Joseph Land,⁶ and Bolivia,⁷ etc.

¹ 'Juraformation,' p. 453. (α) 'British Fossil Brachiopoda,' vol. i, p. 99. (β) 'Lower Oolitic Rocks of England' ('Jurassic Rocks of Britain,' vol. iv, p. 579).

² Renévier, "Chronographie Géologique," 1897.

³ 'Denk. Math. Nat. Class. K. Acad. Wiss. Wien,' vol. i, 1885.

⁴ Nikitin, 'Geol. Karte Russ.,' 1885, pl. 17.

⁵ Waagen, 'Pal. Ind.'

⁶ Newton, "Quart. Journ. Geol. Soc.," vol. liii.

⁷ Steinmann, "Neues Jahrb.," 1881.

When we turn to our own country the same phenomena of distribution are very clearly manifest, though on a small scale. The Lower Jurassic maximum is shown by the Lower Lias extending from Lyme Regis to Yorkshire and beyond to Dunrobin, Arran, and Antrim; and it is followed by the changing and decreasing strata of marine formations from the Oolites to the Forest Marble in the south, the Estuarine Clays and Northampton Sands in the centre, and the plant beds extending to the Coal of Brora in the north. Again, the Upper Jurassic maximum commences with the Cornbrash, whose constancy is only equalled by that of the succeeding Oxfordian strata, whose basal bed it forms, and extends with scarcely a noticeable change from Weymouth to Scarborough, and is represented at a slightly later date by the "roof-bed" of the Brora Coal.

Such a change as this from constancy to variability would seem to indicate a true basis of classification into two parts—the Upper and the Lower, each representing a distinct cycle of deposits. In the presence of this coincidence of the development of certain types of Ammonites, with an almost world-wide expansion of the rocks containing them, the accidents of their local form or colour sink into insignificance. Such accidents seemed quite natural in the days of Conybeare and Quenstedt, though the line of division between the Lower and Middle Oolites of the former in no wise coincided with that between the Brown and White Jura of the latter. It was only when further travel introduced the knowledge of the wider distribution of the Upper Jurassic that the significance of the zone of *Macrocephalites macrocephalus* as the base of a new series of deposits was perceived, and the meaning of the constancy of the Cornbrash, as of that of the Rhaetic, was indicated.

Yet it is quite true, as indicated by Phillips, that in the South-West of England, where both series are equally developed, the fossils of the Cornbrash commonly observed are "not much different in general aspect from that of the Great Oolite below them."¹ This is because only the so-called "demoid" fossils are commonly observed, but when all the fauna is examined it may happen, and it does, that there are a crowd of new forms of a higher type, showing alliances with the strata above rather than with those below. To determine these forms is one of the objects of the present monograph.

From the above considerations it appears that the critical line to draw is the basal line. Often the change of character in the strata below the Cornbrash is characteristic—as clay in the central counties, or as estuarine sands in Yorkshire. In these cases there is no difficulty in recognising this line, but when limestone follows limestone, as in the south-western portion of its course, where the highest bed of the Lower Oolites is the Forest Marble, more care is required to distinguish between the two. Consequently I have accepted as belonging to the Cornbrash

¹ 'Geology of Oxford,' 1871, p. 155.

only those forms represented by specimens obtained from above the base line assumed either by myself or where there is no confusion possible.

This line is recognised as being the basal bed which shows two or more of the following characters: It is rubbly, nodular, or without regular minor stratification; it is an "aggregate" crowded with fossils, many of which may be heterochthonous; it is often ferruginous or phosphatic. Such are recognised as basal beds, often unconformable on a large scale, as in the cases of the Cambridge Greensand, the roof-beds of the Brera Coal, or the nodular beds at the base of the Speeton Clay. Similar beds are found associated with *Mac. macrocephalus* or *Clyd. discus* at various localities on the Continent and in England, and the base of the rubble beds with *Avicula echinata* is taken in any case of doubt as the base of the Cornbrash.

The exact definition of the upper limit is not of so great importance, for the change of the matrix from limestone to clay will of itself cause some change in the fauna; but, as H. B. Woodward observes, "there is no palæontological break in the South of England or elsewhere between the Cornbrash and the Oxfordian series, for in the Kelloway Rock we find more or less abundantly some of the characteristic fossils of the Cornbrash." *Mac. macrocephalus* has, however, been recorded to ascend to the Kelloway Rock in Wiltshire, but the evidence is not satisfactory to me, for in many places where the lowest Oxford Clay is exposed the first Ammonites to occur are always of the varieties *koenigi*, *goverianus* and *modiolaris*.

CRITICAL EXAMINATION OF THE SECTIONS WHICH HAVE YIELDED CORNBRAsh FOSSILS.

The following is a description of the localities which have yielded Cornbrash fossils, together with critical reasons for the rejection of others which have been supposed to yield them. It will be seen that in most of the former cases the basal rubble beds are exhibited, below which no fossils are recognised as belonging to the Cornbrash.

1. RADIPOLE, Weymouth backwater.—This is the well-known locality where the end of the backwater faces the town, exposing the whole sequence, from the Oxfordian downwards. The highest bed on the east of the section is only exposed on the foreshore, beneath the supports of the drain-pipes; it is characterised by species of *Goniomya* and *Pholadomya* (Bed *a*). On the other side of the bounding wall the following series can be made out:

| | Ft. | in. |
|---|-----|-----|
| 1. Solid blue limestone | 1 | 0 |
| 2. Soft and brashy, with irregular thin doggers | 0 | 10 |
| 3. Lenticular compact white limestone | 1 | 8 |

| | Ft. in. |
|--|---------|
| 4. Soft sub-laminated yellow weathering brash, with large white compact lenticular doggers and large <i>Pholadomya deltoidea</i> | 2 8 |
| 5. Coarsely crystalline pure limestone, varying greatly in thickness, with <i>Modiola lonsdalei</i> say | 1 0 |
| 6. Blue soft sublaminated brash | 1 2 |
| 7. Solid compact limestone, not weathering lenticularly | 1 6 |
| 8. Sandy fucoïd flag with irregular surface say | 0 6 |
| (Resembles the Oxfordian starfish bed, and forms the lowest continuous scar rising to westward and overhanging.) | |
| 9. Blue shaly material (resembles Bed <i>a</i>) | 1 6 |
| 10. Continuous earthy limestone | 0 9 |
| 11. Very brashy material, full of small oysters and <i>Mycidæ</i> , semi-indurated say | 1 0 |
| 12. Softer brash, with many oysters | 1 8 |
| 13. Compact earthy limestone with root-like hollows | 0 10 |
| 14. Obscure, probably brashy, and possibly containing another hard band | 2 0 |
| 15. Solid crystalline limestone | 0 9 |
| 16. Great rubble beds, without stratification, but with many <i>Avicula echinata</i> and other fossils and parts hardened or concretionary | 8 0 |
| | 26 10 |

Beyond the end of the cliff the coast suddenly recedes for some distance, and nothing is seen till near the road are found, on the slope at the water's edge, some flaggy, thin beds, quite unlike any of those recorded above.

In this section it is to be noted that a large proportion of the lower beds are brashy or irregular, and that the extent of the beds above is at the expense of the Oxford Clay. Nevertheless, the first Ammonites represented in these beds are *A. koenigi*, *A. gowerianus* and *A. modiolaris*.

On the opposite side of the backwater several beds of the series can be recognised in the scanty exposures; but below them, on the northern side of a small depression, thin, hard slabs are found, with small oysters and *Lima cardiiiformis*, like the typical beds of the Forest Marble, and farther on, doggerly yellow sands, like the Hinton Sands of Wilts. The contents of these latter beds, though mapped as Cornbrash, are not therefore included in its fauna.

2. EAST FLEET.—At the west end of the same range of Cornbrash we find somewhat the same sort of beds exposed in separated parts. The first section shows a downward succession with *Macrocephalites in situ*, beginning with the basal Oxfordian beds at the far side, followed by :

| | Ft. in. |
|---|---------|
| 1. The <i>Goniomya</i> bed, like <i>a</i> of Radipole | 1 6 |
| 2. Softer purplish flaky rock | 2 2 |
| 3. Hard, pale, gritty limestone, with small fossils and tetragonal <i>Serpula</i> | 1 6 |
| 4. Hard and soft bands with round doggers alternating | 9 2 |
| 5. Massive hard yellow limestone | 2 1 |
| 6. Low continuous reef of crystalline whitish limestone with largish <i>Macrocephalites</i> | 3 0 |
| 7. Broken, brashy rock with large doggers | 1 0 |

Further on the downward succession seems to be :

| | Ft. in. |
|--|--------------|
| 1. Grey-purple, fucoid, gritty limestone, with fragments of <i>Macrocephalites</i> and <i>Trigonia</i> | 2 6 |
| 2. Disintegrated purple soft brash | 1 0 |
| 3. Hard band, top only seen, with doggers in an interval below. | say 4 0 |
| 4. Weak purple flaky stone, harder below, with tetragonal <i>Serpulae</i> | say 1 6 |
| 5. Massive limestone, level at the top, cavernous below | 1 ft. to 1 6 |
| 6. Softer flaky brash with large septate nodules | 1 4 |
| 7. Massive limestone, only upper part seen | 3 0 |

None of the *Avicula echinata* brash is yet seen. For this we must go farther west to the "Passage" on the old Ordnance map. After passing some isolated bands we reach some massive irregular limestone full of *Avicula echinata* with many *Pholadomya* underlain by brashy, rubbly rock; this is the base of the Cornbrash, and the Forest Marble follows, thrown out by a spring in clay.

3. BUCKLAND RIPERS TO LANGTON.—The strata in this neighbourhood being thrown into an anticlinal, we see the Cornbrash again on the northern side of it. At first it forms a low crag on the south side of the stream at Buckland Ripers Farm. This consists of imbedded rock with abundance of *Avicula echinata* and Myacidae corresponding to No. 16 of the Radipole section, with flaggy rock of the Forest Marble type behind, and no doubt dipping beneath it. At the quarry in the farmyard (A) the rubble bed is overlain by 6—8ft. of softer brash, with bands of rubbly clay, the outcrop at the crag being thrown back to the top of the hill slope. To the west, however, beyond Buckland Ripers the Cornbrash outcrop expands, and the Oxford Clay, indicated by its large septaria, succeeds in due course; accordingly on the slopes leading down to this we find representatives of the higher beds in the Cornbrash. On approaching Langton Herring the outcrop rapidly narrows, and the basal beds are almost confined to the north side of the road. On the south side of the road, at the turning to the Rectory, the basal rubble is seen crossing the flaggy Forest Marble which lies in the same bank. As there are many other exposures of Forest Marble, and all of these are fossiliferous, great care is necessary in quoting fossils from Langton as Cornbrash, unless proved by the nature of the matrix. There is also an exposure in Rodden Lane, just beyond Langton. A fault passes through a sand-pit at the summit of the hill, and on the north side of this fault is some yellowish brash capped with harder stone containing Cornbrash fossils and dipping rapidly northwards. On the other or west side of the road the same is exposed in temporary excavations, but more resembling that at Buckland Ripers.

4. ABBOTSBURY WALL DOWN.—This affords the most westerly exposure known in this district, but is rather obscure both at the top and at the bottom, and the low ledges forming a promontory which bounds the swannery are not suitable for accurate measurement. After some flaggy beds and loose doggers with large

Pholadomya comes a hard band with very large and thick fucoidal markings on the surface, 1 ft. 8 in., followed downwards by alternations of soft and brashy bands and harder bands for a space of 15 ft. Round the corner of the promontory is seen hard nodular material, becoming rubbly below and containing *Avicula echinata* through 8 ft., beyond which, as the promontory widens, the slabs of true Forest Marble are seen. In this series we can recognise the basal bed as the equivalent to No. 16 of Radipole, and the overlying series as generally equivalent at the two ends. Speaking generally of the deposits, they appear to be divided into two groups: the lower is the specially rubbly bed, about 8 ft. in thickness, without internal stratification, but characterised by abundant *Avicula echinata*; the upper is an irregular alternation of hard and soft calcareous brashy beds, about 18 ft. in thickness in all, and containing in one bed or another most of the known Ammonites of the Cornbrash of this district.

In many districts, both in South and North Dorset, whence Cornbrash fossils have been quoted, it is not safe to rely upon them in cases where Forest Marble occurs in the same quarry, or where the basement bed of the Cornbrash is not seen. Those in South-west Dorset records from Punchnowl and Swyre are scarcely available, and any from North Hill, Burton Bradstock, and even Bothenhampton require great caution. In North Dorset, Rampisham now shows only a deserted quarry in Oxford Clay, but any Cornbrash seen there would be available. Nearly the same kind of quarry occurs at Melbury Osmond, but the base is there said to reach the Forest Marble. This is the case also with Corscombe and the quarry at the corner of the road leading up to Closeworth. Similar difficulties appear at Hartington, East Coker, Ryme and Yetminster. We get into contact again with the stratigraphy at Alveston on the road from Sherborne to Holwell. Here a gradient leads down from the Cornbrash to the Oxford Clay, the strata dipping at a higher angle. Along the cross-road from Alveston to Folke is seen a rubbly mass full of *Avicula echinata*, and in the slope leading down to the Oxford Clay are two hard dogger bands with intervening soft rubble, eight feet thick in all. These, then, definitely repeat the higher strata of the Weymouth district.

5. HOLWELL.—This is an important and instructive quarry situated half a mile west-north-west of the village on the rise of the road leading to Bishop's Caundle. From it a large number of fossils from the Cornbrash, collected by Rev. H. H. Wood, were obtained, which are now deposited in Sherborne School Museum. In it the following strata may be made out:

| | Ft. in. |
|--|---------|
| 1. Fine brecciated rubble with solid lumps, <i>Macrocephalites</i> and <i>Terebratulæ</i> | 4 6 |
| 2. Solid white limestone with autochthonous fossils, <i>Macrocephalites</i> , etc. | 5 0 |
| 3. Rubbly rock in several indistinct beds, <i>Avicula echinata</i> , <i>Pholadomya deltoidea</i> , and <i>Terebratula intermedia</i> | 5 0 |

| | Ft. in. |
|---|---------|
| 4. Junction bed of shelly shale | 0 2 |
| <i>a.</i> Hard blue shelly band | 1 0 |
| <i>b.</i> Soft oyster marls | 1 3 |
| <i>c.</i> Hard band, fissile at the top | 0 10 |
| <i>d.</i> Soft shelly material | 0 8 |
| <i>e.</i> Hard blue rock | 1 4 |
| Talus to the base of quarry | say 4 0 |

This quarry has a long face from west to east, the beds as a rule rising towards the east. The top bed (No. 1) is in the upper level at the west end and No. 2 vertically below it in another level. From this spot the beds, rising, form a continuous face, the upper part of which is No. 3. The beds below the junction bed (No. 4) are of a different character, more massive, and though shelly they are not rubbly. These are taken to represent beds on the horizon of the Forest Marble, and not of the Cornbrash. I cannot make the beds below the rubble correspond in thickness with those recorded by H. B. Woodward, but, as the face is long and the basal rubble thick, this probably represents the characteristic variation of Forest Marble. The fact that a very large series of fossils was here obtained by Rev. H. H. Wood, seems to be due to *all* the beds having been taken as Cornbrash. Amongst his collection are found numerous Gasteropods not known elsewhere, which have not been here included as Cornbrash fossils for this reason.

6. STOURTON CAUNDLE TO WINCANTON.—There are two quarries between Bishop's and Stourton Caundle with Cornbrash confined to the top layers, and more massive beds below; they require caution therefore in collecting. There were also recorded a quarry at Stalbridge Weston and others along the ridge that runs *viâ* Templecombe to Wincanton. But I could neither find them nor hear of them, and conclude they were temporary exposures or even railway cuttings. The road sections at Wincanton are peculiar, and their character as Cornbrash I was unable with certainty to recognise.

7. FROME DISTRICT.—The neighbourhood of Frome shows the Cornbrash perhaps reduced to its minimum; it scarcely makes a feature below the flat surface of the Oxford Clay. There is seldom more than three or four feet of it, and when the rubble of which it is made is extracted, the openings are again closed. Such may be spoken of as "shallow openings." There is seldom a chance of including any Forest Marble fossils with theirs, for the openings seldom sink so far. One such has been made on the north-west of Berkeley. At Road the sides of the two roads leading down from the village to the river show a thicker mass of very loose rubble, but the quarry on the west side of the river, about half a mile north of the village, is in "blue shelly limestone" and is not, therefore, free from doubt. Chatley, whence some of Sowerby's fossils

were obtained, is about a mile and a half north-west of Road, and here, opposite the lodge, is an overgrown quarry in Forest Marble, but a little further up the hill the surface of the ground is strewn with Cornbrash fossils. At Trowbridge all the openings are now closed, and those available in 1850 ('Quart. Journ. Geol. Soc.,' vol. vi) are no longer so, which is unfortunate, for three species of Ammonites were recorded therefrom. At Hilperton all the former openings are now covered with market gardens. Probably most of the fossils there obtained belong to the Forest Marble. The rocks at Laycock, whence Mr. Walton, of Bath, recorded many fossils, are now referred on the survey maps to the Forest Marble likewise. But at Westwood there is a broad spread of Cornbrash all over the village, seen in the roadside banks, especially towards the west, where six feet of rubble is shown. At Thingley also, nearer Chippenham, there is a shallow opening of the usual type.

8. At FOLLY FARM, opposite the ninety-sixth milestone on the road from London to Bath, is a very instructive quarry showing a long face of considerable depth, referred to by E. Hull ('Geol. of Parts of Wilts and Gloucestershire,' Geol. Surv. Sheet 34). In this the following section is seen :

| | Ft. in. |
|---|---------|
| 1. Hard brown denticles of stone (weathered) on the west side only | 0 10 |
| 2. Brash mixed with clay | 0 8 |
| 3. Broken up, very irregular, brash | 0 10 |
| 4. More solid brashy limestone | 2 0 |
| 5. More solid limestone, with a base of mingled material full of <i>Mycetes</i> casts | 1 0 |
| a. Brown laminated carbonaceous clay with drift-wood | |
| 2 in. at each end, increasing at the west to | 2 2 |
| b. Shelly layers of Forest Marble with intervening clays characterised by <i>Terebratula</i> | |
| <i>maxillata</i> and <i>Lima cardiformis</i> | 10 0 |

The most remarkable features in this section are the thinning out of the clay Bed *a* in so short a space, suggesting a local unconformity, and the absolute distinction of the fossils of Bed *b* from those of Nos. 1—5. These latter alone, which are all of a brashy character and contain abundance of *Avicula echinata*, are taken to represent the Cornbrash, and the quarry is considered as a justification for a similar separation elsewhere. The Beds Nos. 1—3 are the most easily broken up and the most fossiliferous, and Nos. 4 and 5 more solid and less fossiliferous. In the numerous shallow openings of the neighbourhood and elsewhere the Cornbrash is sometimes of the character of Nos. 1—3 and sometimes of Nos. 4 and 5. In the latter case the upper three beds have probably been washed away, as, for instance, in the shallow opening at Biddestone close by.

9. CHIPPENHAM is a name often used, but there are at the time of writing few satisfactory openings, and these are usually only temporary.¹ Nevertheless,

¹ Since the above was written one has been opened up.

the matrix of most of the fossils is most like that found at Sutton Benger, of grey colour with narrow black specks. In this case they are probably Cornbrash specimens, but there is the possibility that when brought from excavations they may be taken as Oxfordian instead.

10. SUTTON BENDER is the name applied to many specimens, but there is no Cornbrash at the village itself. It was the home of Wm. Buy, a well-known collector who distributed many fossils obtained by him in the neighbourhood. There is, however, a spot in the middle of the area marked Oxford Clay in the Geological Survey Map where a clay pit is sunk, at the base of which the Cornbrash is reached. It is on the road to Heath Farm, and the section here exposed is:

| Oxford Clay with an 18-in. basement bed composed of fragments of shells, mostly <i>Terebratula</i> . | | Ft. in. |
|---|--|---------|
| 1. Crystalline solid shell limestone of peculiar brashy aspect | | 3 0 |
| 2. Dark blue brash, weathering brown to the base of the quarry | | — — |

This last bed corresponds, no doubt, to the usual brash, but it is here seen unweathered. It is full of *Avicula echinata*. Below this there are said to be ten feet or so of stone-bands, below which is reported salt and then some more stone. No doubt some of the fossils recorded by Wright and others have come from this pit, as well as some labelled generally Chippenham.

11. CHIPPENHAM TO MALMESBURY.—Between Stanton St. Quintin and Lower Stanton there are two deserted quarries showing both Cornbrash and Forest Marble. The one west of the main road to Malmesbury is mainly of the latter rock. Another, by the side of the road leading past Lower Stanton, is interesting as the locality observed by Opper. It is not entirely Cornbrash. The long section here consists of:

| | | Ft. in. |
|--|----------|---------|
| 1. Hard brown-weathering lenticular band | | 1 0 |
| 2. Soft yellow brash with few stones | | 0 8 |
| 3. Contorted brash, harder pieces arranged in festoons | | 1 6 |
| 4. More regular brash, with darker and smaller pieces | | 1 8 |
| 5. Solid band | 2 in. to | 0 8 |
| 6. Regular brash | | 3 0 |
| 7. Dark blue brash, with argillaceous intervals | | 0 10 |
| 8. Clay and brash mixed, nodular, it weathers light | | 2 0 |
| a. Soft dark clay with hard Forest Marble band | | 3 0 |
| b. Solid shelly false-bedded Forest Marble | | 10 0 |

It is from Beds Nos. 7 and 8 that the dark bluish fossils from this locality have been obtained, and the Cornbrash must extend downwards at least as far as these. The strata below have the character of the Forest Marble. In this locality, therefore, the strata are continuous.

The shallow opening at the sixth milestone from Chippenham, described by

H. B. Woodward, has three feet of loose shelly material, with many small echinoderms at its base, with a lenticularly weathering band of hard stone above, about one foot. This and an opening at Corston, as also the beds at Hullavington Station, are fairly comparable to those at Sutton Bengier; but the beds exposed at the Bradfield end of the railway cutting seem to belong to the Forest Marble, at least in part.

12. GARSDON AND CHARLTON.—The only locality in these two quarries which can be compared to the Cornbrash is in the north-east corner of Garsdon Quarry, where the long face is worked back along the dip, thereby showing higher beds than any seen elsewhere :

| | Ft. in. |
|---|---------|
| 1. Clays without noticeable fossils. | |
| 2. Loose rubbly mass of calcareous matter with numerous fossils, including <i>Macrocephalites</i> and <i>Microthyris lagenalis</i> | 2 0 |
| Solid limestone for which the quarry is worked to the bottom. | |

On turning the south-east corner the dip again appears, and then bedded, soft, and almost brashy beds rise from beneath. These are plentifully supplied with echinoderms of different species from those above (No. 2). The solid limestone is the main bed, and extends into the long worked and now deserted Charlton quarry. It doubtless forms part of the Forest Marble, as *Terebratulina digona* has been quoted from it by Prof. J. Buckman.

13. MURCOTT.—At a distance of two miles due north from Garsdon, near Murcott Farm, there is a shallow opening of the ordinary type which is remarkable for the number of *Astarte* and *Anabacia* which it contains. The Forest Marble and other beds that should lie below it are seen at a distance of half a mile at Hankerton Field Farm. At Pool Keynes and at Sandy Lane other beds corresponding to them are mapped as Cornbrash.

14. CIRENCESTER district was formerly much more fully exposed, but the exposures, mostly in railway cuttings, are not now available. The best of them from the Midland and South Western Junction Railway south of Watermoor was recorded by H. B. Woodward (*op. cit.*, pp. 443, 444), who gives the following section :

| | Ft. in. |
|---|---------|
| 1. Earthy limestone, with an intervening marly clay | 4 0 |
| 2. Impure marly and sandy clay, with nodular limestones containing <i>Am. macrocephalus</i> and <i>Ostrea flabelloides</i> , etc. | 1 0 |
| 3. Hard earthy limestone, with few fossils | 3 0 |
| 4. Earthy limestone and marl, with large ammonite | 1 0 |
| 5. Earthy and shelly limestones, with seams of marly clay containing <i>Nautilus</i> and <i>Avicula echinata</i> , etc. | 6 0 |

Here we find a repetition of the upper limestones with *Macrocephalites* at the top and the rubbly form with *Avicula echinata* at the base, as we have seen at

Weymouth. The various members of the Cornbrash are seen scattered about the neighbourhood, but their position relatively to the above can only be determined by the fossils. Thus there are two quarries on the roads leading from Driffield Cross to S. Cerney; that on the northern road is probably high in the sequence as containing a species of Ammonite, that on the south may be lower as containing a *Nautilus*.

15. FAIRFORD TO WOODSTOCK.—In all this flat country the Cornbrash appears to be reduced to its minimum, and forms a mere surface capping exposed in a series of shallow openings, and the fossils are principally composed of the larger and rougher sorts. Some of these shallow openings may be seen: between Fairford and Hathrop, between Fairford and Southrop, east of Southrop, and on Curbridge Down. It forms a capping only to lower strata in quarries at Alvescott, at the cross-road west of Shield Farm, at the side of the Woodstock Road near Whitney, probably the locality of Horton's fossils (see p. 19, No. 27), and in the railway line at Handborough. The coral bed of Fairford has already been proved to belong to the Great Oolite (see Woodward, *op. cit.*, p. 296).

16. AT SHIPTON-ON-CHERWELL on the Woodstock Branch Railway, east of the Banbury Road, is seen a complete section from the Oxford Clay to the Forest Marble Clay, of which the following description is given by H. B. Woodward (*op. cit.*, p. 44):

| | Ft. in. |
|---|---------|
| 1. Rubbly and fissile marly limestone, with lignite, <i>Waldheimia lagenalis</i> | 1 0 |
| 2. Impure limestones, with lignite, etc. | 1 2 |
| 3. Hard mottled limestones, <i>Waldheimia lagenalis</i> | 1 6 |
| 4. Soft earthy and shelly marl and mottled blue and grey limestone, <i>Avicula echinata</i> , etc. | 4 0 |
| 5. Hard bluish limestones with marly patches, <i>Avicula echinata</i> , etc. | 2 0 |
| 6. Fissile marly beds and tough brown and grey shelly limestone, with <i>Avicula echinata</i> and <i>Terebratula intermedia</i> | 2 0 |
| Forest Marble Clay, 6 feet, etc. | |

The horizon of fossils obtained from the spoil-heaps when the railway was being made can only be judged from the matrix, which leaves in some cases room for error. *Macrocephalites* has been recorded from this section, but not from any definite position.

17. KIDLINGTON, KIRKLINGTON, AND ISLIP.—The exposure known as Kidlington is a now deserted pit by the side of a field path branching off to the north from the road leading from the village to the station. Many fossils have been recorded thence and may still be found. Woodward's section may still be seen:

| | Ft. in. |
|--|---------|
| 1. Rubbly limestone, with <i>Avicula echinata</i> | 4 0 |
| 2. Grey racy clay | 0 8 |
| 3. Rubbly limestone, with <i>Terebratula</i> in the lower part | 3 0 |

- | | |
|-------------------------------------|------------------|
| a. Gritty limestone, 6 ins. | } Forest Marble. |
| b. Laminated sands and clays, 1 ft. | |
| c. Oolitic limestone, 3 ft. | |

In this section the basal beds of Shipton-on-Cherwell are seen, but the underlying Forest Marble has changed, in 2400 yards, from clay to fossiliferous limestone, and the greatest care is therefore necessary in examining the matrix of the recorded fossils.

At Kirklington there is a very large quarry in the Bathonian limestone, with only a capping of not very fossiliferous Cornbrash, the records of which can only be received with caution.

At Islip likewise the fossils were obtained from a band of Cornbrash capping about five feet of Forest Marble Clay, underlain by Bathonian Oolite, but at the date when the fossils were collected by Mr. J. F. Whiteaves a wider meaning was given to the name of Cornbrash than is adopted here or generally received. Mr. Whiteaves, however, has kindly informed me which specimens he remembers to have been obtained from the lower strata, then associated with the Cornbrash, so that any source of error may be eliminated.

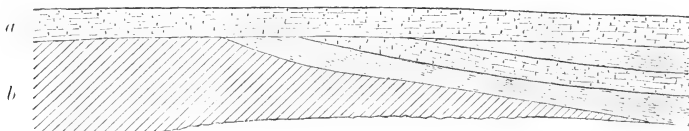


FIG. 1.—Unconformity near Bicester. a. Cornbrash with *Avicula echinata*. b. Various members of the Forest Marble series.

18. BICESTER TO BEDFORD.—Two quarries are situated near Bicester Workhouse showing rubbly Cornbrash overlying more massive building stone. The farther one shows two sections along the sides of a re-entering angle, in which the lower beds change, while the upper, with *Avicula echinata*, remain constant (text-fig. 1); thus the Cornbrash rides over a false-bedded section unconformably.

At Blackthorn the rubbly Cornbrash is very distinct from the well-bedded Forest Marble strata, and yields many of the characteristic fossils. On the road to Buckingham only shallow openings are shown, and at Fringford it is only reached at the base of an Oxford Clay brickyard. At Akely brickyard there is now a very curious section, greatly affected by faults, the effects of which are hard to realise; but the Cornbrash itself seems to be represented by a limestone irregularly packed with fossils faulted between infra-Callovian clay and Great Oolite Clay. At Bedford the Cornbrash is only exposed by cutting beneath the Oxford Clay. Such was the case in an excavation made for the Midland Railway on the south side of the main line. Many fine fossils were thence obtained, and some of the stone is now placed in the wall adjoining the entrance to the Ampthill tunnel.

19. STEVENTON, BOURNE END BLETSOE, AND RUSHDEN.—In the first two localities the Cornbrash forms the base of Oxford Clay brickpits, which contain doggers of large size such as occur in the south. At Rushden, on the contrary, we see the underlying beds in abundance, and the Cornbrash is everywhere covered; only local traces of it can be recognised by the curious matrix of its fossils. This is in aspect very like the rock at Scarborough, and is sub-oolitic in character. A large number of fossils were obtained while building was going on.

20. THRAPSTON.—The original quarry whence most of the recorded fossils were obtained is situated by the side of the Midland Railway station. It is not now worked and is somewhat obscured by age. It has been described by Woodward. There is now a newer quarry a mile and a half west of the town, opposite the Islip furnaces, which may go by the name of Thrapston to save confusion with the Islip in Oxfordshire. It shows a freshly worked face of about two hundred yards, yielding the following section :

| | | |
|--|---|---------|
| Boulder clay—derived from the Oxford Clay. | } | |
| 1. Hard brashy limestone | } | 5 feet. |
| 2. Loose and clayey brash, with broken shells | } | |
| 3. Rather solid brash, with <i>Macrocephalites</i> | } | |
| 4. Softer brash, with <i>Waltheimia lagenalis</i> | } | |
| a. Great Oolite Clay, 12 feet. | | |
| b. Massive Great Oolite Limestone, 11 feet. | | |

Here no confusion between one horizon and another is possible (except in the spoil heaps). It may be noted that the *Macrocephalites* is rather in the upper portion of the five feet to which the Cornbrash is limited.

21. BARNWELL AND OUNDLE.—On the north side of the village of Barnwell, Northants, beyond the Castle, there is a quarry worked for the Great Oolite. This is a massive rock, and is covered by about eight feet of blue-black clay. The surface of this is bent into a low festoon, having a maximum thickness of about two feet six inches, which is filled with a fossiliferous rubble of Cornbrash fossils, with harder bands at the top and bottom. At Oundle there appear to be no exposures of Cornbrash: the only quarry in work on the north side of the town shows nothing higher than the Great Oolite Clay—the others are all grassed over.

22. FINESHADE.—In the railway cutting between Fineshade Abbey and Kingscliffe there is an excellent section giving a complete view of the succession about this district, the beds dipping gently to the east :

| | Feet. |
|--|-------|
| Oxford Clay, with doggers widely separated | 40 |
| 1. Loose, dark-coloured brash, <i>Alectryonia</i> abundant | 1 |
| 2. Two courses of purplish massive limestone | 4 |
| a. Clay | 10 |
| b. Five courses of Great Oolite Limestone | 10 |

Thus the Cornbrash is isolated amongst clays. The upper part is here characterised by *Alectryonia*.

23. YAXLEY OR STILTON.—Under one or other of these names numerous and important fossils have been recorded, but nothing can be seen in the district at the present time. The fossils were obtained from an opening between the two places named, now grassed over, but originally sunk through Oxford Clay till it reached hard beds referred to the Cornbrash. These do not seem to have been pierced, so that it resembles the pit at Sutton Benger, in Wilts.

24. PETERBOROUGH.—Along the sides of the united railways north of Peterborough Station a considerable area of Cornbrash is exposed, three or four feet in thickness, but part of it is left as a floor, so that the base is not visible. It is probably thicker than when last seen at Fineshade, twelve miles to the west, as it spreads over an area at various deviations in the city and extends by the roadside as far as Walton. But the best exposure made in the area is near Castor, where is a quarry on the west side of Milton Park. Here is seen eight feet of pretty solid stone weathering in the usual irregular lenticles. This is said to rest upon clay. The rubbly character of the base is not shown, but the higher bed is indicated by the abundance of the *Macrocephalites* in it.

25. AREA NORTH OF PETERBOROUGH.—In the undulating country north of Peterborough to the neighbourhood of Lincoln numerous Cornbrash localities have been quoted, but they are mostly unverifiable at the present day, as was to be expected. I have not found in this area any locality yielding a section through the Cornbrash so as to show its complete development. All sections are only shallow openings. One is seen on the road towards Market Deeping, four miles out of Peterborough, behind an Oxford Clay pit. Signs of the Hanthorpe pit, where *Terebratula bentleyi* was first found, are still recognisable. At Quarrington, on this side of Sleaford, a road-stone quarry still exists. At Roxholme a typical shallow opening is worked while it lasts. At Sudbrook, east of Lincoln, there is still the edge of the old working that has yielded so many fossils, and six miles further on a new shallow opening has been made, at Walton.

26. OUTLIERS TO THE WEST OF THE CONTINUOUS RANGE.—The outliers that are found near Northampton owe their position to having been let down by faults along with the strata on which they rest. In the case of Stowe Ninechurches these consist of a complete sequence of beds from the Oxfordian Clays to the Upper Estuarine Beds. It is plain from this that the Cornbrash must be included. Mr. Beeby Thompson, who first described it, assigns a single bed to the Cornbrash, the upper part of which contains characteristic fossils, the lower part containing only the demoid forms which are common to more than one horizon. This exposure is also remarkable for the last presence of the Forest Marble, known by the quality of stone and the presence of vegetable remains, and still only demoid fossils—that is, fossils common also to the Cornbrash. Other

Cornbrash fossils have been obtained from well-sinkings at Roade, Woodford, and Quinton in the same county, known by their sequence in a vertical succession between two clays.

27. NEAR APPLEBY.—At the Appleby Station (Lincolnshire) there are now only banks to be seen with stone at the base, containing loose fossils of no definite character. At a lower level on the opposite side of the road is a deep clay pit, and at a higher level there are large masses of sand, which may either be Kellaway Sand or derived from it by drift agencies. The lower clay must be "Great Oolite Clay," "perhaps forty feet thick," but there are no exposures of the Cornbrash between. It may be assumed, therefore, that the Cornbrash is very thin here, and that it "occupies the surface of the ground," or rather did so before it was removed from where the station now stands.

Between Thornholme Priory and the old river Ancholme there is another area where excavations have been made in the level surface. In the sides of these excavations, now filled with water, a foot or two of rubbly Cornbrash is seen resting on a dark clay, which holds up the water. The Cornbrash is not very fossiliferous, but the underlying clay is full of small oyster fragments, apparently *O. subrugulosa*, heaped together by the entrance of new conditions.

It will be noted that were it not for artificial openings neither of these exposures would be known. When, therefore, elsewhere, as farther south or across the Humber in the South of Yorkshire, no Cornbrash is known, the reason is just as likely to be lack of artificial openings as absence of the stratum itself.

Yorkshire Localities.

28. STONECLIFF WOOD.—The succession of the Jurassic rocks on the south side of the Pickering Valley synclinal is less easily followed than on the north. Nevertheless we have from the pen of Mr. Hudleston a very clear account of what is to be seen in Stonecliff Wood ('Proc. Geol. Assoc.,' vol. iii). The beds No. 8 of his section, called the Stonecliff Wood series, consist of three parts, viz.:

| | Feet. |
|--|-------|
| 1 (e). "A perfect mass of fossils" | 7 |
| 2. "Loosish red and white sand" | 18-20 |
| 3 (d). "Hard fossiliferous band" | 2-3 |

No. 1 is followed after a short interval by Kellaway (?) Sand, and that by the Oxford Clay. From the observed character and relations of the Cornbrash elsewhere, we should have no difficulty in recognising the Bed 1 (e) as its representative, unless the fauna forbade it. There is, however, no *Macrocephalites* or other Ammonite recorded in any bed, but *Trigonia signata* is recorded, a species which nine years later Lycett ('Suppl. Brit. Foss. Trigoniæ') recognised as

occurring in Yorkshire only at Cloughton, near Scarborough, though Wright had already recorded it from the Cornbrash of Scarborough.

29. SCARBOROUGH.—The Cornbrash is here no longer to be seen. A solitary block of it amongst the *débris* on the north side of the Castle was all I could recently find. In Bean's days (1838) he described its range as easily observed; and in Wright's time (1860) he states "the rock has been worked out and will be shortly covered up." When I first knew the locality the shore was largely strewn with its blocks, mingled with those of the Kellaway rock—now there is a roadway over all. We are, therefore, entirely dependent on the past. Fortunately the matrix, of purplish oolitic aspect, is very distinct from the only other fossiliferous zone here, the yellow Kellaway Sandstone, and when recognised is absolutely decisive. The fossils here have one great advantage over almost all localities in the south: they are autochthonous, and not mixed with any deposit made during an earlier epoch.

30. CAYTON BAY.—In this bay the position and composition of the Cornbrash are perfectly clear. At the north end it is faulted and spread out on the foreshore, but at the south end the following section is seen:

Kellaway Sandstone in the cliff—

| | Ft. in. |
|---|---------|
| 1. Shales with <i>Avicula brambariensis</i> , Crustacea, and <i>Macrocephalites</i> | 8 0 ? |
| 2. Hard shaly band full of <i>Ostrea marshii</i> on the surface | 0 8 ? |
| 3. Hard ferruginous dogger band, with <i>Macrocephalites</i> forming a strong scar | 0 10 |
| 4. Soft gritty rubble bed full of broken shales | 0 8 |
| a. Pale clay with a sharp boundary above and no sign of a fossil. | |

The inclusion of the *Avicula*-shales with the ordinary fossil-bearing masses below is justified by the occurrence of *Macrocephalites* in them, and confirmed by the overlying rocks containing the three characteristic Ammonites of the next zone, *modiolaris*, *koenigi*, and *gowerianus*, but when this development is compared with that at Weymouth we learn the variation of lithological characters in general. Here the upper part of the Cornbrash is shale, at Weymouth largely limestone; while the overlying beds are here of sandstone, at Weymouth largely clay.

In this locality the bed here included with the Kellaway rock, being seen *in situ*, has not always been distinguished from the Cornbrash, but it is darker in colour, with lighter oolitic grains, and the fossils are not always identical.

CHRONOLOGICAL LIST OF WRITINGS RECORDING SPECIES OF
FOSSILS REFERRED TO THE CORNBRASH.

The following list comprises those writings which are original authorities for the occurrence of fossils in the Cornbrash, whether figured, described, or named only, whether recorded before or not, whether rightly assigned to the Cornbrash or not, but not those which deal with corrections of nomenclature only or merely quote the lists of others. The numbers in brackets at the end of each item indicate the number of supposed additions to the fauna made by each.

1. 1812-27. SOWERBY, J. and J. de C., 'The Mineral Conchology of Great Britain,' vols. i-v (28).
2. 1816. SMITH, W., 'Strata identified by Organised Fossils' (3).
3. 1822. CONYBEARE, W. D., 'Outlines of the Geology of England and Wales' (4).
4. 1832. LONSDALE, W., "On the Oolitic District of Bath," 'Trans. Geol. Soc.,' ser. ii, vol. iii (3).
5. 1835. PHILLIPS, J., 'Illustrations of the Geology of Yorkshire,' Pt. I, 2nd ed. (29).
6. 1839. BEAN, W., "A Catalogue of the Fossils found in the Cornbrash Limestone of Scarborough," 'Mag. Nat. Hist.,' ser 2, vol. iii (79).
7. 1850. MORRIS, J., "List of Organic Remains obtained by Reginald N. Mantell, Esq., from the Railway Cutting above discussed" (near Trowbridge), 'Quart. Journ. Geol. Soc.,' vol. vi (2).
8. 1850. LYCETT, J., "Tabular view of Fossil Shells from the Middle Division of the Inferior Oolite in Gloucestershire," 'Ann. Nat. Hist.,' ser. 2, vol. vi (1).
9. 1851-4. MORRIS, J., and LYCETT, J., "A Monograph of the Mollusca of the Great Oolite," 'Pal. Soc.' (8).
10. 1851-2. DAVIDSON, T., "British Fossil Brachiopoda," vol. i, 'Pal. Soc.,' (5).
11. 1851. WRIGHT, T., "On the *Cidaridæ* of the Oolites," 'Ann. Nat. Hist.,' ser. 2, vol. viii (3).
12. 1852. WRIGHT, T., "On the *Cassidulidæ* of the Oolites," 'Ann. Nat. Hist.,' ser. 2, vol. ix (2).
13. 1853. BUCKMAN, J., "On the Cornbrash of the Neighbourhood of Cirencester," 'Ann. Nat. Hist.,' ser. 2, vol. xii (3).
14. 1853. MORRIS, J., "On some sections in the Oolitic district of Lincolnshire," 'Quart. Journ. Geol. Soc.,' vol. ix (2).
15. 1854. MORRIS, J., 'A Catalogue of British Fossils,' 2nd ed. (8).
16. 1854. HAIME, J., "Description des Bryozoaires Fossiles de la Formation Jurassique," 'Mém. Soc. Géol. France,' ser. 2, vol. v (1).
17. 1855. WRIGHT, T., "On a New Genus of Fossil *Cidaridæ*, with a Synopsis of the Species included therein," 'Ann. Nat. Hist.,' ser. 2, vol. xvi (1).
18. 1855. LYCETT, J., 'The Cotteswold Hills' (8).
19. 1856. WOODWARD, S. P., "Notes on British Fossil Diademas," 'Mem. Geol. Surv.,' Decade v (2).
20. 1855-8. WRIGHT, T., "A Monograph of the British Fossil Echinodermata, Oolitic," vol. i ("Echinoidæ"), 'Pal. Soc.' (12).
21. 1856-8. OPPEL, A., "Die Juraformation Englands, Frankreichs und des Südwestlichen Deutschlands," 'Württemb. Naturw. Jahreshefte,' xii-xiv (9).
22. 1857. HULL, E., "The Geology of the Country round Cheltenham" (Fossils by R. ETHERIDGE) 'Mem. Geol. Surv.' (2).
23. 1858. BUCKMAN, J., "On the Oolitic Rocks of Gloucestershire and North Wiltshire," 'Quart. Journ. Geol. Soc.,' vol. xiv (7).

24. 1858. HULL, E., "Geology of Parts of Wiltshire and Gloucestershire" (Fossils by R. ETHERIDGE), 'Mem. Geol. Surv.' (sheet 34).
25. 1859. LECKENBY, J., "On the Kellaway Rock of the Yorkshire Coast," 'Quart. Journ. Geol. Soc.,' vol. xv (12).
26. 1859. HULL, E., "Geology of the Country round Woodstock" (Fossils by R. ETHERIDGE), 'Mem. Geol. Surv.' (9).
27. 1860. HORTON, W. S., "On the Geology of the Stonesfield Slate and its Associate Formations," 'Geologist,' vol. iii (2).
28. 1860. WRIGHT, T., "On the Sub-divisions of the Inferior Oolite in the South of England, compared with the equivalent Beds of that Formation in Yorkshire," 'Quart. Journ. Geol. Soc.,' vol. xvi (11).
29. 1861. MACALISTER, J. H., "The Fossils of North Bucks and the adjacent Counties," 'Geologist,' vol. iv (2).
30. 1861. PORTER, H., 'The Geology of Peterborough and its Vicinity' (1).
31. 1861. WHITEAVES, J. F., "On the Oolitic Echinodermata of the Neighbourhood of Oxford," 'Geologist,' vol. iv.
32. 1861. WHITEAVES, J. F., "On the Invertebrate Fauna of the Lower Oolites of Oxfordshire," 'Rep. Brit. Assoc.,' 1860 (24).
33. 1862. OPPEL, A., "Palæontologische Mittheilungen," Pt. III, 'Ueber Jurassische Cephalopoden.'
34. 1863. LYCETT, J., "Supplement to the Monograph of the Mollusca of the Great Oolite," 'Pal. Soc.' (35).
35. 1864. GREEN, A. H., "The Geology of the Country round Banbury, Woodstock, Bicester, and Buckingham," 'Mem. Geol. Surv.' (2).
36. 1865. HUXLEY, T. H., and ETHERIDGE, R., "A Catalogue of the Collection of Fossils in the Museum of Practical Geology," 'Geol. Surv.' (18).
37. 1869. DESLONGCHAMPS, E., 'Notes Palæontologiques, Monographie iv, Le Jura Normand' (1).
38. 1871. NEUMAYR, M., "Die Cephalopoden von Balin," 'Abh. k.k. Geol. Reichsanst.,' vol. v (1).
39. 1871. PHILLIPS, J., 'The Geology of Oxford and the Valley of the Thames' (8).
40. 1872. WRIGHT, T., "On the Correlation of the Jurassic Rocks in the Department of the Côte d'Or, France, with the Oolitic Formation in the Counties of Gloucester and Wilts, England," 'Proc. Cotteswold Nat. F. C.,' vol. v.
41. 1872-9. LYCETT, J., "A Monograph of the British Fossil Trigonæ," 'Pal. Soc.' (6).
42. 1873. SHARP, S., "The Oolites of Northamptonshire," Pt. II, 'Quart. Journ. Geol. Soc.,' vol. xxix (12).
43. 1874-6. HUDESTON, W. H., "The Yorkshire Oolites," Pt. I, 'Proc. Geol. Assoc.,' vol. iii; Pt. II, *ibid.*, vol. iv (3).
44. 1875. JUDD, J. W., "The Geology of Rutland," 'Mem. Geol. Surv.' (11).
45. 1875. PHILLIPS, J., "Geology of Yorkshire," Pt. I, 3rd ed. (Fossils by R. ETHERIDGE) (18).
46. 1875. CROSS, J. E., "The Geology of North-west Lincolnshire," 'Quart. Journ. Geol. Soc.,' vol. xxxi (Fossils by R. ETHERIDGE) (2).
47. 1876-78. DAVIDSON, T., "Supplement to the Monograph of the British Fossil Brachiopoda," vol. iv ("Oolitic") 'Pal. Soc.' (8).
48. 1877. MANSEL-PLEYDELL, J. C., "Notes on a Gavial Skull from the Cornbrash of Clossworth. With a description of the same by J. W. HULKE," 'Proc. Dorset Nat. Hist. F. C.,' vol. i (1).
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50. 1880-85. HUDLESTON, W. H., "Contributions to the Palæontology of the Yorkshire Oolites," 'Geol. Mag.,' Dec. 2, vol. ii, and Dec. 3, vols. i and ii (8).
51. 1883. VINE, G. R., "Third Report of the Committee on Fossil Polyzoa," 'Rep. Brit. Assoc.' (3).
52. 1883. HINDE, G. J., 'Catalogue of the Fossil Sponges in the Geological Department of the British Museum' (1).
53. 1883. TOMES, R. F., "On the Fossil Madreporaria of the Great Oolite of the Counties of Gloucestershire and Oxfordshire," 'Quart. Journ. Geol. Soc.,' vol. xxxiv (22).
54. 1883. WHIDBORNE, G. F., "Notes on some Fossils, chiefly Mollusca, from the Inferior Oolite," 'Quart. Journ. Geol. Soc.,' vol. xxxix (1).
55. 1884. DAMON, R., 'Handbook to the Geology of Weymouth and the Island of Portland,' new edition (3).
56. 1885. WALFORD, E. A., "On the Stratigraphical Position of the Trigonæ of the Lower and Middle Jurassic Beds of North Oxfordshire and Adjacent Districts," 'Quart. Journ. Geol. Soc.,' vol. xli (1).
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58. 1886. WOODWARD, H. B., "Account of a Well-sinking made by the Great Western Railway Company at Swindon," with lists of Fossils, by E. T. NEWTON, 'Quart. Journ. Geol. Soc.,' vol. xlii (5).
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60. 1887. PLATNAUER, H. M., "On the Occurrence of *Strophodus Rigauxi* (Sauv.) in the Yorkshire Cornbrash," 'Rep. Yorks. Phil. Soc.,' 1886 (1).
61. 1888. USSHER, W. A. E., "Geology of the Country round Lincoln," 'Mem. Geol. Surv.'
62. 1889. LYDEKKEE, R., 'Catalogue of the Fossil Reptilia and Amphibia in the British Museum' (Natural History), vol. i (1).
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64. 1890. USSHER, W. A. E., "The Geology of North Lincolnshire and South Yorkshire," 'Mem. Geol. Surv.' (1).
65. 1890. WOODWARD, A. S., and SHERBORN, C. D., "A Catalogue of British Fossil Vertebrata' (1).
66. 1891. HARKER, ALLEN, "On the Geology of Cirencester Town, and a recent Discovery of the Oxford Clay in a deep Well-boring at the Waterworks," 'Proc. Cotteswold Nat. F. C.,' vol. x.
67. 1891. THOMPSON, B., "The Oolitic Rocks at Stowe-Nine-Churches," 'Journ. Northants Nat. Hist. Soc.,' vol. vi (4).
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70. 1893. VINE, G. R., "Notes on the Polyzoa, *Stomatopora* and *Proboscina* Groups, from the Cornbrash of Thrapston, Northamptonshire," 'Proc. Yorks. Geol. and Polyt. Soc., new series, vol. xii, pt. iii (8).
71. 1894. WOODWARD, H. B., "The Jurassic Rocks of Britain," vol. iv, "Lower Oolitic Rocks of England," 'Mem. Geol. Surv.' (22).
72. 1895-96. GREGORY, J. W., "A Revision of the Jurassic Bryozoa," 'Ann. and Mag. Nat. Hist., ser. 6, vols. xv-xvii. Repeated in 'Catalogue of the Jurassic Bryozoa in the British Museum (Natural History)' (17).

73. 1896. GREGORY, J. W., "*Stomatopora Smithii*," 'Rep. Yorks. Phil. Soc.'
74. 1901. WINWOOD, H. H., "Excursion to the new G.W.R. Line from Wootton Bassett to Filton," 'Proc. Geol. Assoc.,' vol. xvii.
75. 1902. REYNOLDS, S. H., and VAUGHAN, A., "On the Jurassic Strata cut through by the South Wales Direct Line between Filton and Wootton Bassett," 'Quart. Journ. Geol. Soc.,' vol. lviii (1).
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Nomenclature—General.

77. 1904. FOX-STREANGWAYS, C., "The Geology of the Oolitic and Cretaceous Rocks south of Scarborough" (1st ed., 1880), 2nd ed., 1904, 'Mem. Geol. Survey.'
78. 1904. LANG, W. D., "Jurassic Polyzoa," 'Geol. Mag.,' Dec. 5, vol. 1, p. 515.

DESCRIPTION OF THE FAUNA.

VERTEBRATA.

Class REPTILIA.

THE remains of reptiles from the Cornbrash are not numerous, the rubbly nature of the deposit not being suitable for their preservation. The following is a list of the records of this class that have hitherto been made.¹

**Cimoliosaurus brevior*.

**Stencosaurus stephani* (48).

**Megalosaurus bucklandi* (62).

**Teleosaurus subulidens* (39).

**Stencosaurus boutilieri* (37).

Cimoliosaurus brevior.—The entry of this Kimeridgian type of Plesiosaur as a Cornbrash fossil seems to have originated in an error. The name is entered as Kimeridgian in Lydekker's 'Catalogue of the Fossil Reptilia, etc.,' Pt. II, p. 243, and on the same page are entered some vertebræ as "specifically indeterminate," one of them being stated to be from the Cornbrash of Stilton; but the two entries have no connection with each other.

Megalosaurus bucklandi.—In the British Museum, No. 47,169, there is a trunk vertebra said to be "from the Cornbrash, locality unknown." It is "provisionally" referred to this species (see Lydekker, 'Cat. Foss. Rept.,' Pt. I, p. 161). It has no matrix and the only guide to its origin is that it formed part of the Sharp collection. This is not considered sufficient authority for the horizon of the fossil being Cornbrash.

Stencosaurus boutilieri.—With regard to this name we have the following information (A. S. Woodward, 'Geol. Mag.,' Dec. 3, vol. ii, p. 501, note): "Under this name M. Deslongchamps ('Notes Paléont.,' p. 230, pl. xvi, fig. 2) mentions a plaster cast of a skull and mandible from the Cornbrash near Oxford received from the Bristol Institution, and labelled *Crocodylus oxoniensis* Conybeare. . . . But Mr. Edward Wilson . . . is unable to discover any such label in the collection and the present whereabouts of the original specimen seems to be unknown." Nor is it mentioned under either name in Phillips'

¹ In the following lists an asterisk denotes that the name is included in either or both of the lists given by H. E. Woodward and Fox-Strangways in the 'Mem. Geol. Surv.' The numbers in brackets refer to the foregoing list of publications. Names printed in capitals denote those which are adopted, those in italics those which are rejected.

‘Geology of Oxford.’ It will be necessary to wait for further information before admitting this into the known Cornbrash fauna.

Steneosaurus stephani.—The specimen on which this record is founded was obtained from a quarry at Closeworth, in Dorsetshire. It is now in the British Museum, where it is labelled as from the Cornbrash and catalogued as such by Mr. Lydekker (Pt. I, p. 114). But the matrix does not resemble the ordinary Cornbrash in that district. On inquiry of the discoverer of the fossil, the late Mr. Mansel-Pleydell, he kindly informed me that the specimen was extracted by the fossil-collector, Mr. Reynolds, who gave him the following account of the quarry, now grassed over, in which it was found.

| | Ft. | in. |
|--|-----|-----|
| Cornbrash | 0 | 4·9 |
| Earthy matter | 2 | 0 |
| Rubbly ragstone | 1 | 0 |
| Solid, dark, cream-coloured beds | 3 | 6 |

It was in this last bed that the steneosaur lay, and the matrix of the fossil corresponds with the description. The three *overlying* beds also correspond to the usual Cornbrash, and a considerable thickness of stone similar to the fourth bed is seen on the opposite side of the valley near Yetminster, *underlying* the Cornbrash. I conclude, therefore, that the fossil in question was not obtained from the Cornbrash as here restricted. A steneosaurian vertebra, in the Sherborne Museum, found at Stalbridge Weston, and included amongst Cornbrash fossils, is in the same position as this—its horizon is doubtful. (See locality 5, Holwell.)

Teleosaurus subulidens.—This entry is founded on the following extract from Phillips’ ‘Geology of Oxford,’ p. 244: “*Teleosaurus subulidens* Phil. G. O. Enslow Bridge, Kirklington Station Quarries, C. B. Kidlington.” However, on p. 184 of the same volume it is stated that teleosaurian teeth were found in the Great Oolite at Kidlington, but nothing is said about Cornbrash. None are found so labelled in the Oxford Museum, but the lower part of the quarry at Kidlington is composed of beds below the Cornbrash, which contain reptilian bones (see locality 23). On these grounds it is not safe to assume that the crocodile known under the above name survived into Cornbrash times.

From this it would appear that there is no available evidence that any one of the reptiles hitherto recorded belong to the Cornbrash.

Order SAUROPTERYGIA.

Family PLESIOSAUROIDE.

Liopleurodon ferox, Sauvage. Plate I, figs. 1, 2.

1873. *Liopleurodon ferox*, Sauvage, Bull. Soc. Géol. France [3], vol. i, p. 378, pl. vii, fig. 1.

1880. *Polyptychodon ferox*, Sauvage, *loc. cit.*, vol. viii, p. 544.

1880. *Pliosaurus ferox*, Lydekker, Geol. Mag. [3], vol. v, p. 353; and Cat. Brit. Foss. Rept. B. M., vol. ii, p. 145.
1890. *Pliosaurus ferox*, Lydekker, Quart. Journ. Geol. Soc., vol. xlvi, p. 50, pl. v.

Skatype of species.¹—Described thus, *l. c.*: "At the base of the enamel the two diameters of the tooth are as 15 to 13. The root is entirely smooth and conically hollowed at the base. The enamelled portion is rather strongly curved and divided into two parts by a ridge extending to the summit on the anterior and posterior diameters. A strong ridge is also seen on each of the lateral faces, which continues the whole length of the enamel. The external face is divided into two by a strong keel reaching the summit; otherwise it is almost quite smooth, Elsewhere there are strong keels on the inner side, reaching various distances towards the summit." From the lowest zone of the Oxford Clay of Le Wast, near Boulogne.

Description.—Two teeth from the Cornbrash of Rushden showing the characteristic matrix are referred to this species. They do not agree absolutely with the above type, but more closely resemble specimens from the Oxford Clay of Peterborough which have been referred to it, being there associated with more typical forms. In the specimen figured in Pl. I, fig. 1 the section at the base of the crown is nearly circular, and the conical form is very regular; the fine ridges of the enamel proceed directly towards the summit, without showing the twist seen in more typical forms. The longitudinally convex side has very few ridges (7), and these not continuous. It is bounded by a continuous ridge on each side. The concave part has twenty-four more ridges of various lengths, but none especially central as in the type, and all are weak, giving a smooth aspect to the whole. In Pl. I, fig. 2, the ridges are somewhat stronger and more numerous on both sides but have no twist.

As we have only the teeth for examination, they are not sufficient for discussing the genus of the whole animal, for which reason a temporary name, *Liopteurodon*, was given them by the author; at a later date he decided it was a *Polyptychodon*. The teeth certainly agree better with Owen's definition of the latter genus, and disagree with his definition of *Pliosaurus*, so that as far as the teeth are a guide the name last adopted by Sauvage should be right. The associated bones, however, in this country have led to their being placed in *Pliosaurus*. If then the bones do not justify the use of the name *Polyptychodon*, neither do the

¹ If the original definition is defective or deals with a part only, the specimen is what may be called a SKIATYPE (shadow-type), subject to the laws of priority, but if it be erroneous in any essential respect it ceases to be the definition of a real species at all, and by the same laws is barred from use.

Type-specimens being the only ultimate units of fact, the union of associated specimens with them into a species and the union of several such species into a genus are matters of more or less certain inference only, which will naturally vary. Hence the bulk of the synonymy, long lists of which seem to me to be often little more than the substitution of one man's inferences for another's without reasons assigned.

teeth justify the term *Pliosaurus*, and we must fall back upon the first name used as non-committal. It may be that the want of twist or some other peculiarity of the enamel ridges may indicate as much as a specific difference from the Oxford Clay examples.

Distribution.—The two specimens from Rushden are in the Northampton Museum, and a small tooth from Kiddington in the collection of Mr. E. A. Walford may also belong here. The numerous fine specimens from the Oxford Clay of Peterborough are on almost exactly the same horizon as the type, but the Cornbrash is somewhat below that horizon.

Vertebra of *Murænosaurus*. Plate I, fig. 3.

The specimen thus interpreted is from Rushden, and contains in its neural canal some characteristic Cornbrash matrix. It is from the middle portion of the dorsal region. (*See* Seeley, 'Q. J. G. S.,' vol. xxxiii, p. 545.) The centrum has the shape of a short dice-box, but is least concave longitudinally along the base; diameters 45 mm. transversely and 37 mm. vertically. The articular surface is slightly concave in the peripheral portion, but round the perforated centre is a low, irregular swelling: on the lateral surface is seen on each side a vascular entrance. The neural arch is entirely united to the centrum, so that the vertebra is full grown. The canal is large, somewhat triangular in shape. A peculiar feature is seen on the upper surfaces of the anterior zygapophyses, which are hollowed out somewhat deeply in the antero-posterior direction for articulation with the preceding vertebra—apparently limiting the principal motion to a vertical one.

These features, particularly the articulation, seem to recall so much those described by Professor Seeley in *Murænosaurus* ('Q. J. G. S.,' vol. xxx, p. 197), and the general build of the whole resembles so much that of *Cryptocleidus oaxoniensis* as exhibited in the complete skeleton in the British Museum, and as drawn by Professor Phillips ('Geol. Oxford,' p. 309), which is regarded by Professor Seeley as representing a sub-genus of *Murænosaurus*, that we seem justified in going so far as to say that this specimen belongs to that genus.

Distribution.—Besides this Rushden specimen, which is in the collection of Mr. J. F. Walker, there are vertebræ in the York Museum of which no more can be said than that they are Plesiosaurian.

Humerus of Plesiosaurian. Plate I, fig. 4.

In the Leckenby Collection in the Sedgwick Museum there is a specimen of the right humerus of a Plesiosaurian not actually labelled as from the Cornbrash, but showing the peculiar dark tint usual to fossils from that bed in Yorkshire, and

perhaps to be correlated with the vertebra mentioned above. Only the distal half is preserved: it has an elliptic cross-section throughout, the axes of which change from 38 mm. \times 31 mm. in the centre to 109 mm. \times 23 mm. at the distal end. In a transverse direction the distal outline is uniformly curved with a sagitta of 24 mm. (in 109). The posterior outline being the most curved, the greatest thickness is nearer the anterior side.

Specimens such as this are of comparatively little value by themselves palæontologically, but they are of great interest as showing that the Reptilia of the Cornbrash mainly belonged to the great marine family that frequented the Oxfordian seas.

Order CROCODYLIA.

Family TELEOSAURIDÆ.

Genus MACHIMOSAURUS, v. Meyer.

This genus is defined by its author ('Neues Jahrb.,' 1837, p. 560, where it is misprinted "*Madrimosaurus*," an error corrected in 1838, p. 415) as "a saurian with strong, obtusely conical, and closely striped teeth," which is insufficient without his reference to Römer ("*Ichthyosaurus*," 'Verst. N. D. Ool.-gebirges,' p. 12, pl. xii, fig. 19), who describes a tooth as "thimble-shaped, covered with about 100 fine, sharp, close-set longitudinal folds, which are wrinkled at the summit." This defining description is of a specimen from the "Portland Stone," meaning thereby Pterocerian or Virgolian of Kahlenberg, Hanover; so that the genus is an Upper Jurassic one.

Machimosaurus rigauxi, Sauvage. Plate I, fig. 5.

1879. *Machimosaurus rigauxi*, Sauvage et Liénard, Mém. Soc. Géol. France [3], vol. i, no. 4, p. 4.

Skia-type.—"The teeth have their enamelled portion adorned with fine and close striæ, replaced on both faces about the middle of their length by undulating vermiculate lines, following towards the summit, which is, as it were, guilloched, the lines being a little stronger and less crowded than those at the base of the tooth. Between the principal striæ at the base are intercalated some which rise to a feeble height. The lateral angles are marked, especially in the upper third of

the tooth, by a slightly trenchant crest to which the lines on the enamel converge." From the Cornbrash of Le Wast, near Boulogne.

Description.—A single tooth in the collection of Mr. Walford is referred to this species. It has a very polished surface; the diameter at the base of the enamel is 13 mm. and the length 27 mm. Its section is circular, and it is slightly curved—160 very fine ridges may be counted at the base. These are discontinuous, and fresh ones, fewer in number, take their place, nearer the apex, being about 75 half-way up. Where the curvature begins to increase near the apex the ridges become very short, irregular in outline, and join here and there to their neighbours. The median line of the curved surface is raised on both sides into a larger crest, comparable, however, with the rest; it commences half-way up, and becomes stronger as it crosses the apex. The smaller ridges, as long as they remain linear, converge to it at their upper end, but do not join it.

It will be seen that this tooth is in absolute agreement with the type, but the small details of ornament which separate it from the species called *M. interruptus*, found in the Kimeridge Clay of the same locality (Sauvage, M. S. G. F., ser. 2, vol. x, no. ii, p. 51, pl. iii (vii), figs. 7, 8) are such as might well be due to difference of development in the jaw of the same species, in which case the latter name would have the priority.

Distribution.—The only specimen is from the railway station at Handborough. It may be well to note that other species of the same genus from the Stonesfield Slate are represented in the British Museum.

Class PISCES.

No skeletons of fishes are known from the Cornbrash, not even any naturally associated hard parts, all the fossils of the class consisting either of teeth or spines. The following have been recorded:

| | |
|-------------------------------------|----------------------------------|
| *ASTERACANTHUS ACUTUS (15, 63, 65). | *STROPHODUS MAGNUS (42, 62, 65). |
| * — <i>ornatissimus</i> . | * — RIGAUDI (60). |
| * — <i>verrucosus</i> (42). | * — <i>subreticulatus</i> (42). |
| * <i>Pycnodus Bucklandi</i> (42). | * — TENUIS (63, 65). |

Asteracanthus ornatissimus.—The entry of this fish represents the belief that certain teeth belonged to the type called *Strophodus subreticulatus*, and that this type belonged to the spine thus named. The same teeth have been otherwise determined as *Strophodus tenuis*, and if this be accepted the spine theoretically belonging to the other tooth is lost with it. Only one spine is known.

Asteracanthus verrucosus—an erroneous determination of the identical spine called *Asteracanthus acutus*.

Strophodus subreticulatus teeth are now determined as *S. tenuis*.

Order SELACHII.

Family CESTRACANTHIDÆ.

Genus **ASTERACANTHUS**, Agassiz.**Asteracanthus acutus**, Agassiz. Plate I, fig. 6 *a*, *b*.

1837. *Asteracanthus acutus*, Agassiz, Poiss. Foss., vol. iii, p. 33, pl. viii *a*, figs. 1, 2, 3.

1889. *Asteracanthus acutus*, A. S. Woodward, Cat. Foss. Fishes, B.M., vol. i, p. 313.

Skulptype.—The following is the definition of Agassiz (modified, in square brackets, by A. S. Woodward): “More arched and decreasing more rapidly towards the point than *A. ornatissimus*. The tubercles are arranged in two strongly marked series and continue to the end of the ray. They are a little elongated in the direction of the ray; those of the anterior border are largest. Their base forms longitudinal ridges. One of these ridges at the anterior end projects on the middle line of the ray [is keeled], hence the name. The posterior surface is not so flat as in *A. ornatissimus*; its centre already rises above the posterior furrow and rises still higher towards the end of the ray. On this surface are seen two rows of [large] stained teeth [tubercles] pretty distant from each other at their base, but approaching each other as they rise [arranged in close series]. The inner cavity is considerable and extends nearly to the point of the ray.” “From the clay above the Cornbrash on the borders of the Ouse; at Castle Mills, near Bedford.” It has not been seen.

Description.—One specimen only of an Asteracanth spine has been obtained from the Cornbrash. The type of *A. acutus* not having been found, no direct comparison can be made, but so far as the above description goes this specimen agrees with it. It is broken at both ends, but extends for a length of 120 mm., and has a breadth (partly by squeezing) of 25 mm. The anterior (convex) outline has a radius of curvature of 270 mm. The ray is divided longitudinally into an anterior ridged half and a posterior irregularly convex smooth half. The anterior part is raised into 10 ribs, each of which has elongated tubercles, decreasing in size distally and posteriorly. Each tubercle has a raised rim round its base, and consists of a ridged cone, the ridges of which, when worn, show the underlying material in the form of a white star, usually 5-sided. The anterior ones are in definite rows, but the posterior are more irregular. The intervening substance is furrowed longitudinally, the furrows being perforated with deep depressions. The middle line has tubercles like the rest proximally, but for the great part, distally, the intervening substance, with its furrows and perforations, rises into a triangular

ridge. The posterior half of the spine has a number of tooth-like projections, curved in the proximal direction and polished on the distal side. They seem to stand irregularly, but actually occur in a series of oblique pairs, with a zig-zag median line running between the members of each pair. This species differs from *Ast. wastensis*, from the Cornbrash of Boulogne, in that the latter has no tubercles throughout distinct (see Sauvage, 'Bull. Soc. Géol. France,' ser. 3, vol. viii, p. 454, pl. xiv, fig. 5).

Distribution.—This specimen is in the British Museum (no. 47131), and was obtained from the Sharp collection, being recorded by Sharp as *Asteracanthus verrucosus* and stated to be obtained from the Cornbrash at St. Botolph's Bridge, Peterborough, probably from a railway cutting now grassed over. No such spines are known from the Great Oolite, and the type comes from the clay overlying the Cornbrash at Castle Mills east of Bedford.

Genus **STROPHODUS**, Agassiz.

This genus was founded for teeth only ('Poissons Fossiles,' vol. iii, 1838), some of which were separated by Sauvage as *Curtodus* ('Cat. Poiss. Foss. Boulonnais,' p. 53, 1867). These names are regarded only as temporary by A. S. Woodward, the teeth definitely found associated with *Asteracanthus* appearing under that name only. The teeth are said by Agassiz to be "elongated, more or less reticulated and truncated at the ends, showing a torsion in the direction of the long diameter, more or less elevated in the centre or at one end, reticulated on the surface, but without any elevated crest in any particular direction, root flat and broad." In the specimen figured by Owen, however ('Geol. Mag.,' 1869, vol. vi, pl. vii), it is seen that *Strophodonts* are of different shapes in different parts of the mouth. The innermost row (1) is smaller and more elevated than the second (2), which is larger and more irregular in shape, while the other two outermost (3, 4) are the largest, longest, and flattest. These are succeeded by smaller series of teeth running transversely. There may be also a symphyseal set of teeth of quite a distinct shape in one of the jaws. The ornament of the enamel, however, seems to be of the same general type throughout. Thus, the genus *Curtodus*, founded on the difference of shape—inflated instead of twisted longitudinally—loses its significance.

Strophodus magnus, Agassiz.

1838. *Strophodus magnus*, Agassiz, Poiss. Foss., vol. iii, p. 126, pl. xviii, figs. 11—15.

1889. — — — A. S. Woodward, Cat. Foss. Fishes, B. M., p. 315.

Skia-type.—"The teeth are distinguished solely by their generally more stumpy form, and by the fineness of the surface-pores of the crown, which is only just reticulated near the edges, and by the folds being finer and closer than those of the other species." This definition is supplemented by A. S. Woodward in distinguishing the different series. In the most posterior series the teeth are small and oval, with very coarse superficial reticulations. In the fourth they are relatively broad and flat; in the third somewhat longer, the postero-lateral angle gently upturned and the anterior third slightly bent forwards and downwards; in the second they are broadest posteriorly, with an abrupt hinder margin, the antero-lateral angle produced and the postero-lateral angle rounded; and those of the first series are still smaller and apparently shorter.

Description.—It will be seen that species of *Strophodont* teeth are very difficult to be distinguished by their shape; reliance must be placed on the character of their ornament and reticulations. In many cases they are not to be distinguished from those from the Stonesfield Slate. Some of them belong to one of the later series of teeth and some to those of the earlier ones.

Distribution.—Of these teeth, twenty-two are from St. Botolph's Bridge, near Peterborough, in the Sharp collection now in the British Museum, of which thirteen belong probably to series 1 and 2, and the remainder to series 3 and 4; also from Rushden and Shipton-on-Cherwell; from Polebrook; and from Thrapston and Stowe in other collections. That is to say, they only occur where the Cornbrash is underlain at no great distance by calcareous rocks from which they might have been derived, which is rendered not impossible by their abundance in the Neocomian beds in a remanié form.

Strophodus tenuis, Agassiz. Plate I, figs. 7 *a*, *b*, 9.

1838. *Strophodus tenuis*, Agassiz, Poiss. Foss., vol. iii, p. 127, pl. xviii, figs. 16—25.

1889. — — A. S. Woodward, Cat. Foss. Fishes, B. M., p. 317.

Skia-type.—This species of tooth differs from *S. magnus* by being slender and elongated and having a tendency to rise into a protuberance in the posterior portion. Though smaller than *S. magnus*, its surface has a less delicate reticulation and the pores are more masked. The elevated anterior teeth have their ends much pushed in. According to A. S. Woodward, the first three rows of teeth are all much arched, and the superficial coronal ornament is as in *S. magnus*, except the anterior teeth. The hindermost teeth are small and oval, those of series 4 gently rounded; those of series 3 are much longer, the crown raised towards the anterior end and bent downwards and forwards in front; those of series 2 are much elevated mesially, slightly keeled and narrowed at each extremity;

those of series I strongly arched, the apex of the crown being a blunt point, and the longitudinal keel prominent.

Distribution.—There are six convex teeth from Peterborough district from the Emmiskillen collection in the British Museum, and a large specimen from Botolph's Bridge in the Sharp collection, with five others from the same collection in the Sedgwick Museum. Partly on account of its corresponding size, *S. tenuis* is supposed to represent the teeth of the same animal as that to which *Asteracanthus acutus* belongs.

Strophodus rigauxi, Sauvage. Plate I, fig. 8 *a, b*.

1867. *Curtodus rigauxi*, Sauvage, Cat. Poiss. Second Boulonnais, p. 53, pl. iii, fig. 7.

1887. *Strophodus rigauxi*, Platnauer, Yorks. Phil. Soc. Rep., 1886, p. 36, figs. 1, 2.

Skia-type.—The single tooth which served as type is described as oval and raised in the centre, the reticulations radiating from the highest point, arranged like a lozenge on the higher parts, but becoming more elongated on the sides. From the Bathonian of Marquise. At the time of this description the Cornbrash was included locally with the Bathonian.

Description.—The tooth described by Platnauer comes from the Cornbrash on the north side of Scarborough Castle. It is of small size and has a coarsely reticulated, not much raised, crown, though it differs from the type in shape. It is, no doubt, one of the posterior series and may be a distinct type. It is referred by A. S. Woodward to *S. maguus*, but though the posterior teeth of that species have coarser reticulations than the more anterior, yet they do not approach the coarseness of *S. rigauxi*, and this coarseness appears to be of more significance than the shape. It is to these higher beds that we have to go to seek an analogy, as in *S. reticulatus*. It also resembles very closely the posterior tooth figured by A. S. Woodward in 'Ann. & Mag. Nat. Hist.,' ser. 6, vol. ii, pl. xii, fig. 4, as belonging to *A. ornatissimus*, var. *flettonensis*, from the Oxford Clay of Peterborough. In any case it is desirable that it should be recognised as the only tooth of *Strophodus* occurring in Yorkshire.

Order ACTINOPTERYGII.

Family PYCNODONTIDÆ.

Genus **MACROMESODON**, nov.

The genus *Mesodon* was founded in 1851 by Wagner on teeth which the author defined as "long oval, with the surface superficially hollowed in a longitudinal direction and with the slope of the hollow finely furrowed." The name *Mesodon* referred to the teeth occupying a middle position in this respect between *Gyrodus* and *Pycnodus*. It was found, however, when complete fishes were obtained, that the Jurassic Pycnodonts were in many respects quite distinct from the Tertiary Pycnodont, and the name *Pycnodus* was therefore confined to the latter, and *Mesodon* to the former. The above quoted definition is not, however, the principal diagnostic of these Mesozoic forms, and it is therefore fortunate that a new name is required according to priority, since the name already suggested was preoccupied by Rafinesque in 1831 for a member of the Helicidæ, and is actually in use. That suggested refers to the large size of the central vomerine teeth, and the genus may be thus defined:

Teeth smooth and with feeble indications of rugæ; vomerine teeth arranged in five longitudinal series, the lateral pairs being often irregular; splenial dentition comprising one principal series of teeth, with three or more outer series and one or two inner series, usually irregularly arranged.

Macromesodon bathonicus (Sauvage). Plate I, fig. 10.

1880. *Mesodon bathonicus*, Sauvage, Bull. Soc. Géol. France [3], vol. viii, p. 527, pl. xix, fig. 1.

1867. *Pycnodus affinis*, Sauvage, Cat. Poissons Form. Second. Boulogne, p. 15, pl. ii, fig. 6.

Skulpture.—This is a vomerine bone with the teeth in position, so far as preserved. "Four teeth in the principal range, of large size, transversely elongated, a little larger on the outside than on the inside, hinder teeth a little more than twice as broad as long, the anterior teeth a little narrower. The internal range is furnished with five teeth, practically oval, small, 2-3 mm. diam. These teeth show in their centre a mammillated surface surrounded with irregular folds

radiating from the centre. The teeth of the outer range are nearly round, smooth, and larger than the inner." It may be added that the figure shows that the central row of teeth are quite smooth and *much* larger than the others—16 mm. \times 7½ mm. The type is from the Great Oolite of Marquise.

Description.—The teeth referred here to this species are remarkable for their size, being about 12 mm. by 8 mm. They are oval in outline and their uniformly convex surface of elliptical transverse section is quite smooth and shining. On the strength of isolated teeth it is very speculative to refer to any definite species, but in this case the size is so exceptional in comparison with that of the side teeth that the speculation seems justified.

Distribution.—The specimens have all been obtained from St. Botolph's Bridge cutting, near Peterborough, now grassed over. There are a considerable number of them in the British Museum, and more in the Sedgwick Museum. It does not seem impossible that these may have been derived from lower beds in the cutting. I have not been able either to verify their occurrence in the Cornbrash nor, on the other hand, to find anything to throw doubt on it.

MOLLUSCA.

Class CEPHALOPODA.

Order NAUTILOIDEA.

Family NAUTILIDÆ.

Genus NAUTILUS, Breyn.

1732. Breynius, *Dissertatio physica de Polythalamis*.

Amidst the numerous changes that have taken place in recent years in the subdivision of the Nautili, those in Cornbrash times have been left intact under the original title. The following are the species up to the present recorded as occurring in the Cornbrash :

| | |
|-----------------------------|------------------------------|
| * <i>N. baberi</i> (44). | <i>N. inflatus</i> (23, 27). |
| * <i>N. hexagonus</i> (28). | <i>N. lineatus</i> (24). |
| <i>N. TRUNCATUS</i> (23). | |

N. baberi is recorded with a ? from Bourn, but as no specimen so labelled is found in the Museum of Practical Geology, or elsewhere, it may be passed by.

N. hexagonus is Wright's determination of a Scarborough fossil, labelled by

Bean "N., imperfect," and, though listed, has not been recognised in any Yorkshire specimen, unless it be represented by the only Nautilus in the Leckenby Collection, which resembles it somewhat, but is nevertheless otherwise placed.

N. inflatus is recorded by Professor Buckman from Fairford, and by Mr. Horton from Witney, but the corresponding specimens have not been discovered. Nevertheless, as the species is quite distinct from others recorded, and as under the name *N. subinflatus* Messrs. Foord and Crick have recognised a species from the Inferior Oolite below and from the Upper Oxfordian above, it is quite possible that a similar form might occur in the intervening stratum, and these records be the only indication we have of it.

N. lineatus is recorded by Hull from the Witney district, but no corresponding specimen is to be seen; we cannot therefore say what species was intended. As the general aspect is not far removed from the young of *N. truncatus*, and the latter also frequently shows the median or "normal" line, it is not improbable that the latter species was intended.

Nautilus truncatus, Sowerby. Plate II, figs. 1, 2.

1816. *Nautilus truncatus*, J. Sowerby, Min. Conch., vol. ii, p. 49, pl. cxliii.

1900. — — G. C. Crick, Geol. Mag. [4], vol. vii, p. 514.

Not "*N. truncatus* Sow.," D'Orbigny, Terr. Jur., pl. xxxix.

Type.—"Thick, flattened, plain, umbilicate, back flat, mouth elongated, four-angled, siphuncle nearest to the inner margin of the septum. Thickness rather less than half the diameter. The sides are rather conical than even. Mouth above half the diameter of the shell, long, narrowest toward the back, siphuncle oval. Septa very numerous, not recurved towards the umbilicus." In the British Museum with Sowerby's shells, numbered 44117A. It is stated to have come from the Lias of Keynsham, but this is not the case. Mr. Crick has shown (*l. c.*) that no such fossil is known to the collectors of that district, and that the matrix resembles that of the Cornbrash and contains several fossils which are characteristic, at all events, by their association, of that horizon.

Description.—Specimens of this species occur of various sizes, some being very large. As an example of the large form assumed, we may take the specimen figured in Pl. II, fig. 1. This has a diameter of 350 mm.; the last half is body whorl, and the rest contains 17 chambers, the last two being narrower. The rate of increase, both as to diameter and thickness, is in the ratio of 76 : 100 per whorl. Its greatest thickness is at about $\frac{1}{3}$ the way in between the periphery and the umbilical edge. Beyond this point there is little convexity, but within it has a convex slope towards the centre, thus forming a depressed umbilicus,

leaving no part of the inner whorls exposed. The peripheral area in the adult has a well-marked change of aspect, so that its edge is almost angular, but this becomes less so as it is traced backwards towards the origin, near which it becomes almost round. The sutures have a more or less marked backward curve on the peripheral area; they rise to their most forward point on the margin. On the lateral area they form a long backward curve, rising again near the umbilicus, into which they curve backwards again. (Sowerby is wrong on this point, even for his type specimen.) To produce this form of suture the front surface of the septum must be distally concave from side to side as well as in a radial direction, except towards the umbilicus, where it must change in the latter direction to convex. Other specimens show that the siphuncle was about one third the height of the aperture towards the periphery, and that the shell was thick and had no ornament beyond lines of growth.

In a large specimen of 250 mm. diameter found at S. Cerny, the periphery had become concave, like *N. giganteus*, and the backward bend of the sutures had consequently become well marked. On the other hand, when the species is smaller the periphery becomes more and more round, as in the case figured in fig. 2. It scarcely looks the same species, but the change may be traced almost continuously. The following are some measured examples:

| Specimens. | Diam. in mm. | Ratio of transverse diam. | Ratio of thickness. |
|--------------------------------------|--------------|---------------------------|---------------------|
| 1. Bedford, B. M., No. C. 5077 . . . | 350 . . . | 76 . . . | 62 (?) |
| 2. Bedford, B. M., No. C. 7297 . . . | 116 . . . | 74 . . . | 54 |
| 3. Scarborough, Sedgwick Mus. . . . | 160 . . . | 75 . . . | 60 |
| 4. Rushden, B. M., No. C. 3473 . . . | 61 . . . | 73 . . . | 54 |

Relations.—This species does not appear to be the same as the "*N. truncatus*, Sow.," figured by D'Orbigny ('Terr. Jur.,' pl. xxix) as from the Upper Lias of Dijon, which has a slower rate of increase and a different form of septum. The *N. baberi* of Morris and Lycett, which, as those authors say, is closely allied to it, and to which, as it would appear, several specimens of it have been referred, have no such depression in the umbilical region, nor the same style of suture. It develops also other peculiarities in the specimens. *N. giganteus*, however, seems to be a development of it. This is a widely spread form, ranging, according to its author (D'Orbigny, 'Ann. Sci. Nat.,' vol. 5, pl. vi, fig. 3, 1825, and 'Terr. Jur.,' pl. xxxvi), through the whole of the Oxfordian, therein including the Callovian. It is also a large form, as its name implies, and is said to have the "back round" in youth, but the periphery is concave. In this it agrees with our S. Cerny specimen, and there is in the British Museum (No. 32563), from the Oxfordian of Wilts, a specimen with a similar concave periphery in the outer whorl, which, in the inner whorl, imbedded in place, is scarcely even flattened. D'Orbigny's figure, however, represents a more open umbilicus, but this may be due to a more vigorous growth, the specimen being still septate at a diameter of 600 mm.

Distribution.—This species is most abundant at Bedford (Midland Railway Pit), Rushden, Thrapston, Thorn, S. Cerny, Roade (fragments), and Scarborough. It was also recorded by Professor Buckman from Fairford.

Nautilus calloviensis, Oppel. Plate IX, fig. 13.

1842. *Nautilus hexagonus* D'Orbigny (non Sowerby), Terr. Jurassique, p. 161, pl. xxxv, figs. 1, 2.
1856. — *calloviensis* Oppel, Jura formation, p. 547.

Type.—This must be taken from D'Orbigny, as Oppel refers especially to the species of that author, saying at the same time that Sowerby's species differs from it by having a wider mouth-opening. D'Orbigny says: "Shell slightly compressed, smooth, or with fine growth-lines, umbilicus very narrow. Whorls angular, back flattened, sides flattened, with a third less marked round the umbilicus, greatest transverse diameter near the umbilicus. Mouth depressed, broader than high, angular. Sutures simple, deeply furrowed in the middle, rising at the edge of the umbilicus, and furrowed again towards the middle of the back." From the lowest Oxfordian.

Description.—The specimen referred to this species is remarkable for the change it undergoes. If we take only the portion of 64 mm. diameter, as figured by D'Orbigny, it agrees admirably with the above description; but parting from that size the swelling at the side enlarges, and the onward growth becomes more rapid, while the periphery becomes more markedly angular. It then looks very like *N. truncatus*. There is almost an idea that it is approaching *N. giganteus*. It seems probable that *N. calloviensis* may represent the young of *N. truncatus*, and this specimen shows better than any other the change of character. On this ground we might include this with the latter species.

Distribution.—This specimen was obtained from Peterborough by Prof. Garwood, and is now in the Sedgwick Museum.

Order AMMONOIDEA.

All the records of Cornbrash Ammonites, except one, have been made under that name as generic. They are as follows:

- | | |
|--|---|
| * <i>A. bakeriæ</i> (36). | <i>A. HERVEYI</i> (1, 5, 6, 27, 28, 30, 44, 45, |
| <i>A. brocchii</i> (23). | 46). |
| * <i>A. bullatus</i> . | <i>A. HOCHSTETTERI</i> (21, 23). |
| * <i>A. DISCUS</i> (1, 2, 3, 4, 7, 15, 26, 27, 33, | <i>A. HUMPHRIESIANUS</i> (23). |
| 34, 36, 41, 46). | <i>A. JURCENSIS</i> (23). |

- A. MACROCEPHALUS (15, 26, 28, 44, 46, *Harpoceras* PTYCHOPHORUM (40).
 48, 59). *A. subradiatus* (23, 39).
A. modiolaris (42). *A. terebratus* (5).

By *A. bakeriæ* is not intended the species of Sowerby, which will be found rather under *sub-bakeriæ*.

A. brocchii, *A. humphriesianus*, *A. juvenis*, and *A. subradiatus*, are names assigned by Professor Buckman, but never confirmed. The fossils to which they were given were probably from the Kelloway Rock or from some underlying formation.

A. bullatus appears to have been entered from a specimen which has been squeezed transversely, and is not reliable as to its matrix, and in any case cannot be made out.

A. modiolaris is, no doubt, a fossil from the Oxford Clay of Stilton, though I have not seen the specimen, nor any other from the Cornbrash.

A. subradiatus, as recorded by Phillips, I have not seen, and expect it came out of a lower bed, or is possibly an ally of *Clydoniceras discus*.

A. terebratus is a synonym for a smooth type which the *Macrocephalites* are apt to take on in the adult age.

Besides these corrections there are the various generic names to which the various species must now be assigned, as to which some introduction is called for.

From time to time one after another of the features of an Ammonite have been selected to form the foundation of their classification, and as one after another comes to be studied the importance of the particular feature made the subject for study impresses itself on the mind and becomes the basis of classification. At one time it is the shape, at another the sutures, at a third the radial lines, and so on. In my view, all these are of a partial character, only applicable to certain minor groups. A general classification of the Cephalopoda, as of any other group, must embody the history of that group and consist of a series of classifications for each epoch, like a series of transverse sections across an animal. Thus when the Cephalopoda first appeared the first variation was the position and function of the siphuncle. When Ammonoids commenced the siphuncles had taken up a final peripheral position, and their function had ceased to be of importance. Nevertheless, there was still a division, into those the necks of whose siphuncles were as before directed backwards and their sutures primarily lobed, and those the necks of whose siphuncles were directed forwards and their sutures provided with additional secondary lobes, forming the *Retrosiphonata* and *Prosiphonata*. These last, again, at a later date, were divided into *Latisellati*, with broad saddles in youth, and only the lobes secondarily cut, and the *Angustisellati*, with narrow saddles in youth and indefinitely variable septa. Then among the latter the septa became the seat of variation and had no common type, but their shell-forms remained comparatively simple, until ultimately, from the Jurassic times onwards, the sutures settled down into a fairly fixed type, to which the terms

dorsal, superior lateral, inferior lateral, etc., apply; but the shell varied much in form, and could be arranged in groups and families.

From this point of view the classification given by Zittel in his 'Handbuch,' in 1884, embodies the principle of a natural classification much more than the new classification by Hyatt, which has been substituted for it, but which goes back to the partial principle of classifying all by one organ. In the phraseology above set out the Cornbrash Ammonites are all of them angustisellate prosiphonates and belong to the groups *Ægoceratida*¹ with the family Stephanoceratidæ,² and *Arietida* with the family Harpoceratidæ.

Family STEPHANOCERATIDÆ.

Ammonites with numerous transverse ribs, which cross the periphery without change, but which tend to unite on either side at some point towards the umbilicus.

Genus **MACROCEPHALITES**, Zittel.

This genus was established by Zittel in his 'Handbuch der Palæontologie,' I Abth., II Band, in 1884, with the following definition: Involute, with broad, rounded exterior, all the whorls regularly covered with numerous sharp ribs, which divide into two or more near the narrow, deep umbilicus. Sutures much divided.

The name was founded on part of the group of *Macrocephali* instituted by von Buch ('Abh. Berlin. Akad.' (1830), 1832) for the allies of the shell known as *Ammonites macrocephalus*. These allies are indicated by Zittel as *A. morrisoni*, Opp.,³ *A. macrocephalus*, Schloth., *A. tumidus*, Rein., and *A. herveyi*, Sow., etc. It is fortunate that the name proposed, being a generic one, will cover the specimens figured by Zittel (fig. 655), as well as that to which the name of *A. macrocephalus* was given by Schlotheim, for they are different species. The latter was

¹ See Art. "Cuttle Fish," Enc. Brit., ed. x.

² It has been suggested that the name *Stephanoceras* might be confounded with that of the rotifer *Stephanoceros*, but, as a matter of fact, it never has been so confounded by those who know them both—nor has any one taken *Rhinoceros* to be a Cephalopod. The termination *ceras* has been taken to mean "horn-like as a whole," and *ceros* to mean "horned" in some part. Thus, *Stephanoceras*, a horn-like animal with a crown; *Stephanoceros*, an animal with its horns in a crown; *Rhinoceros*, an animal with horns on its nose.

³ This name is given by Oppel to the species figured by Morris and Lycett from the Great Oolite as *A. macrocephalus*. It is certainly distinct from that species; it is also distinct from *A. viator*, d'Orb., to which Lycett ('Supplement,' p. 121) later referred it. This is a *Phylloceras* from the Mediterranean province!

established in Schlotheim's 'Taschenbuch' in 1813 by the reference "*Ammonites macrocephalus*, 'Oryct., Norica, Suppl.,' tab. xii, fig. 8." (See text-fig. 3, p. 43.) On making this reference to Baier's work, which neither d'Orbigny nor Zittel appear to have done, it is seen at once that the species represented is that now called *A. tumidus* after Reinecke (1818). Accordingly in Schlotheim's 'Petrofactenkunde' in 1820 we find "*A. tumidus*, Reinecke," quoted as a synonym. He now includes numerous varieties under the name, which when a genus is established become species of that genus. Thus *Macrocephalites macrocephalus*, Schloth., sp., is the name of the shell called by Reinecke *Ammonites tumidus*, and the figure given by d'Orbigny as *Ammonites macrocephalus* and by Zittel as *Macrocephalites macrocephalus* is without an appropriate name.

From a stratigraphical point of view, pure and simple, there is no doubt some advantage in speaking of "the zone of *Am. macrocephalus*," for it represents an epoch in the world's history when a certain type of ammonite occupied an extremely wide area; but in this sense "the zone of *Macrocephalites*," using a generic term only, would serve the purpose equally well, if we would follow the history of Ammonites or trace their appearance in the strata.

Of the characters of *Macrocephalites* some depend upon age. It does not appear, however, that any marked change occurs in youth, or at all events that any is observable; but as the whorls grow the number of ribs does not keep an absolute constancy, or even a proportion to the breadth of the whorl, but something between these two, increasing in number two or three in half a whorl. The sutures also become more complex, the inner whorls showing the merest outline of those of the adult; but in large specimens the outer whorls become quite smooth or nearly so (*terebratus*). These changes must be allowed for in any case. Other characters, such as the direction of the ribs, especially those which unite, the place and character of their union, the form of the umbilical edge, etc., can only be appreciated by the eye; but there are others which are capable of numerical expression, and therefore of accurate statement, so long as they remain constant. These are: ¹

- (1) The ratio of the transverse to the greatest diameter (*b*).
- (2) The ratio of the last whorl to the greatest diameter (*t*).
- (3) The ratio of the thickness to the diameter.
- (4) The number of the ribs which cross the periphery in half a whorl.
- (5) The ratio of this number to that of those passing to the umbilicus.

The size of the umbilicus, and the amount of overlapping of the whorls, are not required, being dependent on the above and defined by the equations—

$$\frac{\text{Umbilicus}}{\text{Diameter}} = 1 - b(1 + t^2) \text{ and overlapping} = \frac{b - t^2}{bt^4}$$

on the assumption that the characters remain constant.

¹ See my paper "On the Measurement of the Curves formed by Cephalopoda and other Mollusca," 'Phil. Mag.,' 1878.

Of the 200 examples of *Macrocephalites* examined, a selection of 37 has been taken, which are undoubtedly from the Cornbrash, and which afford fairly exact measurements.

TABLE I.—Comparative Measures of Cornbrash *Macrocephalites*.

- A. Diameter in millimetres. B. Percentage ratio of transverse diameters.
 C. Percentage ratio of last whorl. D. Percentage ratio of thickness.
 E. Number of outer ribs in last half-whorl. F. Ratio of outer to inner ribs.
 C. *Compressus*. M. *Macrocephalus*. Hh. *Hudlestoni*. T. *Typicus*. H. *Herveyi*.

| No. | A. | B. | C. | D. | E. | F. | Locality. | Species. |
|-----|-----|----|----|-----|-----|------|--------------------|----------|
| 1 | 23 | 81 | 43 | 44 | 45 | — | Scarborough | T |
| 2 | 25 | 83 | 42 | 73 | 28 | 2·8 | " | M |
| 3 | 30 | 85 | 50 | 52 | 29 | 2·25 | Ailsworth | Hh |
| 4 | 31 | 81 | 48 | 45 | 50 | — | Bedford | C |
| 5 | 34 | 85 | 50 | 43 | 43 | 3 | Appleby | T |
| 6 | 37 | 81 | 43 | 71 | 26 | 2·5 | Peterborough | M |
| 7 | 39 | 86 | 43 | 51 | 28 | 2·5 | Appleby | Hh |
| 8 | 43 | 82 | 48 | 72 | 28 | 3? | Rushden | M |
| 9 | 44 | 86 | 50 | 70 | 27 | 2·8 | Scarborough | M? |
| 10 | 44 | 86 | 43 | 64 | 30 | 2·5 | Bedford | H |
| 11 | 48 | 85 | 45 | 56 | 30 | 2·75 | Rushden | Hh |
| 12 | 49 | 82 | 50 | 45 | 42 | 3 | Scarborough | T |
| 13 | 52 | 82 | 46 | 71 | 30 | 2·2 | " | M |
| 14 | 53 | 85 | 51 | 75 | 31 | 2·4 | " | M |
| 15 | 53 | 80 | 51 | 43 | 39 | 3 | Stilton? | T |
| 16 | 57 | 86 | 45 | 68 | 27 | 2·2 | "Herveyi," Type I | H |
| 17 | 65 | 83 | 37 | 48 | 34 | 3 | Scarborough | T |
| 18 | 66 | 82 | 51 | 49 | 41 | 3·2 | " | T |
| 19 | 73 | 82 | 52 | 49 | 33 | 2·5 | " | Hh? |
| 20 | 74 | 84 | 46 | 70 | 32 | 2·6 | Lincolnshire | H |
| 21 | 78 | 81 | 51 | 44 | 49 | 2·9 | Scarborough | T |
| 22 | 81 | 80 | 45 | 58 | 24 | 2·2 | " | H? |
| 23 | 83 | 82 | 49 | 47 | 44 | 3·2 | Peterborough | T |
| 24 | 87 | 85 | 48 | 72 | 28 | 2·1 | Castor | M |
| 25 | 91 | 81 | 52 | 54 | 40 | 2·7 | Fairford | T |
| 26 | 92 | 82 | 52 | 78 | 30 | 2·4 | Scarborough | M |
| 27 | 93 | 84 | 52 | 48? | 47 | 3 | Peterborough | T |
| 28 | 94 | 87 | 52 | 65 | 33 | 2·75 | Scarborough | H? |
| 29 | 96 | 85 | 46 | 73 | 29 | 2·8 | Bedford | M |
| 30 | 100 | 80 | 48 | 42 | 42 | 2·6 | Scarborough | T |
| 31 | 105 | 83 | 50 | 42 | 48 | 2·8 | Castor | T |
| 32 | 105 | 80 | 45 | 60 | 30 | 2·6 | Peterborough | H |
| 33 | 109 | 80 | 48 | 44 | 32 | 2 | Northants | H |
| 34 | 110 | 82 | 45 | 50 | 39 | 3 | Thrapston | Hh |
| 35 | 113 | 80 | 51 | 47 | 44 | 3·6 | Scarborough | T |
| 36 | 138 | 82 | 43 | 64 | 30 | 2·2 | "Herveyi," Type II | H |
| 37 | 355 | 82 | 53 | 42 | 66? | — | Garsdon | C |

In this list, arranged according to size, we see that little change takes place in B, on which the curvature depends, and which varies only from ·80 to ·87, or in C, on which the overlapping depends, which varies only ·42 to ·53; for all the examples are of the same genus, but the relative thickness ranges from ·42 to ·78,

and the number of ribs from 24 to 50 (or 66), which two characters are thus the most important as specific indices. Lists of this sort show how useless it is to run all the species together, but they serve as a means of separating those species into which the genus is really divided. As the data obtained from the columns D and E are the most important, a system may be adopted of displaying them graphically and uniting with them other measures obtained from specimens which show only those two satisfactorily. Such a scheme is shown in text-fig. 2.

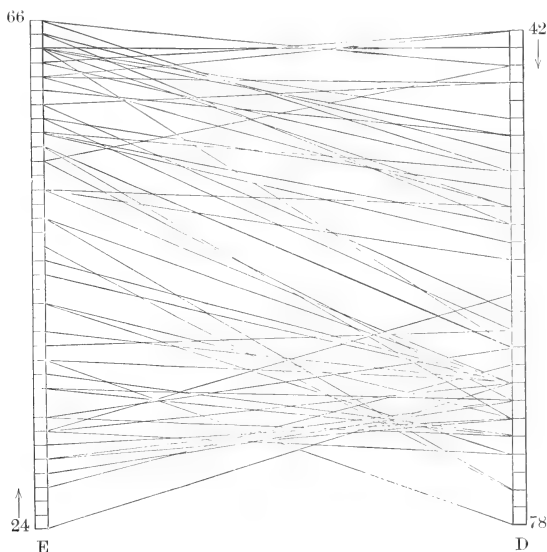


FIG. 2.—Diagram illustrating disagreement in detail of various *Macrocephalites*.

in which the entries in column D are arranged along a vertical column increasing downwards, and those in column E increasing upwards. The lines joining the entries corresponding with the same specimens will thus be more nearly horizontal. The divergence shown by these lines appears greater than could be expected in a single species; in fact, we can see indicated several species characterised by (1) small thickness and abundant ribs, shown by the upper lines; (2) great thickness and few ribs, shown by the lower lines; (3) greater thickness and few ribs, shown by lower lines sloping to the left, and possibly some more. These will be found to correspond with the various species adopted.

Macrocephalites typicus, nom. nov. Plate III, figs. 1, 2, 3; Plate IV, fig. 5.

1846. *Ammonites macrocephalus*, D'Orbigny, var. *compressé*, Pal. Franç., Terr. Jur., pl. cli, p. 430.

1881. *Stephanoceras macrocephalum*, Nikitin, Mém. Soc. Moscow, vol. xiv, pl. iii, figs. 15-17.

1884. *Macrocephalites macrocephalus*, Zittel, Handb. Palæont., p. 470, fig. 655.

1885. — — Nikitin, Mém. Soc. Moscow, vol. xv, pl. (viii) x, fig. 44.

Type (Pl. III, fig. 1).—Sides compressed, umbilical wall quite distinct from and vertical to the sides; diameter of umbilicus about $\frac{1}{6}$ of the whole diameter of the shell. Ribs scarcely touching the umbilical wall, but commencing on the sides with a backward bend, where they are strong and few, forming sigmoidal curves, with the concavity forwards, breaking up into and intercalated with 3 or 4 times as many ribs, which gradually expand so as to be close-set on the periphery, and assume ultimately a radial or slightly forward direction. The ribs on the cast do not accurately coincide in position with those on the shell, so that the thickest part of the shell is a little behind the rib-cast and the thinnest part a little in front, till towards the aperture the surface ribs occupy the furrows on the cast. No sutures are seen on this specimen, so the body chamber occupies at least $\frac{5}{6}$ of the last whorl, and the thickness decreases relatively towards the aperture. Numerical details are given in No. 35 of Table I. From Scarborough, in the Sedgwick Museum.

Description.—The smallest specimen, also from Scarborough (No. 1 of Table I) shows no alteration of characters beyond the fact that the ribs do not combine into bundles towards the inside, while the umbilical edge is rounded. One from Peterborough (No. 27) shows the last suture followed by a complete whorl, and a third in the Sharp Collection at Birmingham shows the same form of sutures on a larger scale. The ratio of the outer to the inner ribs is mostly over 3, and they show a well-marked forward sweep. The breadth of whorl is mostly over 50 of the corresponding diameter, except in one example from Thrapston doubtfully placed here, but the thickness of the whorl, except in one case from Fairford, is always a good deal less than its breadth; in fact, the species is specially distinguished by its thinness, as may be seen in D'Orbigny's figure. But he distinguishes two varieties among the specimens he refers to the species. The present he calls the compressed variety, and the other may be the species described by Schlotheim, as he states the two differential characters of the latter to be (1) its compression, (2) the greater number of the ribs. It seems, however, that at a later date he adopted Reinecke's name of *tumidus* for this, since he says it differs from *A. macrocephalus* by its more spherical form and fewer ribs, though at the same time he gives the thickness of the last whorl as .81 only, against .87 for the swollen variety of *macrocephalus*.

Distribution.—This species occurs at Scarborough (13), Peterborough (5), Bedford (11), Castor (3), Thrapston (4), Stilton (2), Rushden (2), Fairford (3), Appleby (3), Northants (2). It is, therefore, rather confined to the north, and the specimens from the most southerly point, Fairford, are somewhat peculiar.

Macrocephalites macrocephalus, Schloth., sp. Plate III, figs. 4, 5, 6; Plate IV, fig. 1; text-fig. 3.

1757. Figure by Baier, *Oryct. Noric. Suppl.*, pl. xii, fig. 8.

1813. *Ammonites macrocephalus*, Schlotheim, *Taschenbuch*, p. 70.

1818. *Nautilus tumidus*, Reinecke, *Maris Protogœi Naut. et Argon.*, p. 74, pl. 7, fig. 47.

1820. *Ammonites macrocephalus*, Schlotheim, *Petrefactenkunde*, p. 70.

1835. — *terebratus*, Phillips, *Geol. Yorks.*, 2nd edition, p. 116.

1846. — *tumidus*, d'Orbigny, *Pal. Franc. Terr. Jurass.*, p. 469, pl. 171.

Type.—Schlotheim having given no description of the species as distinct from the genus, and Baier, to whom he refers as above, having also left the shell

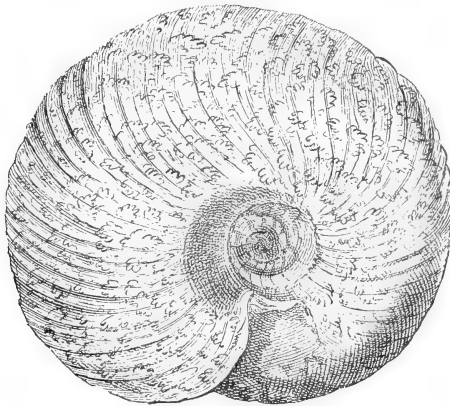


FIG. 3.—Copy of Baier's original figure of the Ammonite now named *Macrocephalites macrocephalus*.

nameless and without description, we are thrown back on the figure he gives as representing the shell called by Schlotheim *Am. macrocephalus*, which is here reproduced (text-fig. 3). It is clearly the same form as was called by Reinecke *Nautilus tumidus*, and duly described under that specific name by D'Orbigny. This, therefore, must be taken as the type of *Macrocephalites macrocephalus*. Schlotheim's later remarks in the 'Petrefactenkunde' relate only to the generic characters and an enumeration of the varieties observed.

Description.—The specimen which most nearly resembles the type is figured in Pl. III, fig. 6. Its numerical characters are given in No. 26 of Table I (p. 40). As in all the specimens referred to this species, the thickness is great and the ribs are few. The umbilicus is small and its walls are vertical within. The ribs are sharp and, as near as may be, radial, and increase in number almost entirely by bifurcation near the umbilicus, and the divisions, except at the bifurcation, where the elevations are combined, are nearly equal throughout. The greatest thickness is not at the umbilical edge but some distance away, and thence there is a funnel-like depression leading down to the ultimately vertical ribbed edge.

The smallest specimen referred to this species (M. P. G., 8653) has a diameter of 25 mm. (see No. 2 in Table I, and Pl. III, fig. 4). The last whorl is here so very convex laterally, that though it leaves one fourth of the penultimate whorl exposed, it nevertheless overhangs part of the latter; the united ribs at each junction, where is the greatest breadth of the shell, are so much raised as almost to look spinous. The inner slope gives a funnel-shaped appearance to the umbilicus. The riblets take on their full size as soon as possible; they are mostly grouped in threes, two of which join, and the joined ones pass over the umbilical slope. Comparing one side of the shell with the other, any pair of peripheral ribs which unite to form one umbilical rib on one side pass to consecutive umbilical ribs on the other—*i. e.* the ribs mismatch. Another fragmentary specimen of about the same size, from Appleby, in Lincolnshire, shows similar characters, but the riblets match on the two sides, as they do also on the inner whorl, where the diameter is only 7 mm.

The next stage is seen, No. 14 of Table I (Pl. III, fig. 5). In this stage it closely resembles the figure given by Reinecke (fig. 47) of *N. tumidus*. The greatest convexity is found near the inner third of the outer whorl, but the whole surface is uniformly elliptical in a transverse—*i. e.* radial—direction, the pseudospines forming the highest line. This convexity gives the apparent umbilicus a wider opening.

The final stage, after the typical adult form has been passed, is a gradual failing of the ribs till the surface is smooth. At 10 in. diameter and a thickness of 7 in. only a few ribs are seen at the smallest part of the whorl. This is a common feature whenever the shells are large, as seen also in *M. compressus* from Garsdon, but in the present case it has induced the introduction of the name *terebratus* given by Phillips to a shell which he describes as more globular than *A. herveyi*, and which, therefore, he intends for the present species. Representatives of this senile form occur in Scarborough and York Museums. They are terebrate *M. macrocephalus*.

Distribution.—Specimens definitely determined as belonging to this species have been seen from Scarborough (9), Appleby (1), Rushden (3), Aldwinkle (1), Castor (1), Fineshade (1), Northants (1), Peterborough (1), and Bedford (3). It is

probable, however, that several of the specimens in the south generally named only *Macrocephalites* may represent this species of the genus.

Macrocephalites compressus, Quenstedt. Plate IV, fig. 4; text-fig. 4.

1849. *Ammonites macrocephalus compressus*, Quenstedt, Cephalopoden, p. 184, pl. xv, fig. 1.

1886. — — — — — Quenstedt, Am. Schwäb. Jura, p. 651, pl. lxxvi, figs. 14, 15 (but not fig. 4).

Non 1881. *Stephanoceras compressum*, Nikitin, Mém. Acad. Imp. S. Petersb. [vii], vol. 28, pt. 5.

Type.—“The ribs are extraordinarily fine, the mouth is also so strongly compressed that the sides and the back together have a parabolic outline. Rate of whorl growth $\frac{37'''}{20'''} = 1.85$; of thickness growth $\frac{20'''}{14.5'''} = 1.38$.” From the *Macrocephalus* beds of Lochen and Laufen.

Description.—This species is distinguished by the fineness and regularity of its ribs, which run in a nearly, but not quite, radial direction, and do not combine into groups towards the umbilicus, but tend to die away altogether. The sides are tolerably flat, but the greatest thickness is near the umbilicus. This would seem to make it a very distinct species, nevertheless when it is young it is hard to distinguish from *M. typicus*, and it is not therefore very certain in its range. The specimen figured (Pl. IV, fig. 4; B.M. 8321) was obtained from the interior of a large dogger, the remainder being the outer whorl of the ammonite, which shows sutures on the outside. No measures are here possible except the ratio of the thickness, which is .52 of the corresponding diameter. The ribs number 48 in a half-whorl, and slant somewhat forwards, and cross the edge of the umbilicus, which is vertical. On the outside of the large shell some remains of ribs are also seen.

From the same pit is another example—the largest seen of any *Macrocephalites* (No. 37 of Table I, B.M. 8322). It is 14 inches in diameter, and has 22 ribs left on less than one fourth of the circumference, and the remainder is body chamber, on which the ribs are first replaced by wide and obscure undulations and finally by smoothness. In this condition it might well be called *terebentalis*, but it is not worth while, since this is the final condition of all the large shells. For the same reason it has a tumid aspect, though it is really one of the thinnest—only .42 of its diameter. Its umbilicus is vertical, and very complicated and crowded sutures are seen beyond the body chamber, as shown in text-fig. 4.

By these and the other characters may be recognised smaller specimens, especially when, as at Castor, they lie side by side with *M. typicus*. Waagen, in his ‘Cephalopods of Cutch,’ supposes the present type to be characteristic of the true *Macrocephalus*, from which we may conclude that it is common in Germany, where Quenstedt names it. It is, however, a special form when adult, though the young

even resembles that called *Cad. tchekini* in the Callovian of Russia (D'Orbigny, 'Geol. Russia,' pl. xxxv, figs. 14, 15).

Distribution.—The specimens are from Garsdon (2), Bedford (3), Castor (3), Roxholme (1), and from an unknown locality (1).

Sub-species **Macrocephalites herveyi** Sowerby. Plate III, fig. 7; Plate IV, fig. 2.

1818. *Ammonites herveyi* Sowerby, Min. Conch., vol. ii, p. 215, pl. cxv.

Types.—There are two co-types, both of which are now in the British Museum (Nos. 43883 and 46485). Of these the author notes that the border of the umbilicus is angular and its sides are vertical, the ribs bifurcate or trifurcate and



FIG. 4.—Adult suture-line of *Macrocephalites compressus*.

do not match as to their union on the opposite sides. They enlarge gradually, and the thickness is half the height. The numerical characters are given in Nos. 16 and 36 of Table I (p. 40). One of them is said to have come from Bradford-upon-Avon, and the other from the drift.

Description.—The above description would suit so nearly *M. macrocephalus* s.s. that it is no wonder that *M. herveyi* and this have been merged by authors, and that the former can only be regarded as a sub-species of the latter. Nevertheless, there seem to be in most cases several distinctions between them. (1) *M. herveyi* has a less relative thickness; it is seen from Table I that in *M. macrocephalus* it is always greater than 70 of the diameter, but in *M. herveyi* it is always less. (2) On the inner half the whorls are flatter and descend suddenly into a nearly vertical umbilicus, instead of bending round gradually into it. (3) The additional ribs which are found near the periphery rise gradually from points at some distance from the umbilical edge and are not simple bifurcations. And (4), most characteristically, the ribs of *M. herveyi* have a sigmoid curvature, with the concavity forward near the umbilicus.

In the figured specimen in the Museum of Practical Geology (No. 32 in Table I, No. 8650) the umbilicus cannot be called vertical, but the sigmoidal curvature is very well shown, so probably it is misshapen. The specimen from "Northants" (No. 33 of Table I), very likely from Thrapston, is much thinner in proportion. In fact, we scarcely know sufficient of this species. This is especially seen to be the case as the types are neither of them obtained from a known bed of Cornbrash, and also from the fact that the smaller of them is also the smallest of all that are referred to this species.

Distribution.—Besides the types other specimens have occurred from Scarborough (4), Cayton Bay (1), Appleby (1), Lincolnshire (1), Bedford (1), Northants (2), and Peterborough (3). This, therefore, like *M. macrocephalus*, is confined, so far as actually known, except the smaller type, to the northern part of the range.

Macrocephalites hudlestoni, sp. nov. Plate IV, fig. 3.

Type.—Only the body chamber preserved. The thickness is somewhat more than half the diameter. Compressed on the sides, umbilicus one fourth the diameter, edge rounded, marked with the ribs, which are not very sharp, but narrow and distinct. They have scarcely any bend, but run out obliquely in a forward direction in relation to the radius. The intercalated ribs arise at less than one third out—all are equal on the periphery—and those that join to form an umbilical rib scarcely make the rib larger when joined. Those on opposite sides generally join again after splitting over the periphery.

Numerical characters are given in No. 11 of Table I. The shell appears to have been excessively thin, to judge by a Bryozoan growth. From Rushden, in the Collection of Mr. W. H. Hudleston.

Description.—A smaller specimen from Ailsworth (No. 3 of Table I) shows the same characters, except that the umbilicus is somewhat smaller. Another specimen from Peterborough is half enclosed in a later whorl, which is septate up to a diameter of 5 inches, and has fourteen very convex septa, the sutures being very approximate and more complicated. They cannot be drawn in either case. The ribs bend forward near the periphery. This is the largest specimen including the outer whorl. The thickness is generally about half the diameter, which suggests a relation to *M. typicus*, but the latter loses its thickness more rapidly towards the umbilicus, and thus presents a different aspect, while the ribbing is different in many respects.

Distribution.—Specimens have occurred at Rushden (1), Appleby (1), Ailsworth (1), Peterborough (2), and possibly at Thrapston (1) and Scarborough (1).

Besides the above-named species of *Macrocephalites*, which are characterised by

more than one feature, there are others in which the finer details have not been observed, but have been classed only as (1) *typicus* and (2) *macrocephalus*. Of these the following is the list :

(1) From Scarborough (8), Bedford (8), Thrapston (17), Stilton (5), Fairford (6), Sudbrook (3), Edenham (2), Cirencester (1), and Holwell (2).

(2) From Scarborough (33), Peterborough (4), Thrapston (7), Bedford (1), Holywell (1), and Radipole (1).

Genus CADOCERAS, Fischer.

1882. Manuel de Conchyliologie, p. 394.

“Shell very inflated, umbilicus narrow, keeled, last whorl entirely smooth. The preceding whorls with the ribs forming an angle directed forwards on the ventral region. Ex. *C. modiolare*.”

Cadoceras breve, sp. nov. Plate V, fig. 1.

Cf. 1886. *Ammonites sublevis*, Quenstedt, Am. Schwäb. Jura, p. 671, pl. lxxix, fig. 3.

Type.—The numerical characters are as follows: Diameter, 81 mm.; ratio of transverse diameter, .88; last whorl, .37; thickness, .41. The centre is occupied by a deep umbilicus, though shallow (*breve*) for a *Cadoceras*. Its sides face inwards at a high angle, but are concave and smooth. The diameter, from edge to edge, including some part of the outer chamber, is a third of the whole. The shape of the outer whorl is semi-elliptical, axes as by above dimensions 37 : 20½. The umbilical edge rises on the upper and more distal side by a number of oblique folds, about ten in number in half a whorl; these become feebler in the body chamber and slant forwards. Further on they give place each to about three weaker, almost evanescent, folds, which still slant forwards and pass over the periphery unchanged, but all die away towards the aperture. About seven eighths of the whorl is body chamber, which shows no further change near the aperture. The septal chambers are distinguished by their crystal interior, but the terminal sutures do not show their outline. The oblique evanescent ornaments and the shallow umbilicus for a *Cadoceras* are regarded as characteristic, but it is difficult to imagine how the inner whorl can be contained in the thickness of no more than 16 mm. between the visible bases of the last umbilical walls on the two sides (although the fossil has been distorted). The specimen is in my collection,

and was obtained from the higher part of the Cornbrash, *i. e.* above the *Avicula echinata* rubble at East Fleet, near Weymouth. It is at present unique.

This species agrees exactly in the numerical characters with the side view of the shell figured by Quenstedt (*Am. Schwäbische Jura*, pl. lxxix, fig. 3) as one variety of *Am. sublewis*, to which, however, he assigns no special name. It agrees also in the description of the ornaments and length of the body chamber. With regard to its thickness, this is only given by the statement that the back is arched like a half-moon, which with the figure indicates an agreement with our species. Very probably the two forms are the same, both being companions of the *Macrocephalites*, but as, in any case, a new name is required, one source of error is eliminated by assuming the present as the type. As it rather varies from the generic definition of "very inflated," it would be better that, in this case, the latter were altered to "more or less inflated." It is probably an introductory species to the fully characterised genus.

Distribution.—In the upper part of the Cornbrash, only at East Fleet.

Genus **PERISPHINCTES**, Waagen.

1869. Benecke, Beiträge, vol. ii, pt. ii.

The genus, as defined by its author, is intended to include all the *Planulata* of the Middle and Upper Jura. In youth, and nearly to age, the aperture shows auricles, and the earlier whorls at least show constrictions. Body chamber $\frac{2}{3}$ –1 whorl. Thus widely defined it has since been separated by Siemiradzki (*Paleontographica*, vol. xlv, 1898–99) into six divisions, to which, in some cases, generic or subgeneric names have been applied. In the case of the Cornbrash fossils, at least, I see no advantage in adopting these minuter groups; only 11 species out of 367 are recorded as coming from horizons earlier than the Callovian.

Perisphinctes subbakeriæ (D'Orbigny). Plate V, fig. 2.

1843. *Ammonites triplicatus*, Quenstedt (non Sowerby), Floetzgebirge Württembergs, p. 364.
 1845. — *bakeriæ*, D'Orbigny (non Sowerby), Pal. Franç. Terr. Jurass., pl. cxlviii (non pl. cxlix).
 1849. — *triplicatus*, Quenstedt (non Sowerby), Petref. Deutsch. Cephalopoden, pl. xiii, fig. 7, p. 171.
 1850. — *subbakeriæ*, D'Orbigny, Prodrôme, et. II, No. 11.
 1858. — *triplicatus*, Quenstedt, Jura. pl. lxiv, figs. 17–19.
 1858. — *funatus*, Oppel, Juraformation, p. 550.
 1883. — *triplicatus*, Quenstedt, Amm. Schwäbischen Jura, p. 680, pl. lxxxvi, fig. 2.

Type.—This species affords a striking example of the evil of not selecting a definite specimen as type, but uniting under one name several specimens which are believed to be related as young and adult. In this case the specimens were first referred to two species of Sowerby, to neither of which they belong. Later, D'Orbigny discovered his mistake, and renamed one of the species as above, but gave no separate description of the new name, consequently it has to be gathered from the figure. At a later date Oppel renamed the specimens which had been referred to the other Sowerbyan species as *funatus*. We are thus thrown back for the type on D'Orbigny's figure and Quenstedt's description. D'Orbigny says the ribs become very regular and die away on the outer third and are replaced by four to six riblets on the back, becoming less marked and even effaced along the median line. All but the larger lateral ribs are lost at a diameter of 74 mm.; there are two or three transverse furrows per whorl. Aperture, when complete, shows a large ear-shaped process, narrow at the base and much enlarged and oblique at its extremity. Quenstedt only says that the whorls "have their greatest breadth, not in the middle of the side, as in the *ornati*, but close to the umbilical edge"—a character which makes the least fragment recognisable. D'Orbigny's type is from Niort, but it is not certain whether his specimen is referred to the Great Oolite or to the Lower Oxfordian—and probably, therefore, to the Cornbrash.

Description.—The principal specimen on which the occurrence of this species in the Cornbrash is founded, has compressed whorls only slightly overlapping and leaving exposed in the umbilicus seven or eight of the earlier whorls. The sides are somewhat flattened in the centre. They commence with an elevated, quickly-turned umbilical border and gradually decrease in thickness to the rounded periphery. The earliest whorls are much more rounded, and gradually become flatter. In the first whorl the surface is nearly smooth; in the second begin irregular ribs, certainly resembling in this respect the Oxfordian *P. bakeriæ*; in the third there are 35 uniform rounded ribs, in the fourth 41, in the fifth 45, and in the sixth 40, the outer portion commencing to show the divided peripheral ribs. Here the body chamber is reached, and on it the ribs become gradually more separated. The outer ribs are uncovered towards the end of the sixth whorl, but they do not obviously spring out of the inner ones, but leave a ribless space between them, having a slightly forward slope. In the remaining quarter of the body whorl there is a lesser rate of increase, and the ribs are more spaced and the riblets disappear. The sides are contracted and produced into auricles. Here and there a rib and its corresponding posterior concavity are more pronounced, producing the characteristic constrictions of the genus. The shell is fairly thick, but when it is thinner there is a distinct intermission along the median line, where is a feeble raised band bounded by two parallel depressions. The septal part of the shell is so completely crystalline that no sutures can be made out.

This specimen is in the Museum of Practical Geology, No. 8654, and was obtained at Stalbridge Weston in a matrix exactly resembling the upper part of the limestone at Holwell, whence I obtained a fragment of apparently the same species. There is another example also in the Sherborne Museum from the same locality. These all come from the same district in which, like that near Weymouth, a series of massive earthy limestones *overlie* the usual rubble beds. These rocks thus represent a special encroachment upon the Oxfordian or Callovian strata, but they contain, nevertheless, a species which, as Quenstedt said of his, is a "constant companion of *A. macrocephalus*."

It is believed that a comparison of the descriptions here given will show that we are dealing with the same species as that named *subbakeriæ* by D'Orbigny and *funatus* by Oppel, which come from the same horizon. These identifications can only be determined by actual examination; any other process would only lead to further confusion; but *A. moorei*, Oppel, is confessedly only a synonym for *A. subbakeriæ*, D'Orb., or is otherwise undescribed.

The following Table II shows for comparison the numerical characters of No. 1, the specimen here figured; No. 2, a Sherborne specimen; No. 3, Quenstedt's species in 'Amm. Schwäbischen Jura,' the type of *funatus*; and No. 4, D'Orbigny's type, as given in 'Terrains Jurassiques,' pl. cxlviii. A—F as before in Table I.

TABLE II.

| No. | A | B | C | D | E | F |
|-------|---------|---------|---------|---------|--------|-----|
| 1 . . | 100 . . | .86 . . | .30 . . | .23 . . | 50 . . | 3 |
| 2 . . | 143 . . | .88 . . | .33 . . | .27 . . | — . . | — |
| 3 . . | 84 . . | .88 . . | .31 . . | .35 . . | 48 . . | 2.2 |
| 4 . . | 96 . . | .86 . . | .32 . . | .27 . . | 57 . . | 3.6 |

The breadth of the last whorl in No. 2 is probably caused by the specimen being all body chamber.

Distribution.—From Stalbridge Weston (1), Holwell (2), and Garsdon ? (1). It is also recorded by H. B. Woodward under the name of *bakeriæ* from the Weymouth district and from Sudbrook.

SPECIES IMPERFECTLY DEFINED.

Perispinctes flagellans, sp. nov. Plate V, fig. 3.

1883. *Ammonites* cf. *arabustigerus*?, Quenstedt, Amm. Schwäbischen Jura, pl. lxxx, fig. 7.

Sciotype.—Only a quadrant of a whorl seen—but this contains sufficient data to enable us to judge of its original form as restored in outline on Pl. V, fig. 3. The outer radius of curvature is about 60 mm., and the radial breadth of the

whorl is 40 mm. The thickness is comparatively small, though unmeasurable. The surface slopes gently towards the umbilicus, but turns over rapidly to the narrow periphery. The surface is ornamented on the umbilical half by about ten ribs per quadrant. These are rather narrow and have a curvature somewhat convex to the aperture; about half-way out they form the base of three times as many peripheral ribs, with the convexity reversed. The grouping of the inner and outer portions is irregular—the latter pass over the periphery unaltered. The whole group has a scourge-like appearance. No further details are observable. The specimen is in the collection of the author and comes from the part of the series which lies above the rubble bed in East Fleet, near Weymouth.

Description.—So far as it can be tested this appears to agree in every way, except in the sigmoidal bend of the ornament, with the shell figured by Quenstedt, *loc. cit.*, as "*Am. cf. arbustigerus*, D'Orb." D'Orbigny's Great Oolite species, however, is thicker and narrower whorled, with different ornament in detail. Quenstedt's, on the other hand, besides the agreement in the measurable details, is said to have "roughly trifurcate ribs," which, however, are rather indistinct. Though it "has a certain relation to its companion *A. macrocephalus*, it cannot be denied that its rate of increase in thickness is somewhat too slow."

Distribution.—Besides the above I have seen two smaller fragments, one from Radipole and another from Sutton Benger, which, by the small slope of the umbilical half and the strength of the inner ribs, may possibly belong to the same species as this.

SPECIMENS UNNAMED.

Perisphinctes, sp. 1. Plate V, fig. 4.

Description.—A specimen obtained from the rubbly beds of South Cerny is certainly distinct from any of the above. It consists of a quadrant of the outer whorl and the impression on the matrix of the inner whorls, but it is, unfortunately, not well enough preserved to yield definite characters, except the shape of the section as shown in Pl. V, fig. 4. This is seen to be slightly transverse (36—33) at the spot chosen (from knob to knob), and to overlap but slightly the previous whorls. On the surface of the quadrant, *near* but not *at* the umbilical edge, there are signs of six radial knobs, beyond which are about twenty peripheral riblets in the same space. These are not actually seen passing from side to side, but the surface is here worn away. On the inner whorls the knobs seem to be closer together, as if they were only elevations of ordinary inner ribs.

Relations.—There are only two already known ammonites that I have been able to find resembling this in any approximate degree—*Reineckia rehmanni*, Oppel, and *Perisphinctes mutatus*, Trautschold. The former is figured by Oppel in ‘Palæontologische Mittheilungen,’ 1862, pl. 48, fig. 1. The build of the section is of the same type, but there is no proof of the intermission of the ribs on the periphery and therefore of its being a *Reineckia*, though it is from the “zone of *Ammonites macrocephalus*.” The section and other details of *Perisphinctes mutatus* are given by Nikitin, Mem. Soc. Imp. Nat. Moscou (1881), vol. xiv, pl. i, figs. 1—3. This shows similar side knobs and peripheral ribs, but the shape and proportions of the outer whorl are quite different. It belongs to a slightly higher horizon, but is a companion of *P. funatus*.

Perisphinctes, sp. 2. Plate V, fig. 5.

Description.—A fragment of an outer whorl from the Upper Beds at Holwell may be the indication of another species. It is remarkable for its quadrate section. The umbilical portion of the side of the whorl has large radial swellings, but the periphery is too rough to show the minor ribs; those of the previous whorl are seen, however, as impressions on the inner side. The specimen might possibly be an indication of *P. mutatus*.

Family HARPOCERATIDÆ.

Genus **CLYDONICERAS**,¹ nov.

This genus is established on account of the peculiarities of the sutures of *A. discus*. There are many forms which are discoid, all or almost all of which have been called *discus*. Thus, v. Buch, in his ‘Trois Planches d’Ammonites,’ pl. i, fig. 1, gives a figure under that name which he says is distinguishable from others wrongly so called, by the sutures; yet the sutures drawn are not those of *discus* of Sowerby. Similarly the *A. discus* of D’Orbigny, ‘Pal. Franç. Terr. Jur.,’ pl. cxxxi, has sutures quite different from those of Sowerby’s species, and more like those of *A. aspidoides* of Oppel, who first distinguished it from *discus* by its sutures. The genus may be thus defined:

Keeled ammonites, with sickle-shaped ornament, whose thickness is small and involution great, thus producing a discoid form. The sutures can scarcely be represented by the usual lobes and saddles, but are thrown into undulations,

¹ Κλυδωνιον, a little wave.

the axes of which never depart very far from the direction of the circumference of the whorl, the edges seldom being supplied with secondary branches, and, so far as known, never with branches of a higher order. Ex. *C. discus*.

Clydoniceras discus (Sowerby). Plate VI, fig. 1; text-fig. 5.

1813. *Ammonites discus*, Sowerby, Min. Conch., pl. xii.

1862. — — Oppel, Pal. Mitth., pl. xlvii, fig. 1.

1863. (?) — — Lycett, Suppl. Great Ool. Mollusca, pl. xli, fig. 8.

Type.—Has the following numerical characters: Diameter, 92 mm. Ratio of transverse diameter .82; of last whorl .60; of thickness .26. The umbilicus is closed when the shell is present, infundibular in the cast. Surface uniformly convex, but bevelled off at the edge, making the sides of the peripheral portion slightly concave. The shell is ornamented with very obscure sigmoid risings, bending forwards rapidly at the outside towards the inner margin of the exterior level. The portion of the body chamber preserved occupies half a whorl. The septa are of the same character as those in the specimen here figured, but in the type only one or two are seen in their original condition, the rest being worn down and imperfectly formed. From the "stone quarry near the House of Industry, Bedford." In the British Museum, No. 43942.

Description.—The specimens of this species examined vary from a diameter of 44 mm. to one of 168 mm. The smallest (B. M., 33482) has a very sharp periphery, but is thickest at the smaller end of the whorl. The sides of the keel are slightly concave, but there are no furrows. The ribs are sigmoid but very feeble. At a diameter between 50 and 60 mm. the inner part of the whorl rises into radial undulations roughly corresponding with four outer ribs. These undulations continue till a diameter of about 75 mm. is reached, after which it is difficult to find anything to represent them. The shell when preserved becomes smooth and shining, with only the finest lines of growth, crossed here and there with equally fine spiral lines. The umbilicus appears to be as small as possible through the greatest thickness being very near it. The various sutures are given in text-fig. 5, *a—d*. They begin as an undulating toothed line, which gradually becomes more complex with growth, the inner lobes and saddles always occupying a forward position, the principal lobes running parallel to the spiral, but increasing in number, the outer lobe and saddle becoming more accentuated and less regular in its running, the lobe being provided with several lobules converging more or less radially towards a centre.

Distribution.—Specimens referred to this species, as here described, have been examined from Sudbrook (7), Barnwell (1), Thrapston (9), Bedford (4), Kidling-

ton (2), Woodrow (1), Wilts (1), "Gloucester" (1), Holwell (1), Radipole (2). In other words, they have not been found north of Lincoln, and in particular none are known in Yorkshire. They would seem, therefore, to be dependent on the presence of the Great Oolite series below, from the Ammonite fauna of which they are probably a relic. Nevertheless they do not characterise any lower portion of the Cornbrash, but where found are absolutely associated with the *Macrocephalites*. In the figure given by Lycett of his *A. discus*, from the Bradford

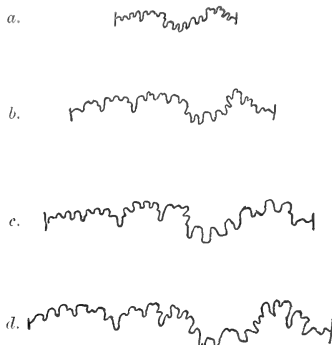


FIG. 5.—Suture-lobes of *Clydoniceras discus*.

Clay, we see the Clydonian characters imperfectly developed, and if these are correct, the specimen is probably a forerunner of the Cornbrash form.

***Clydoniceras hochstetteri* (Oppel). Plate VI, fig. 2.**

1858. *Ammonites hochstetteri*, Oppel, Jahresh. Württ. Verein., vol. xiii, p. 174, and Juraform., p. 473.

1862. — — — Oppel, Pal. Mitth., p. 147, pl. xlviii, figs. 2 and (?) 3.

Type.—The only figures given are those of the sutures. In the text we read: "The lobes are very simple, as in *A. discus*, but the side lobe has three long-drawn-out teeth, whereas in *A. discus* there are more. The ribs in young examples are broader and less crowded than in *A. discus* and die out also sooner." In Oppel's fig. 2 of the 'Pal. Mitth.' it is seen that the side lobe has one bifid tooth and one single one. From the Cornbrash of the neighbourhood of Chippenham. The suture drawn in Oppel's fig. 3 is from a specimen obtained at Lochen, near Balingen, which may or may not belong to the same species, but it is not the type.

Description.—The figured specimen (Pl. VI, fig. 2), though only a cast, shows

the characters of the species very well. Its diameter is 138 mm.; the transverse diameter is .82 of this, the last whorl .58, the thickness .24. The side has a peculiar inflated appearance, owing to the rounded infundibular form of the umbilicus and the greatest thickness being some way ($\frac{1}{3}$ out) from it. The periphery is somewhat produced radially. Up to a whorl breadth of 43 mm. the peripheral portion has the relics of sigmoid radial ribs, just as in *C. discus*; beyond this point nothing appears upon the cast. The sutures are most characteristic. They may be described as consisting of 12 narrow-pointed lobes, or backwardly directed teeth, whose axes or edges are all more or less parallel to the curve of the periphery. The eleven saddles, or forward parts of the sutures, are more or less incised, but usually only slightly so. The outer eight of them do not all advance to the same level, but hang back in the centre, thus producing the appearance of a "superior lateral lobe," the sides of which are more jagged than any other part of the suture-line, and form between them, with the intervening shorter saddle, the "three teeth" mentioned in the type.

These peculiarities are continued to the smaller part of the whorl, and are quite distinct from the features of *C. discus* of the same size, as seen by comparing Fig. 3 and Fig. 2, though the sutures, as a whole, both show a Clydonian type.

Distribution.—Besides this specimen from Norton Brize and that recorded from Chippenham by Oppel, there are at least two from Bedford and a fragment from S. Cerny, recognisable by their sutures and shape, and probably one from Holwell of smaller size (64 mm.), in which the sutures are not so well developed.

Clydoniceras ptychophorum (Neumayr). Plate VI, fig. 3.

1869. *Ammonites discus*, Brauns, Der Mittlere Jura, pl. 2, fig. 4 (non fig. 1).

1871. *Harporceras ptychophorum*, Neumayr, Ceph. v. Balin, Abh. x k. Geol. Reichsanst., vol. v, p. 27.

Type.—Brauns, figuring a species as *Am. discus*, says of it that it has flat, broad ribs, which correspond each to 6—8 fine ones, which bend sharply forwards to pass over the periphery. The diameter is 33 mm., the thickness is 8 mm., and the height of the last whorl is 17 mm. The umbilicus has a breadth of 6 mm. This at first grows with the outside of the shell, then remains stationary, and later becomes narrower. The sculpture is lost with age, and three quarters of the last whorl is body chamber. From Lechstedt, in *Macrocephalus* beds. Neumayr (*loc. cit.*) calls the species thus defined *Harporceras ptychophorum*, thereby making it the type. The sutures are drawn in Brauns' figure, though not mentioned. They consist in an undulating line which sinks in the centre and there terminates in a point directed backwards.

Description.—If this be a distinct species, which seems by no means certain,

then we can verify the statement of Neumayr that it is found in England, though he gives no details except mentioning that it is from the zone of *Macrocephalus*. A specimen showing the peculiarities relied upon is in the British Museum (33541) said to have been obtained from the Cornbrash of Trowbridge (Pl. VI, fig. 3). This has a diameter of 80 mm. The half of which it is composed seems to consist entirely of body-chamber. The ribs are fairly straight at first but towards the periphery they bend rapidly forwards; later they become rougher and more separate and then soon die away. This would appear to indicate an adult form. The breadth of the periphery also diminishes and the shell becomes almost of the shape of *C. discus*. The siphuncle is seen in the cross-section to lie below the level of the keel. So far there is nothing distinctive, but two other features are only seen in the specimen and description given by Brauns. The transverse section exposed by fracture shows by the matrix which fills the umbilical cavity that that cavity was larger at one time than at a later, the diameter of the cavity decreasing with growth from 6.5 mm. to 5 mm. The sutures also are of the character observable in Brauns' figure; that is to say, they recede farther from the aperture to a point consisting of a central prong and two minor side ones. There is, however, only one specimen which shows those features. It is even accompanied by a smaller specimen which has a furrow on either side its keel and shows no sutures.

Further information is very likely to throw light on the relations of this species to the other *Clydonicerata*. If it had not been for Neumayr's giving it a name, it would probably have been included in *C. legayi*, though it is difficult to imagine how a suture with a central lobe of two teeth could possibly change into one with triple teeth.

Distribution.—A single specimen from Trowbridge.

Clydoniceras legayi (Rigaux and Sauvage). Plate VI, figs. 4, 5, 6.

1867. *Ammonites legayi*, Rigaux et Sauvage, Mém. Soc. Acad. Boulogne, vol. iii, p. 21, pl. i, figs. 1, 2.

Type.—"Discoid, very compressed, keeled, with broad, nearly flat whorls, ornamented with flexuous ribs; back square, with a small keel bounded by two narrow furrows. Umbilicus small. The external borders are angular." The specimen is only 30 mm. in diameter, and is from the "Calcaire des Pichottes," recognised later as Cornbrash.

Description.—The most nearly perfect specimen seen (Pl. VI, fig. 4) has a diameter of 35 mm., to which its transverse diameter has a ratio of .82 and last whorl .57. The thickness cannot here be measured. The umbilical edge is very clearly marked, almost swollen, and the inside nearly vertical; the triangular

keel and furrows are well marked; the sigmoidal ribs are very uniform, 38 per half-whorl, slanting forwards near the periphery and dying away toward the umbilicus. The sutures are characterised by a pair of backwardly projecting parallel teeth or lobes, with a saddle between, which does not rise so far forwards as those within or without; both sets are three in number, rising higher as either edge of the whorl is reached, and slightly jagged.

In another specimen (Fig. 5) from the same locality the umbilical half has a slope towards the centre. The sides of the periphery beyond the furrows are more swollen, the umbilicus is two-elevenths of the diameter, and the greatest thickness in the centre of the whorl is .28. A third specimen (Fig. 6) has some sign of the collection of the ribs into groups; its thickness is only .24 of the diameter, consequently the sides are flatter. The umbilicus is one fifth of the diameter. The sutures are of the same type.

All these specimens are of small size, and their most remarkable feature is the variation of the size of the umbilicus from one eighth to one fifth of the diameter. This recalls the character of *C. pychophorum*, but in most cases it may be only characteristic of an early stage of existence. In this view these small forms would be the young of either *discus* or *hochstetteri*. M. Rigaux says that *discus* has no furrows in the young of the same size, but it has something that would easily become such if a little deeper. The real difficulty is that the sutures do not agree at the same size, though we know of no *hochstetteri* so small as *legayi*. Nevertheless, there is a specimen from Thrapston which has sutures approximating to those of *hochstetteri* and the furrows on either side the keel approximate to those of *legayi*.

Distribution.—This species has been found at Sudbrook (2), Rushden (1), Trowbridge (1 ?), Holwell (2), and Thrapston (1 ?).

Order BELEMNOIDEA.

The occurrence of Belemnites in the Cornbrash appears to be doubted, as none are mentioned in H. B. Woodward's list except a "sp." from Dorsetshire, while Fox-Strangways records them with a query. The actual records are: *Belemnites tornatilis* (6, 28); *Bel.* sp. (43).

The first of these refers to the Belemnites found in the "clays of the Cornbrash" in Cayton Bay. Phillips states, in his first edition of the 'Geology of Yorkshire,' that "no Belemnites have been found in the Cornbrash of Yorkshire," but in 1835 this statement becomes "Belemnites are rare in the Cornbrash of Yorkshire." Leckenby, writing on the Kelloway rock (25), records *B. tornatilis*

from that horizon, but does *not* mark it as occurring in the bed below. Wright, however, (28) records it as from the Cornbrash in Mr. Leckenby's cabinet. Nevertheless, after this date, Phillips, in his 'Belemnites' (Pal. Soc.), states that "as far as he remembers" no Belemnite has been quoted from the Cornbrash except by error. It would seem, therefore, that the ? is justified by the literature. We may take it, however, that Leckenby's specimen has since been confirmed by the discovery of a second specimen of *Bel. redivivus* (*q. v.*) by Mr. H. Keeping.

The second record is from Helpstone, near Peterborough, by Mr. Sharp. There is a fragment of Belemnite in the Sharp collection at Birmingham, but it has no label. It appears to be in a Cornbrash matrix like that of other Cornbrash fossils; it is rather stout and shows no furrows, and could not be named even if localised.

Belemnites redivivus, sp. nov. Plate VII, fig. 1, 2.

Type (Pl. VII, fig. 1).—This is a portion of the guard including the alveolus. The length of the axis (*i. e.* between the extremities of alveolus and guard) is 60 mm. The antero-posterior diameter at the alveolar apex is 19 mm., and the transverse diameter 18 mm. This compression is caused by a slight flattening on the two sides of the post-apical surface. On the ventral side is a narrow groove commencing at the apex, expanding opposite the middle of the axis, and dying away at the upper two-thirds; it has rounded boundaries. There are no other marks on the surface. The alveolus has an angle of about 22° , and its apex is situated at about $8\frac{1}{2}$ – $10\frac{1}{2}$ of the antero-posterior diameter, and the thickness of the guard on either side maintains the same proportion throughout. It is from clays referred to the Cornbrash in Cayton Bay, associated with *Macrocephalites herveyi*, and is in the Sedgwick Museum (Leckenby coll.).

Description.—Another example from the same locality, obtained by Mr. Henry Keeping, differs only slightly from the type in being a little narrower in proportion—its outline tending to a more conical shape. The dimensions are: Length of axis 68 mm.; diameter 17×16 ; angle of aperture 24° ; apex at a point 7–10 along diameter. The species belongs to the group that has been variously named after *Bel. pusozianus*, *Bel. owenii*, and *Bel. magnificus*, which characterise the zone above. It has the same kind of groove and compressed shape, but the relative length of the axis is very much less, being only $3\frac{1}{6}$ ($\frac{69}{18}$), or 4 ($\frac{68}{17}$), instead of 6 or more as in *B. pusozianus*. It is the first and less characteristic form which presents itself on the revival of Belemnite life in this country. This is the form which has been called *toruatilis*, but though the latter

species is shorter it is also much narrower, so the proportion is 10. This is its next successor in the Kelloway rock.

Distribution.—All the known specimens (two in the Sedgwick Museum and two fragments in the York Museum) are from the clay at Cayton Bay.

GASTEROPODA.

The remains of Gasteropoda in the Cornbrash are not numerous, and afford little scope for any general observations. It must be borne in mind, however, that we are dealing now with a group which contains both recent and fossil members, and the classification and corresponding nomenclature are to a large extent derived from the former by the consideration of parts not observable in the latter. In such a case the placing of any fossil in a family or genus not founded on positive shell characters may be a matter of unverifiable opinion. They may be treated of accordingly in the order and under the families adopted by Huddlestone in his memoir on the Inferior Oolite Gasteropoda.

Family APORRHAIÐÆ.

Genus **ALARIA**, Morris and Lycett.

The records of *Alaria* are as follows :

A. bispinosa (6, 28).

**A. bispinosa* var. *elegans* (50). **A. myurus* var. *teres* (50).

**A. hamus* var. *phillipsii*. *A. trifida*.

The early entry of *A. bispinosa* indicates only a member of that group. The variety *elegans* is taken here to be a distinct species described as *A. bicornis* (see p. 63). *A. hamus* var. *phillipsii* is taken to represent *A. composita* (see p. 64). *A. myurus* var. *teres* is described under the name *A. erinacea* (see p. 61). The specimen recorded as *A. trifida* is not well preserved, but has no relation to Phillips' species, and, like some other specimens, suggests an *Aporrhais*.

The species of *Alaria* depend on (1) the nature of the wing, (2) the ornament of the spire. The latter feature divides them into groups, the former separates species within those groups. The groups are those ornamented (*a*) with simple lines, (*b*) with a median spiral keel, or (*c*) with longitudinal ribs.

(*a*) Spire with simple lines ("Myurus group," Huddlestone).

Alaria erinacea,¹ Piette. Plate VII, figs. 3, 4.

1860. *Rostellaria levigata*, Héb. and Desl., Bull. Soc. Linn. Normand., vol. v, p. 11, pl. vi, fig. 10
(non Morris and Lycett).

1864. *Alaria herinacea*, Piette, Pal. France, t. 111, p. 122, pl. xii, figs. 2-5; pl. xxxiii, figs. 1, 2.

1884. *Alaria myurus*, var. *teres*, Hudleston, Geol. Mag. [3], vol. i, p. 197, pl. vii, fig. 4.

Type.—"Shell fusiform, composed of 10-11 convex, rounded whorls, covered with very fine spiral striæ. The last whorl is doubly keeled and is gibbous on the side opposite the wing. The posterior keel, which is the stronger, carries a spine or rudimentary wing placed at equal distances from the wing and the gibbosity. The young have no such spine. The suture is very pronounced. Wing formed of two digitations, whose curvature is unknown. Canal straight. The base is covered with larger, alternating with finer, threads" (Piette)—Callovian, Montreuil Bellay.

Description—The specimen figured in Pl. VII, fig. 3, is the same as that figured by Hudleston (*loc. cit.*), and is still the only one known that preserves the ornament. It agrees in all particulars with the above description and with the figures quoted, except in (1) the presence of a gibbosity in the last whorl, which is apparently accidental; (2) the occurrence of a spine before the lip is reached, which *may* have existed when the shell was broken, or more probably has not yet been developed; and (3) the finer details of the ribbing. On this latter point Piette states that there are 23 lines on the penultimate whorl, of which 11 are large, alternating with very fine ones; the latter in some cases are wanting. Hudleston's description of our present specimen states that "the furrows are narrow and shallow; there are about 20 on the penultimate, the intervening space being about three times the width of each groove, and presenting a flat, strap-like appearance. One of the straps towards the middle of the whorl is rather wider than the rest, but scarcely more prominent. This represents the median keel." The earliest whorls look very smooth, but the furrows gradually die out, and are ultimately masked by fine lines of growth. The anterior canal also loses its ornament and becomes smooth after a few alternate large and fine threads beyond the anterior band. It is certain that both of these bands ended in a spine.

Relations and distribution.—Hudleston considers this as "almost . . . a new species" as compared with *A. myurus*, and that it is very near to the *A. levigata* of Hébert and Deslongchamps. These are just the two species to which Piette refers, but he identifies the species with the latter instead of regarding it as a variety of the former. It cannot be a *variety* in the strict sense of an Inferior Oolite species, though it is probably a mutation; but our form has changed more than Piette's. The figured specimen is from the characteristic Cornbrash of Scarborough and in

¹ The name is spelt by the author with an h, but presuming that the reference is to the "spine" on one of the "keels" this is probably an oversight.

the Leckenby Collection of the Sedgwick Museum. There is, however, a cast from Bedford which corresponds in the shape of the spire, which, if casts can be named at all, should be placed here. But the last whorl here becomes more angular by the development of more conspicuous keels, the posterior of which shows *two* spinous risings, while the anterior shows one, before the aperture is reached (see Pl. VII, fig. 4).

(*b*) Spire with a median keel.

Alaria tridigitata (Piette). Plate VII, fig 5.

1855. *Pterocera tridigitata*, Piette, Bull. Soc. Géol. France [2] vol. xiii, p. 89, pl. v, figs. 4—7.

1864. *Alaria tridigitata*, D'Orbigny, Pal. Franç., Terr. Jurass., vol. iii, p. 76, pl. x, figs. 4, 5.

Type.—Shell fusiform, with 7 or 8 smooth, keeled whorls; the last whorl with two keels. Wing formed by two thick digitations keeled outside and furrowed within. The posterior digitation turns towards the summit of the spire, describing a curve and ends in a point; the other descends first in a straight line, describes two festoons, and then suddenly rises, becoming thin, and forming a curve. Canal long and broad, descending at first in a straight line and then turning suddenly in the form of a hook. The last whorl on the opposite side from the wing tends to become slightly gibbous and has the keels more marked. From the marly limestones representing the Cornbrash at Rumigny (Ardennes).

Description.—The specimen figured (Pl. VII, fig. 5) does not fully show the remarkable bendings of the type; but if these be interpreted as the final products of growth under favourable circumstances, our shell is just such as might produce them, as it agrees in all the other characters. The central keel is very marked, and the suture lies, as it were, in a deep valley between two parallel elevations. There is no sign of any finer ornament, in both cases probably a matter of preservation. The two ridges on the last whorl and the corresponding digitations are very thick and there is a deep excavation between them. Posteriorly the wing sends a branch backwards over the whole length of the penultimate whorl. The whole has a characteristic lumpy aspect, the short canal especially so. The only specimen is from Murcot, and is in the author's collection.

Relations.—Piette does not compare this with any other species, regarding it as very distinct. Nevertheless it has great resemblance to *A. pupæformis* which accompanies the type, but the canal is more stumpy. The last named has also a greater length of wing before the digitations separate and is strongly striated in the spire. It is probably continued into the Oxfordian *A. glaucus*, D'Orb.

Alaria bicornis, sp. nov. Plate VII, fig. 6.

1884. ? *Alaria bispinosa*, var. *elegans*, Hudleston, Geol. Mag. [3], vol. i, p. 152, pl. vi, fig. 8.

Type.—The similarity of this specimen to the one figured by Hudleston (*loc. cit.*) as *Alaria bispinosa* var. *elegans* is such that the description, where it agrees with this, will be given in inverted commas: “Approximate spiral angle 32°. Shell turreted, somewhat elongate, the spire increasing with great regularity.” The spire as preserved consists of 10 whorls. “The earlier whorls are short, tumid, and scarcely angular.” The first 3, in addition to spiral lines, have about 12 coarse longitudinal ribs which absolutely disappear in the later ones, and these “are ornamented with spiral lines of great regularity, one of which presently begins to develop as a keel rather below the middle of the whorls, which in that part of the spire immediately posterior to the body whorl become more angular, the upper half projecting outwards to meet the keel, whilst the lower half is slightly constricted. The spiral lines continue about the same in number but increase in size with the increasing whorls. These keels are split by a very shallow spiral groove—sutures close. The spiral lines in the anterior portion of the whorls are fewer and wider apart than those in the upper portion. A similar style of ornament pervades the body whorl, where a very sharp and prominent upper carina occupying a median position is developed and a very subordinate anterior one. This upper keel is prolonged into a very stout digitation” whose base extends backwards as far as the keel of the penultimate whorl, and forwards into a broad glacis; distally it is grooved on the posterior side and curved into a backward hook. “There is no trace of any digitation in connection with the anterior keel,” which merely drives out slightly the margin of the wing. The canal sheath or most anterior digitation is at first nearly parallel to the axis of the shell, but soon forms a long curve in a plane perpendicular to that of the posterior digitation, and downwards when the latter is placed to the left. The upper part of “this portion of the shell is ornamented with spiral lines, which are rather finer than those of the spire.” From the sandy bed in the Woodstock Railway cutting at Shipton-on-Cherwell. In the collection of Mr. Hudleston.

Distribution.—The agreement with the type of the specimen described by Hudleston from Scarborough in so many details, and the divergence only in parts better preserved, show that it belongs here. It is of no use to compare our species with the “*Rostellaria bispinosa*” of Phillips; that name is not sufficiently characterised and can only serve as a group name. It is not even certain whether the specimens so named were bispinose or trispinose. It would appear, however, that all the records of *A. bispinosa* refer to the single specimen here referred to.

Relations.—The characters of the spire not being very remarkable, almost any

Alaria not actually showing the digitations of the wings, and with whorls striated and keeled may represent this, such as *A. cornuta* (of Piette or *A. polygona*). It seems very probable that the second species figured by Phillips, as *R. bispinosa*, from the Kelloway rock (*loc. cit.*, pl. vi, fig. 13) is the same as this. For the long digitations might easily be found to be hidden in the matrix if the specimen were at hand, but the name assigned belongs to the other species (so called) and cannot be used for this. The horizon, however, seems doubtful, it having been referred in the third edition to the Cornbrash, and called *A. myurus*, which it obviously is not.

(c) Spire with longitudinal ribs (Hamus group).

Alaria composita (Sowerby). Plate VII, figs. 7, 8.

1827. *Rostellaria composita*, J. de C. Sowerby, Min. Conch., p. 111, pl. dlviii, fig. 2.

Type.—Shell turreted, striated, with costated spire. Last whorl armed by two keels, one lobe only cuspidated on the outer lip. From the Oxford Clay of Weymouth and Brora.

Description.—The specimen here referred to this species is of larger size than the type, but that is about the only difference. Four whorls before the last are preserved, and there were probably at least three more. The spiral angle is 26° . The lower half of all the whorls except the last is crossed by about 12 longitudinal ribs, which are low anteriorly, but swell out to a maximum in the centre of the whorl and then die out suddenly, especially in the later whorls. In the last whorl they are confined to the keel itself, which they swell out and render gibbous, but this gibbosity is lost as the aperture is approached. The lower keel has a similar gibbosity in the same way and near the same place, but dies out almost to nothing at the edge of the wing. The whole of the surface is covered with irregular spiral riblets, continuing below the anterior keel as far as the shell is preserved; and crossing the ribs in the spire over all are fine sigmoid lines of growth. The penultimate whorl is very angular in outline, and the wing extends back upon it a little beyond the line of knobs. The upper digitation or outer process is very short and curved upwards (*i.e.* backwards). The lower keel having died away, the anterior edge of the wing is carried by a gentle curve to the point where the canal sheath is broken off. Where the shell is broken off the cast is seen to show only a gentle spiral swelling (the shell being thick) and to become attenuated at the apex. The aperture in this specimen shows the thin left lip spread over the penultimate whorl.

Distribution and Relations.—The above shell is from Scarborough, in a truly

Cornbrash matrix. It bears the name *A. composita*, in Lycett's handwriting, but has been recorded as *A. hamus*, var. *phillipsii*, which has a different form of wing, etc. Another specimen, showing the shell and the wing, but both of them chemically worn, is in Mr. B. Thompson's cabinet from Quinton, Northants. The cast may probably be recognised by (1) its agreement in proportions; (2) the spiral swelling rising gradually higher in the whorl; (3) the apex being screw-like (cochleate); and (4) the gibbosity opposite the left side of the aperture. In this case the species occurs at Bedford (see Pl. VII, fig. 8).

The species is closely allied to *Alaria denticulata* (Piette, *loc. cit.*, pl. xvi, figs. 4-8), with which the author includes the *A. hamus* of Morris and Lycett. It certainly belongs to that group, but is more angular exteriorly when well preserved, and has a shorter wing, and in any case the name *composita*, not considered by Piette, has the priority. This species is quoted under Piette's name from the Cornbrash of Boulogne.

Alaria palmata, sp. nov. Plate VII, fig. 9.

Type.—Spiral angle 23° . Three whorls of the spire preserved behind the last; probably there were three more. Ornament of the *hamus* type—*i. e.* longitudinal ribs affecting the anterior half only—greatest in the penultimate whorl, dying out towards the apex, but reduced to denticulations of the posterior keel in the last whorl. This keel is gibbous on the radius perpendicular to the direction of the wing on the side of the aperture. The anterior keel comes to its maximum near the same spot and dies away on either side. The whole is crossed by 13 riblets per whorl, extending 4 or 5 riblets below the anterior keel, the canal sheath below being bare. It bends towards the wing and is of medium length. The outside of the wing is imbedded and cannot safely be removed, but the keels must both die out without making any digitation. The wing extends backwards to the middle of the prepenultimate whorl, making a wall of shell behind the aperture. It also extends forwards half way down the canal sheath, and then is cut off squarely and the posterior border *seems* to be continued backwards like a horn. The wing is very thick and massive. The specimen is from the rubbly Cornbrash of the Woodstock railway cutting at Shipton-on-Cherwell, and is in the collection of Mr. Hudleston.

Distribution and Relations.—The character of the wing of this species removes it from all the ordinary forms of *Alaria* and makes one think of *Aporrhais*; but the posterior whorl of the shell does not seem to have been reflected on the inner lip of the aperture. It is comparable, however, to *Aporrhais pagoda* of Morris and Lycett in respect of its wing, though different in all other respects.

Alaria, sp. ind.

Besides the specimens above enumerated, which show the characters of both the spire and the wing, there are others in which the latter is wanting and the species of which cannot therefore be adequately determined.

Family CERITHIIDÆ.

These so-called cerites can only be defined as shells with dextral apex, of small spiral angle and small body-whorls, with simple interior cavities. Scarcely as much as this can be said of all the shells which are or have been included under this title, yet the definition above given would include such shells as *Terebra*, *Turritella*, and *Scalaria*. Fossil shells of such unspecialised character cannot be definitely arranged in families by means of their forms alone. It is useless to attempt to thrust the creatures of the Jurassic period into the pigeon-holes prepared for the most part only at a later date. As has happened among the Cephalopoda, the seat of variation has doubtless varied from time to time, and the classification to be true to nature must vary likewise with time.

Deslongchamps, who first studied the cerites of the Jurassic rocks, noted that they had "a facies different enough [*assez différent*] from that of living species or of Tertiary fossils," but was unwilling to create new genera. He divided them, however, into 6 groups—(1 *a*) whorls concave in the middle, intumescent at the sutures (would now be called *Aptyxiella*); (1 *b*) whorls concave, raised at the sutures (*Cryptaulax*); (2) whorls flat or subrotund (mixed, inc. *Turritella*); (3) whorls round but not clathrate (*Turritella*?); (4) clathrate, muricate (*Bittium*); (5) longitudinally nodulose, series oblique from right to left (*Cryptaulax*?); (6) polygonate or tuberculate, one series perpendicular to the suture (various). Some of these have channeled apertures and some have not. We cannot therefore include the channeling of the aperture in the "family" character.

The records of *Cerithium* are:

**C. gemmatum* (6, 28, 43), **C. muricatum* (43, 48).

**C. variabile* (32, 37).

For *Cerithium gemmatum* and *C. millepunctatum* see *Bittium pingue*, p. 67. For *C. muricatum* see p. 68. *Cerithium variabile* has been quoted from the Cornbrash of Islip by Whiteaves, and thence quoted by Phillips; but the only specimens bearing that name are not in the collection of the former but in the Oxford Museum. They are two poor casts only, and in any case there is a doubt, as has been noted before, as to the horizon from which they were obtained. The species was called

a *Chemnitzia* by the author, but it belongs to the *vetusta*-group of *Cerithium*, as defined by Hudleston—a group not elsewhere recognised in the beds above the Great Oolite.

Genus **BITTIUM**, Leach.

The genus *Bittium* is often quoted as Leach's, but it appears that Leach never published anything upon the subject, only naming certain shells in his own cabinet by this name. After his death the MS. prepared by him was published by Gray in 1847 ('Ann. Nat. Hist.,' vol. xx, p. 267), the already named species included in it being indicated, but no description was given. Zittel ('Handbuch der Palæontologie'), and Fischer ('Man. Couch.,' p. 680) give the definition thus: "Shell small, lengthened, with numerous granular whorls, irregularly varicose; anterior canal short, scarcely distinct, not curved; lip open, varicose and dilated on side, columella edge simple." It is certain that many Jurassic shells show these characters rather than those of a *Cerithium* with its curved canal.

Bittium pingue, sp. nov. Plate VII, fig. 10.

Type.—The lower half of the shell preserved, in which are five whorls; the greatest breadth along the spirals of the large whorl is 7 mm. The sutures make an angle of 79° with the axis, but are impressed lines only. It is ornamented by five rows of small equal knobs, joined longitudinally by a broader, and spirally by a narrower rising. The longitudinal groups—of which there are twenty-four in the last whorl—are curved in a direction concave to the aperture. The base is convex, joining the side without an angle. It has seven spiral ridges not divided into knobs. The columella is nearly straight, making an angle, or pseudo-furrow, with the outer lip. The left lip smooths over the spirals of the outside of the whorl.

Distribution and Relations.—From Scarborough, in the Museum of Practical Geology. There is a second example of the species in the York Museum, but it is not known elsewhere. One of these is the foundation for the record of *C. gemmatum*, but it is not that species, which is not recorded by Hudleston from the Cornbrash. It differs in the presence of spiral bands between the knobs and the undivided spirals on the base. The last feature also divides it from *C. millepunctatum* (Desl.) of the Oxfordian, which it otherwise much resembles.

Bittium lorieri (Héb. and Desl.). Plate VII, fig. 11.

1860. *Cerithium lorieri*, Hébert and Deslongchamps, Bull. Soc. Linn. Normand., vol. v, p. 192, pl. vi, fig. 2.

1884. *Cerithium muricatum*, Hudleston, Geol. Mag. [3], vol. i, p. 54, pl. iii, fig. 4.

Description.—Our specimens agree in all respects with the type: the length is 21 mm.; greatest breadth, 6 mm.; spiral angle, 10°. There are sixteen whorls, including the apex. The general level of the sides of the spire is almost uniform, so that there are steps at the sutures. The longitudinal ribs are 21 per whorl, and are closer together than the spiral ones. They decrease in height, and die out anteriorly. The knobs are much raised but rounded at the top. On the base are seven raised spirals, decreasing anteriorly. The most posterior one is crimped posteriorly by the longitudinal raised line.

Distribution.—Two exceedingly characteristic specimens have occurred at Shipton-on-Cherwell. More imperfect forms have been found at Thrapston (1), at Scarborough (7, including the specimen figured by Hudleston), and at Bedford (1). The species occurs also at Le Waast in the Boulonnais.

Relations.—In these small *Bittia*, unless the characters are very closely noted, it is impossible to say how far agreement may be recognised with other forms. This is a finer shell than *B. pingue*, and has 4 knobs in a longitudinal group instead of 5, and 21 groups in the last whorl instead of 24, so that the knobs are less crowded together. It is quite possible such changes might take place in a single shell, but they have not been seen to do so. With regard to *C. muricatum*, if we define it as having "5 (or 4) rows of knobs arranged in straight (or curved) longitudinal bands," our shell may be included therein, but not if we leave out the brackets. The same is the case with *C. russiense* of D'Orbigny and *C. granulato-costatum* of Goldfuss.

Genus **CRYPTAULAX**, Tate.

The following is the author's definition: "Shell turriculated, pointed, with a polygonal spire ornamented with transverse costæ, angles of whorls disposed in a more or less marked spiral series; imperforate columella straight, thin, aperture ovate, not produced into a distinct canal in front, peristome entire, broadly reflexed upon the left lip, a shallow oblique posterior canal in the angle formed by the body whorl and outer lip."

Cryptaulax tortilis (Héb. and Desl.). Plate VII, figs. 12, 13.

1860. *Cerithium tortile*, Hébert and Deslongchamps, Bull. Soc. Linn. Normand., vol. v, p. 191, pl. vi, fig. 6.

Type.—Length to breadth, $3\frac{1}{2}$. Shell twisted, pointed, with a polygonal twisted spire; whorls slightly rounded, showing a variable number of angles, generally six or seven. Sutural furrow broad and rather deep. Each whorl is marked with two transverse (spiral) ridges placed before and behind. The interval is marked with much smaller parallel ridges, variable in number. Angles of the whorls arranged in a more or less pronounced spiral series. In the Oxfordian of Montreuil-Bellay.

Description.—The length of the figured specimen (Pl. VII, fig. 12) is 15 mm., and its maximum breadth is about 4 mm. The spiral angle, 15° . Thirteen whorls preserved, of which the first two only are smooth. The two bounding ribs and one intermediate rib commence together. The second intermediate rib commences in the seventh whorl anteriorly to the first, but no more appear. The base has five spirals more, and then they are less influenced by the longitudinals posteriorly. There are thirteen longitudinal rows in the last whorl. The suture line is undulating. The aperture is somewhat imperfect in the specimen, but is well shown in another. Fig. 13 exhibits the generic characters of the “peristome broadly reflexed upon the left lip” and the “posterior canal in the angle,” etc.

Relations.—Roughly speaking, the shells from the Inferior Oolite, referred by Huddlestone to this species, may belong to it; but as they differ in some respects of an importance equal to that which is often made to separate forms in this class of shell, they can be considered perhaps as the ancestors only of shells from which the latter are mutations. These differences are a wider spiral angle, less deep suture which is not thrown into curves by the overlapping of the marginal knobs, and the greater equality of the knobs in each longitudinal group.

Distribution.—Nearly forty specimens of this have been seen associated at Shipton-on-Cherwell. In the collection of Mr. W. H. Huddlestone.

Genus **CERITHINELLA**, Gemmellaro.

The genus is defined by the author as follows: Shell turreted, slender, whorls numerous, flat, ornamented with spiral ribs or rows of small nodes; aperture quadrilateral, with a very faint canal.

Cerithinella biserialis, sp. nov. Plate VII, figs. 14*a*, 14*b*.

Type.—Imperfect at apex and base; seven whorls preserved in 9 mm.; spiral angle about 12° ; whorls flat; sutures deep. Ornament consists of six narrow spiral bands raised into knobs at intervals, commencing at the posterior end. The first row of knobs overlaps the first two spirals. The second row is on the third spiral; the line between the two rows slants from the aperture. There are about twenty-two pairs per whorl. The fourth spiral is scarcely raised, and appears as a dividing line separating two series of knobs. The fifth spiral bears knobs as large as those of the first row, but those on the sixth spiral are much smaller. The pairs of knobs of the second series do not correspond with those of the first, but are rather more numerous, and the lines joining them slant towards the aperture. On the last whorl the fourth spiral becomes slightly knobbed, and a seventh slightly knobbed spiral is developed, followed by five or more plain spirals on the base. This base becomes nearly perpendicular to the outer surface of the whorl, but the character of the aperture is not disclosed, being broken away. There is no umbilicus. From Shipton-on-Cherwell. In the collection of Mr. W. H. Hudleston.

Distribution and Relations.—The type is the only specimen known. Though the aperture is not seen, this appears to agree otherwise with the definition of *Cerithinella*, and especially it agrees with the figures given by Hudleston, in his pl. xii, of our own Inferior Oolite forms, in having the posterior part of each whorl ornamented independently of the anterior part.

“Cerithium” multivolutum, Piette. Plate VII, fig. 15.

1857. *Cerithium multivolutum*, Piette, Bull. Soc. Géol. France [2], vol. xiv, p. 547, pl. v, figs. 17, 18.

Type.—“Shell turreted, lengthened, composed of a large number of narrow whorls whose surface is flat or slightly convex, which appear smooth at first, and are so, in fact, in many individuals; but on specimens better preserved can be distinguished, with good eyes, a range of fine granulations and some transverse striæ along the suture—and on the shell also can be seen pretty regular, flexuous, longitudinal striæ.” From the marly limestone of Rumigny and Éparey.

Description.—The specimen here figured is imperfect at both ends. It shows eight whorls in a length of 22 mm. The spiral angle is 13° . The sutures are scarcely impressed, the whole surface being practically conical; they make an angle of 85° with the axis. The lower part of the spire is quite smooth, but the upper part shows five whorls preserving their oblique grooves (doubtless the

“striæ” of the type), bending very slightly towards the aperture, sixteen in a whorl at last—stronger and fewer near the apex. Also “with good eyes”¹ the excessively minute spiral striæ may be noted near the posterior suture, if not all over. There are no Nerinaean processes, but the characters of the base and aperture are not here shown at all.

Distribution and Relations.—This specimen is at present unique and comes from Shipton-on-Cherwell, and is in the collection of Mr. W. H. Hudleston. It is identified with Piette’s figures 17 and 18 only—perhaps his figures 16 and 20 may be different. This species is abundant in the Cornbrash at Le Waast as well as in the underlying beds (*vide* Rigaux, ‘Bas Boulonnais,’ p. 36).

Family NERINÆIDÆ.

First named by DeFrance (‘Dict. Sci. Nat.’), but first defined by Deshayes (‘Coq. Char. des Terrains,’ p. 203). According to the definition there given the shells have the aperture subquadangular and canaliculated, a broad umbilicated columella with strong spiral folds and one or more folds in the interior of the inner lip. According to this the interior folds and the umbilicated columella would be alike essential to the name, but we, nevertheless, call those with solid columellas *Nerinaea*, while those without the folds are distinguished as *Aptychiella*. In this case there are also other reasons for separation.

Genus **NERINÆA**, DeFrance.

The records of *Nerinaea* in the Cornbrash are

- | | |
|--------------------------------|---|
| * <i>N. cingenda</i> (28, 43). | * <i>N. granulata</i> (5, 6, 15, 28, 34, 43, 50). |
| * <i>N. fasciata</i> (50). | * <i>N. goodhalli</i> (29). |

With regard to *N. cingenda*, which is an Inferior Oolite species characteristic of the Dogger of Yorkshire, it is once recorded by Wright (and after him by Etheridge) from an examination of Leckenby’s collection. But the only *Nerinaea* in that collection is the one now called *N. fasciata* (*q. v.*).

The specimen in the Leckenby collection bearing the name *N. fasciata* has not exactly been recorded, since Hudleston (*loc. cit.*) only mentions the name to reject it. He figures it, however, as “*Nerinaea* sp.” and states that “the matrix is a little peculiar, but on the whole resembles that of the Scarborough Cornbrash more than any other.” This resemblance, I think, is misleading.

¹ They were not, in fact, noticed till Piette’s description had been read.

The records of *Nerinæa granulata* are numerous, but there appears to be only one specimen between them all. Dr. Lycett figured the single specimen in the Scarborough Museum. Further remarks will be found under that heading.

The record of *N. goodhalli* is by Macalister as from some Jurassic bed at Gayhurst, a locality not now marked as showing Cornbrash; but as this is only ten miles distant in the direction of the range of that rock from the section at Akely, the name may probably indicate a fossil thence described here as *N. bathonica*.

"*Nerinæa granulata*" (Phillips).

1835. *Terebra granulata*, Phillips, Geol. Yorkshire, pl. vii, fig. 16.

1854. *Cerithium granulatum*, Morris, Catal. Brit. Foss., ed. 2, p. 240.

1863. *Nerinæa granulata*, Lycett, Suppl. to Great Ool. Mollusca (Pal. Soc.), p. 10, pl. xxxi, fig. 12.

1875. — — Phillips, *op. cit.*, 3rd edition, p. 258.

Lycett's description is the only one yet given; in some respects it does not agree either with Phillips' figure or his own.

"Shell elongated, turreted, volutions numerous (about 20) [only 8 shown], narrow (so that their height is little more than half of their opposite diameters) [drawn only a little less], flattened, but slightly contracted towards the base of each volution and encircled with numerous (9 or 10) irregular, unequal, slightly nodulous lines; the aperture is small, subquadrate, and oblique; the columellar lip has a single strong plication." Sixteen volutions are preserved. This specimen was discovered before the year 1835 (see headlines); since then it has made no progress, except to reduce to half its size. One after another author has had a guess at it. First it was a *Terebra*; then under Morris in 1854 it became a *Cerithium*; and, finally, when half worn away, it changed to *Nerinæa* in 1863; but no one has seen its interior structure, which should demonstrate whether it is a *Nerinæa* at all.

A second specimen is that in the Museum of Practical Geology, which has been compared with *N. granulata*. It shows the same ornament as the type. The base makes an angle of about 60° with the continuation of the surface, and shows six spirals on it. The lines of growth are very fine and nearly vertical.

Nerinæa bathonica, Rigaux and Sauvage. Plate VII, fig. 17.

1868. *Nerinæa bathonica*, Rigaux et Sauvage, Mém. Soc. Acad. Boulogne, vol. iii, p. 27, pl. iii, fig. 2.

Type.—Length 120 mm., breadth of last whorl 30 mm., height of the same 21 mm. "Shell large, elongated, conical, not umbilicated, whorls concave ex-

teriorly, smooth, lip with one fold, columella unknown. There are no longitudinal striae, and in old age the whorls become less concave and are not swollen near the anterior border." From the Cornbrash and Great Oolite of the Boulonnais.

Description.—In the upper bed of supposed Cornbrash at Akely brickyard are several fragments of a large *Nerinea* which seem to belong to this species. They agree with it in general shape, size, and spiral angles, in the concavity and smoothness of the whorl surface, in the slope of the sutures, and in the lack of swelling near the anterior border. There is also one strong fold in the outer lip.

Nerinea dimidiata, sp. nov. Plate VII, fig. 16.

Type.—Length preserved 23 mm. Maximum width 5.5 mm. Spiral angle 10°. Nine whorls are shown. Sutures inclined 75° to axis. Each whorl has the upper part swollen and smooth, the remainder being slightly concave and marked with six equal raised spirals. Interior not seen. The surface of the shell is on the whole step-like. From Scarborough. In the British Museum.

Here we also see the interior arrangements. The fold on the outer lip is strong and a good deal posterior to the lip on the columella. This latter leaves only a narrow inlet between it and the anterior surface of the whorl—like a canal. On the posterior part of the columella there is in one case a very feeble sign of a third keel (see Pl. VII, fig. 16).

Distribution and Relations.—Three fragments from Akely brickyard are all that have been seen. They are associated with *Anabacia* and *Avicula braamburiensis*. It is probable that a similar occurrence in the continuation of this bed past Newport Pagnell has caused the record of *N. goodhalli* (Sow.) at Gayhurst. There is a considerable resemblance between the two, but our species has not the swelling noticeable in the anterior part of the whorl, nor the long fold on the posterior wall in the whorl of the latter species. The first distinction separates it also from *N. desvoidyi*, D'Orb., which exhibits different relative positions of the two principal folds; but our species is no doubt related to both these Corallian forms by way of ancestry.

Genus **APTYXIELLA**, Fischer.

Aptyxis, Zittel, name pre-occupied and altered to *Aptyxiella* by Fischer ('Man. de Conchyl.'). Zittel's diagnosis is as follows: "Turreted, very slender, imperforate, aperture quadrangular, inner and outer lips without folds, columella somewhat thickened." This name may be used for all shells with anterior canals whose external shape suggests a *Nerinea*, but whose internal section shows no folds.

Aptyxiella lineata, sp. nov. Plate VII, fig. 18.

Type.—A fragment of length 29 mm. Maximum breadth 8 mm. Spiral angle 6° . Three whorls are shown. The suture makes an angle of 74° with the axis. The surface of the shell is nearly conical, the sutures being very little impressed. The ornament consists of fine spiral lines; the base is angular and smooth; the aperture channeled in front. No folds are seen at either end. From the neighbourhood of Chippenham. In the British Museum (no. 27422).

Description.—The whorls seem to have a very thin shell, and sometimes show nothing within, though sometimes with a quadrate interior and a spiral depression along the middle of the outside of the whorl.

Distribution.—There are two specimens from Chippenham, four have been obtained at Shipton-on-Cherwell, and one at Holwell. They are usually in short fragments, and appear to have been buried as such in a different matrix from that which fills the interior. The general shape of the species shows a great resemblance to that of *N. sharmani* from Boulogne, but that is said to have numerous folds.

Aptyxiella blainvillei (Desl.). Plate VII, fig. 19.

1843. *Cerithium blainvillii*, Deslongchamps, Mém. Soc. Linn. Normandie, p. 192, pl. viii, fig. 35.

Type.—Shell turreted, very long in proportion to its diameter, striated transversely; whorls a little less high than broad, concave in the middle, slightly swollen near the sutures, where they form a well-pronounced projecting angle; base slightly concave; aperture rhomboidal; columella ending below by a canal in the form of a straight, rather elongated beak. From the Pierre Blanche of Langrune.

Description.—The figured specimen (Pl. VII, fig. 19), so far as preserved, agrees accurately with the above description, with the figure of the type, and with its numerical data. It has no folds when cut. The number of spirals on each whorl is normally four, but intervening feebler ones are seen on the final whorls. The spiral angle is 16° , and the sutures make an angle of 77° with the axis.

Distribution and Relations.—Five specimens of this shell have been collected at Shipton-on-Cherwell for Mr. Hudleston, but none are known elsewhere. The broader form known as *C. defrancii* has been united to this by some, but the latter species differs from ours, certainly in its spiral angle, and possibly in the form of its aperture. It comes also from a somewhat different facies of rock which may be also lower. On the other hand, it is quite possible that our specimens come from the beds underlying the Cornbrash, and not from the Cornbrash itself. The matrix is only seen in the interior.

Family EULIMIDÆ.

The family is thus defined in the last edition of Zittel's 'Handbuch': "Small, polished, elongate-conic shells with oval aperture; the axis often distorted; nucleus dextral."

Genus **EULIMA**, Risso.

"Rather thick, highly turreted; suture distinct; spire plane, that of the summit mammellated; aperture oval, attenuated to the right" (Risso, 1826).

The sole record of this genus is **Eulima lævigata* (34, 43, 48). There is, however, some confusion here. The name was first applied by Lycett ("Great Oolite Moll," pl. xv, fig. 4), to a shell from "near Scarborough," which indicates what is now called the Scarborough limestone, but his figure does not correspond with the description. In the Supplement (pl. xxxi, fig. 3) he applied the same name to another shell, differing from the first in character. In the first he lays stress on the character: "Very subulate, the length of their whorls being nearly equal to their transverse diameter"; in the second he says: "Whorls narrow, the height slightly exceeds half of the opposite diameter." This latter, from the Cornbrash, is fairly drawn, but coincides better in shape with the former figure. Finally Hudleston describes the original by the exact terms used to distinguish it from *E. communis*, and draws a figure of a form from the Cornbrash different from either of Lycett's. In his last monograph ("Inf. Ool. Gast.," p. 244) Hudleston classes the Scarborough limestone species with *Pseudomelania*, and queries both Lycett's figure and his own from the Cornbrash. In these circumstances it appears that we cannot call either of them *E. lævigata*, but must give new names to both.

Eulima lachryma, sp. nov. Plate VII, fig. 20.

1863. *Eulima lævigata*, Lycett, Great Oolite Mollusca (Pal. Soc.), p. 114, pl. xv, fig. 4 (not Suppl. pl. xxxi, fig. 3).

Type.—Sutural angle, including the last whorl, 32°. There are eight whorls, the last being swollen. The upper whorls are about half as high as their diameter. The surface is slightly convex and polished, the sutures being not deep. There are very fine curved lines of growth, and still finer spiral lines, almost invisible even with a lens. The aperture is pointed posteriorly, and quite round anteriorly,

the surface curving round like the side of a dome. The shell is 17 mm. in length. From Scarborough. In the Sedgwick Museum.

Distribution.—The type is not either of those which have been examined before, but as it resembles so closely Lycett's figure from "near Scarborough," which does not agree with his description, that figure may by accident have been substituted from another specimen of this species; but the name goes with the *description*.

Relations.—The type is so pointed at the apex and so swollen at the bottom, that it resembles a tear-drop, and thus has a quite characteristic aspect. Whether any specimens once named *Eulima* ought not rather to be called *Pseudomelania*, this at least is a true *Eulima*.

Eulima extricata, sp. nov. Plate VII, fig. 21.

1882. *Eulima lævigata*, Hudleston, Geol. Mag. [2], vol. ix, p. 245, pl. vi, fig. 8 (*non* Lycett).

Type.—Length 32 mm.; sutural angle, 23°. About ten whorls, the last being little more than of proportional size; height $\frac{5}{8}$ of diameter. "The whorls are extremely round and full, with a deep suture which gives a strangulated appearance. The whorls are so extremely smooth that even the lines of growth can scarcely be detected" (Hudleston). They are consequently characteristically polished. The last whorl, though seen only at the back, does not seem to be elongated. From Scarborough. In the British Museum.

Distribution.—The specimen figured by Hudleston is also from Scarborough, and casts have been seen which from their shape may possibly belong here from Scarborough (1) and Sudbrook (1).

Relations.—The rotundity and strangulated appearance distinguish this species very well from any other true *Eulima*, but make it more doubtful whether it is rightly referred to that genus. Moreover the specimens are rather large for it. Yet there is no *Pseudomelania* of which they can be suggested as the young. In general form they resemble Morris and Lycett's figures of *Eul. communis*, but according to their description there are peculiarities about that shell neither shown in their figures nor repeated in our fossils. The relative shortness of the body whorl, even more perhaps than the want of ornament and the size, seems to preclude the idea of a *Pseudomelania*, so that this species is congeneric at least with the specimen figured as *Eul. lævigata* by Hudleston.

Family PSEUDOMELANIADÆ.

After having been attached to various groups of living shells with which they had some point of resemblance, it has been found that the *Pseudomelaniadæ*

are sufficiently related amongst themselves to justify a group of their own. They have elongated, pointed spires, growing to a considerable size, their aperture oval, entire, regularly rounded in front, and terminating posteriorly in an angle.

Genus **PSEUDOMELANIA**, Pictet and Campiche.

Shell thick and not umbilicated, ornament usually confined to lines of growth, columella thick. The principal shells placed here are divisible into two groups, one with smooth, rounded whorls with only lines of growth [these are called anoptychia by Koken], and the other with a spiral rib near the tip of the whorls, at least in the adult [called hypsipleura by Koken].

The *Pseudomelania*s of the Cornbrash have been recorded under the old name of *Chemnitzia* or even *Melania*.

C. heddingtonensis (5, 6).

C. scarburgensis? (44).

**C. simplex* (40).

**C. vittata* (5, 6, 15, 21, 25, 28, 34, 40, 42, 44, 48).

Of these *heddingtonensis* has never been recorded since. The only recognisable difference between this species and *P. vittata* lying in the prominence or presence of ornaments, imperfect ones might be registered under this name without both species being present. *P. scarburgensis* has been recorded with a (?) only from Appleby, and no such specimen has been seen in Mr. Cross' collection. *P. simplex*, recorded by Sharp from Peterborough-Stilton district, is represented by two specimens in Birmingham University, but they are worn casts as usual and show no definite features.

Pseudomelania vittata (Phillips). Plate VIII, figs. 1, 2.

1835. *Melania vittata*, Phillips, Geol. Yorks., p. 116, pl. vii, fig. 15.

1853. *Chemnitzia vittata*, cf. Lycett, Suppl. G. O. Mollusca (Pal. Soc.), p. 14, pl. xxxi, fig. 10.

1875. — — Phillips, *op. cit.*, 3rd edition, p. 257.

1882. — — Hudleston, Geol. Mag. [2], vol. ix, p. 244, pl. vi, figs. 5, 5 a, 6.

Type is constituted by Phillips' figure only.

Description.—There are about ten to twelve whorls when adult; corresponding projections lie in a straight line longitudinally. At the apex the surface is smooth and conical, and shows only lines of growth with an undulating twist. These are crossed by fine spiral fimbriated lines. At a diameter of 7 mm. the posterior front begins to rise and the anterior outside edge becomes angular. The suture makes an angle of 75° with the axis. The posterior border rises gradually till the anterior edge becomes a sharp spiral and the rest slopes down backwards to the suture; in

front a concavity becomes produced on the surface, rising to and ended by the angular edge which leaves a part of the base uncovered—so that there are two keels. The aperture is oval and tolerably wide, with fair evidence of thickening posteriorly where the callus is very prominent. The fine “growth-line” ornament continues over all. The shell is so thick that the ridges make little show upon the last.

Distribution.—It has been thought that this species is peculiar to Scarborough, and in fact forty-six specimens showing the shell have been collected; but one has also been obtained from Rushden, in a matrix resembling that of the locality, and is now in the Northampton Museum. It is figured in Pl. VIII, fig. 1. It must be by casts that we may expect to recognise its presence elsewhere, and one of these, I think there can be little doubt, is figured on Pl. VIII, fig. 2, from Garsdon, near Malmesbury. But there are other casts which cannot be referred to the same species—some with too wide a spiral angle and some with too close a whorl. These belong to species which have not been found in the shell, but only in the cast.

Relations.—This species is no doubt removed by small divergences from its representative of the same group in other strata. But it is easily distinguished in the adult, for in it the group rose to its acme, at all events in size; but for ornament it is a very good instance of the shells of the Inferior Oolite returning again with modifications to their old quarters—when conditions again became suitable (*cf.* Huddleston, ‘Gasteropoda of the Inferior Oolite,’ pls. xviii, xix).

Family NATICIDÆ.

Genus **NATICA**, Scopoli (Adanson).

More or less globose, smooth, rarely spirally striated, umbilicated or not, outer lip sharp, inner lip thickened by a callus.

The records of *Natica* are:

**N. insignis* (34, 43). **N. punctura* (6, 9, 15, 25, 28, 43, 48, 67).
N. texatu (65).

To these must be added the records of *Neritopsis*:

Ner. archiaci (34, 43). **Ner. canaliculata* (25, 34, 48).
**Ner. lævigata* (28).

The record of *N. insignis* rests only on the statement by Lycett (‘Suppl. G. O. Moll.’ p. 98), “it has occurred rarely in the Cornbrash at Scarborough.” His type is from the Great Oolite, and measures only 5.5 mm. in length, and there are no ornaments. It is not, therefore, to be wondered at that no specimens from the

Cornbrash are anywhere forthcoming. A small specimen in my collection from Bothenhampton might do very well for it, but it is only a young cast, and might do as well for the young of *N. chauviniana*. For *N. punctura* see below. *N. texata* is quoted by Beeby Thompson from Stow-nine-Churches. No doubt it is that species, but that species is the same as *N. montreuilensis*. The resemblance of the two is noticed by Lycett, but he says the latter "is less depressed and the aperture more lengthened," but in measuring them together I can find no difference between them (see p. 80).

The records of *Neritopsis* must be taken with those of *Natica*. They all three refer practically to one species—*i. e.* in the first instance, all to one specimen. *N. archiaci* was D'Orbigny's name for D'Archiac's species, whose figures and description he merely copied, but the former's name *canaliculata* was pre-occupied in *Turbo*. *Neritopsis canaliculata* is Lycett's erroneous determination of the fossil here called *Nat. montreuilensis*, and *Nerita laevigata* is Wright's erroneous determination for the same specimen.

Natica punctura (Bean). Plate VIII, figs. 3, 3 a; Plate IX, figs. 10, 11.

1839. *Littorina punctura*, Bean, Mag. Nat. Hist., vol. iii, p. 62, fig. 23.

1882. — — Huddleston, Geol. Mag. [2], vol. ix, p. 201, pl. v, fig. 11.

Type.—"Shell turbinated, finely striated longitudinally and transversely. . . . Whorls (6) rounded and well divided, the body whorl occupying one half the length of the shell. Aperture elliptical, pillar lip thick and a little flattened, outer lip very thin. Length nearly $\frac{3}{4}$ inch, breadth $\frac{1}{2}$ inch." From the Cornbrash of Scarborough. Present depository unknown.

Description.—The proportions of the shell vary within certain limits, so that the figures above given are not universal. Thus the relative breadth in Huddleston's figure is $\frac{11}{19} = \frac{3}{5}$, in the figured specimen $\frac{11}{19}$, a third $\frac{1}{3}$. Also the relative length of the body whorl to the whole (along surface axial line) can only be roughly called one half; it is $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{1}{2}$. The punctures are spiral lines, but correspond longitudinally. The spiral angle is 50° – 60° . The general surface is throughout curvilinear. No angles or straight lines need be employed to represent it.

Distribution.—This is essentially a Yorkshire fossil, twenty-four having been found at Scarborough, but it has extended to Sudbrook (7), Peterborough (1), and Bedford (3). Beyond this it has not been found. *Naticæ* of any kind are scarce.

Relations.—This is not the *Natica punctura* figured by Morris and Lycett from the "Bath oolite" of Yorkshire, as may be seen by the figure itself (it is much too broad), and it is not even mentioned in Huddleston's account of the Gasteropoda of the Inferior Oolite. Nor is its relation to *N. bajocensis* any longer upheld. It is

scarcely possible, however, to deny the similarity, if not the identity, of the fossil from the Dogger. We seem to be able to trace a very instructive history here. The species came from the north, and in Inferior Oolite times reached as far as Yorkshire. In Great Oolite times it did not retire to the south, but out of the country. With the new and wider expansion of strata in Cornbrash times it returned and spread beyond the confines of Yorkshire at least as far as Bedford, and later on, as *N. calypso*, it appears to have spread as far as the Ardennes. During its wanderings it gradually became thinner.

***Natica montreuilensis*, Hébert and Desl. Plate VIII, figs. 4, 5.**

1860. *Natica montreuilensis*, Hébert and Deslongchamps, Bull. Soc. Linn. Normand., vol. v, p. 31, pl. ii, fig. 2.
 1853. *Neritopsis archiaci*, Lyeett, Suppl. G. O. Moll. (Pal. Soc.), pl. xxi, fig. 7, p. 21.
 1884. — *canaliculata*, Hudleston, Geol. Mag. [3], vol. i, p. 301, pl. ix, fig. 12.
 ? 1863. *Natica texata*, Lyeett, *op. cit.*, pl. xlv, fig. 30.

Type.—"Length 14 mm., breadth of last whorl 12 mm. Shell globular, the spire not much projecting, smooth throughout, apex obtuse. Whorls rounded. Sutural furrow well marked and rather deep. Last whorl larger than the rest. Base very oblique. Umbilicus scarcely apparent." From the Callovian beds of Montreuil-Bellay.

Description.—The shells referable to this species agree in every respect with the above definition with the exceptions to be noted, and they have somewhat the aspect of the same, which is that of a *Nerita*, the spire being so short and so few-whorled (3-4). Many of them are "smooth throughout," but the best preserved show numerous longitudinal bands like flat folds crossed by over-riding narrower and closer festooned spirals without interfering with the visible smoothness. The umbilicus is small, but perfectly distinct. The inner lip and basal part of the aperture is thicker than the outer lip. There are patches of black and yellow colour like clouds in the shell, and some retain a black incrustation in a separate layer, which may be the remains of an epidermis. The fossils mostly retain their shell in Yorkshire, being there thoroughly autochthonous. The shell is thick so that in casts the whorls are nearly separate.

Distribution.—From their home in Yorkshire seven specimens have been obtained, and one from Stow-nine-Churches, also casts from Bedford (2), Hullavington, and Holwell.

Relations.—It is curious that this shell should have passed muster so long as a *Neritopsis*. The specimens only required development. It then appears that the whorl continues round the columella and there is no callous plate—much less a notch in it.

Natica chauviniana, D'Orb. Plate VIII, fig. 6.

1852. *Natica chauviniana*, D'Orbigny, Pal. Franç. Terr. Jurassiques, p. 198, pl. ccxc, figs. 12, 13.

Type.—"Spiral angle 104° . Length 35 mm. Breadth 29 mm. An interior mould a little longer than broad, oval. Spire short, formed with a very convex angle, composed of short convex whorls of which the last is twice the size of the others. Mouth oval." From the Callovian of Sarthe.

Description.—The specimen referred to this species has a spiral angle of 84° . The breadth is 0.9 of the length. Of this length the last whorl is 0.75, making the breadth of the last whorl 1.2 of its length. It is a cast or mould, the top of the whorls forming a narrow border or ledge. The surface is convex and there are four or five whorls. The remains of the umbilicus form a deep round pit.

Distribution.—Only one full-grown specimen has been seen from Bedford, but the little specimen from Bothenhampton would probably grow up into it, and the species may therefore be more widely spread than appears.

Relations.—Our specimen has not so wide a spiral angle as the type—but it has a wide one, and the other proportions agree. It is remarkable for the great width and short length of its body whorl. If we look through the many figures given by D'Orbigny, it is remarkable that the only one which approximates to this should belong to a suitable horizon.

Natica sp. (*cf. cincta*). Plate VIII, fig. 7.

A single cast obtained from the Cornbrash at Holwell is of so suggestive a character that, in spite of its not being in a fit condition to name, it requires notice. It cannot belong to any of the above described *Naticæ*, though, being made of separated whorls, the shell must have been thick and not easily destroyed. The matrix and the cast are almost inseparable, so that we may conclude that it was a cast before it was imbedded. In other words, it is a *remanié* fossil, and we must look in older spots for its original home. It is a large shell which yields (probably) abundant casts. Exactly such a cast is figured by Hudleston ('Gast. Inf. Ool.,' pl. xxi, fig. 3), as belonging to *Natica cincta*—a shell which, though not recorded from the Inferior Oolite of Dorset, is abundant in the not remote district of Gloucestershire. It would be curious if a shell excluded from a district at the time of its flourishing should be introduced into it in later times as a *remanié*, but it is not impossible.

Genus **CLOUGHTONIA**, Hudleston.

This genus, established by Hudleston in 1882 ('*Geol. Mag.*' [2], vol. ix, p. 203), is thus defined by its author: "Shell short, conical, and solid, with a widish base; shell substance thick. Whorls about 5, flat and angular; body whorl more or less bicarinated, with slight depression of the intervening space. Surface smooth or ornamented with rugose lines of growth. Aperture ovate to ovate-oblong, rounded anteriorly. Pillar nearly straight and with little or no callus." The author now places this amongst *Pseudomelaniadæ*; but it is a little difficult to range a genus whose diagnosis commences "shell short" in a family stated to have its "shell elongated." This, at all events, is impressed on one by the shell described below, which shows an extreme approach to a *Natica*.

Cloughtonia depressa, sp. nov. Plate VIII, fig. 8.

Type.—Spiral angle 95°. Extreme height 25 mm. Breadth of last whorl 23 mm. Whorls 4. Upper whorls squarely rounded. Body whorl in cast is swollen round the suture, then slightly hollowed out anteriorly to this, then swollen along a spiral line. Beyond this it is rapidly bent inwards to form the inner boundary of the aperture, the outer lip at the same time expanding longitudinally. Any umbilicus would probably be covered by the very thick shell, which, however, becomes thin where preserved between the matrix filling the aperture and the penultimate whorl. Surface of cast quite smooth. From Sudbrook. In the Sedgwick Museum.

It is probable that the irregularity of the spire and the expansion of the outer lip are due to pressure on the matrix. The swelling round the suture may not indicate any such swelling on the shell, but rather its hollowing out within, for the apparent furrow between it and the penultimate whorl is entirely filled with the shell substance, broken off above and thinning greatly below.

Distribution and Relations.—Only this one specimen has been seen. The aspect of the matrix seems certainly to confirm its derivation from the Cornbrash, and it thus forms a link between the somewhat similar shells in the Inferior Oolite and the Portland (see Hudleston, *loc. cit.*, p. 203). The drawing in of the body whorl on the inner side may be more or less characteristic of the genus.

TURBINOID SHELLS.

Some various records of Turbinoid shells are as follows:

**Amberleya armigera* (34, 39, 50).

**Littorina phillipsi* (43, 50).

Purpurina ornata (6, 25, 28).

Turbo elaboratus (25, 28, 43).

Purpurina condensata (50).

**Turbo funiculatus* (6, 28, 50).

Rotella expansa (6).

Of these, for *Amberleya armigera* see *Eucyclus armiger*. *Littorina phillipsi* has not been seen distinct from *Eucyclus armiger*. It belongs originally to the Scarborough Limestone. *Purpurina ornata* was the name assigned to the shell afterwards described by Lycett as *Amberleya armigera*. *Purpurina condensata* has been stated to be the same as the Cornbrash form previously referred to *Turbo elaboratus*, which latter form will be found here under the first title. *Turbo funiculatus* is here described as *Littorina cassius* and *Rotella expansa* as *Helicocryptus apertior*.

Family TROCHONEMATIDÆ.

This name is used by Zittel for a number of genera which are considered of doubtful position with respect to the *Littorinidæ*, *Turbinidæ*, or *Purpurinidæ*, but agree in having their whorls ornamented by spiral keels.

Genus **EUCYCLUS**, Deslongchamps.

Established by Deslongchamps in 1860 ('Bull. Soc. Linn. Norm.,' vol. v, p. 141) as follows: "Pyramidal, or nearly turriculate. Shell very thin; whorls rounded, increasing regularly; suture imbedded; surface covered with various transverse [spiral] folds, some more developed than others and forming one or more keels, crossed by numerous longitudinal lines. Base oblique, more or less rounded with concentric [spiral] folds, non-umbilicated; mouth oval, right lip semicircular, thin; left lip not seen on the return of the spire, but resting on the columella, which it thickens and enlarges, unites at a more or less open angle, but makes no notch with the right lip."

A large number of Jurassic species correspond with this generic description, amongst them the Cornbrash form, which must be referred to it, though it has been called *Amberleya*. The original diagnosis of the latter genus does not suit the species referred to, as will be seen by the following quotation, in which the differences are italicised: "Shell turreted, turbinated, apex acute; whorls *flattened above*, convex and *nodulated* beneath, the last whorl ventricose; aperture ovate, entire, inner lip thickened and nearly covering a *small umbilicus*; sutures deeply impressed; no *columella*." The shells answering to the description of *Eucyclus* were at the same time referred to *Littorina*. It was only later that Lycett ex-

panded the meaning of *Amberleya* to include two other genera, one of them acknowledged to differ only in details from his former *Littorina*. *Eucyclus* is too well characterised a genus to admit *Amberleya nodosa* within its limits.

Eucyclus armiger (Lycett). Plate VIII, figs. 9, 10.

1863. *Amberleya armigera*, Lycett, Suppl. Great Ool. Mollusca (Pal. Soc.), p. 20, pl. xxxi, fig. 6.

1884. — — — — — Hudleston, Geol. Mag. [3], vol. i, p. 245, pl. viii, fig. 5.

Type.—"Shell conical; spire elevated, pointed; volutions 5, convex, somewhat angulated with 4 encircling costæ or carinæ which are densely and delicately tuberculated and decussated by fine striations, the two lower costæ being much larger than the upper, so that the lowest costa overhangs the upper part of the next volution; the base has 5 encircling serrated costæ; there is no umbilicus. Height 10 lines, length of the last volution 8 lines." From Scarborough. In the Leckenby Collection.

Description.—The fourth row of knobs from the top occupies the crest of the angle and divides the surface into two halves, the lower half being occupied by smaller and more regular knobs, the third row from the top the largest and fewest. The succeeding whorl does not reach quite to the crest, so making a deep suture which is a well-marked feature of the shell. The upper whorls contain 3 rows only. Six spirals can be counted on the base. One specimen shows the aperture in a perfect condition; the outer lip is angular in the centre, after the pattern of the whorl. It meets the straight columella at an angle, almost like a channel. The deposit from the inner lip obliterates the spirals on their reaching the columella.

The shells of this species are usually preserved and casts are rare. They show the shape very well, especially the deep sutures, also remains of the keel at the angle and of the rows of knobs on the base.

Distribution.—All but one of the specimens seen are from Scarborough (22); the exception, which, being in a soft matrix, is more easily worked out, is from Sudbrook.

Relations.—This species is very closely allied to "*Turbo*" *meriani*, Goldf. (after D'Orbigny), but the angle and the strong features of the third and fourth rows of knobs are more marked. These are little more than local varieties, the one of the other. *Littorina phillipsi*, which has been supposed to occur also in the Cornbrash, is said to have a shorter spire and smaller number of whorls, and it is drawn as having no such deep sutures. I have not seen such in the Cornbrash. There is, however, some variation in size of shell and angle, but not beyond the ordinary range of a species.

Genus **LITTORINA**, Férussac.

As the presence or absence of a pearly layer fails as a criterion between *Littorina* and *Turbo* in Jurassic rocks, the employment of either term must not be considered as stating anything upon that point, except that no differentiation into two layers of different character has been observed. *Turbo*, however, is also characterised by having a calcareous operculum. Such opercula would not more easily perish, I suppose, than the shell, for we have examples, as in *Euomphalus* and *Nerita*, in which they are preserved. Absence of opercula from the beds where the shells in question are abundant is as good a proof as we can desire that they are not Turbines. We must adopt, therefore, other names than *Turbo* for turbine-like shells if we would use exactness.¹ *Littorinæ* are compact shells and the aperture is affected somewhat by the preceding whorl.

Littorina cassius (D'Orbigny). Plate VIII, fig. 11.

1855. *Turbo cassius*, D'Orbigny, Pal. Franç. Terr. Jurassiques, vol. ii, p. 350, pl. cxxxiv, figs. 1, 3.

Type.—"Shell oval, conic, slightly umbilicated, spire regular, composed of slightly convex whorls provided with 4 longitudinal [spiral] ribs formed by hollow tubercles, elevated and imbricated. The last whorl has 11 similar ribs of smaller and smaller size. Mouth round, thickened in the columellar region. Length 15 mm." From the white limestone of Langrune and Luc.

Description.—The single specimen in hand is of the right size and shape, having a spiral angle of 62°. In the uniformity of the ribbing throughout and in the number of ribs or rows of tubercles in the upper whorls it also agrees. According to the description it should have a slight umbilicus; it has at most the feeblest umbilical slit, but more so than the figure. There should be 11 ribs in all on the last whorl, and it has at most 9. The tubercles should be hollow, and they are so filled or covered with matrix that this character cannot be determined—the shell being the softer—but one or two *appear* to be excavated towards the aperture. This specimen is from Scarborough.

Relations.—This is not the same specimen but appears to be of the same species as that figured by Huddlestone as *Turbo funiculatus*, though the angle as drawn is larger. The base and aperture are not seen in that fossil, and the ornament and shape do not seem to agree with the Corallian shell as figured in 1881. Our shell differs from *L. davousti* (D'Orb.) in the spiral angle, coarseness of ornament, and umbilicus.

¹ See remarks by Huddlestone to the same effect ('Geol. Mag.' [2], vol. viii, p. 52). In his 'Memoir on the Gasteropoda of the Inferior Oolite' *Turbo* has almost disappeared.

Genus **PURPURINA**, D'Orbigny.

This genus was defined by the author in 1850 ('Prodrome,' vol. i, p. 270) as having a "large aperture provided in front only with a very narrow furrow (sillon), which replaces the notch (échancrure) of the *Purpura*. Columellar border not flattened." He thus included the shells later called *Eucyclus*, to which, in fact, the majority of the examples quoted below belong. Properly speaking, perhaps this name ought not to supersede D'Orbigny's. But there are certainly two genera included here, which possibly D'Orbigny would have recognised had he lived to write the text on the genus; and Piette, who constituted *Eucyclus*, restricted *Purpurina* to those of which it could be said: "Angular posteriorly, body whorl large, ornamented with longitudinal ribs crossed by spiral striæ."

Purpurina condensata, Deslongchamps. Plate VIII, figs. 12, 13.

1860. *Purpurina condensata*, Deslongchamps, Bull. Soc. Linn. Normandie, vol. v, p. 178, pl. i, fig. 8;
pl. xi, fig. 5.

1882. — — — — — Hudleston, Geol. Mag. [2], vol. ix, p. 196, pl. v, fig. 3.

Type.—"A globular shell with a short spire. Whorls strongly rounded, slightly flattened for a certain distance facing the extremity of the spire, thus forming a very obtuse keel. Last whorl very large, with the surface adorned with about a dozen large rounded longitudinal folds, but transversely by very numerous regular small furrows. Mouth elliptical, lips united without a trace of demarcation, forming in front a very broad and very short gutter. Umbilicus small, but quite uncovered. Length 14 mm., length of last whorl 9 mm., breadth 10 mm."

Description.—Two specimens of this species have been seen, which are almost exact representations of Deslongchamps' figures. The smaller of the two (Pl. VIII, fig. 12) retains the shell, and shows the young form; the larger (fig. 13) is a cast only of the variety with coarser spirals, which should be called riblets rather than furrows. These are only feebly indicated. The differences noted are in the proportionate size of the last whorl. In our specimens we should not say "very large," for it is a good deal narrower and much shorter in comparison. The state of the apertures preserved does not enable us to verify the existence of a gutter, on which the genus depends. Better specimens alone can decide whether they are *Purpurina* or not.

Distribution and Relations.—No others than these two specimens from Scarborough have been seen, but the species occurs there also in the Kelloway Rock (*vide* Hudleston). Though these specimens have been called *Turbo elaboratus*, they

are not the same as the type of that species, which, like most, if not all, *Purpurinas*, has the direction of its body whorl at a less angle with the axis, making it appear longer. Our specimens, on the contrary, are even shorter than the type of *P. condensata*.

Genus **HELICOCRYPTUS**, D'Orbigny.

D'Orbigny in his 'Terrains Jurassiques,' vol. ii, thus describes a remarkable small shell: "Shell depressed, orbicular, nearly coiled in the same plane. Spire formed of whorls which embrace on both sides, leaving an umbilicus below and another above. In the latter is a spire almost entirely hidden by the later¹ whorls. Mouth vertical, oval, transverse, provided inside, both above and below, with a strong callosity which fills the spaces where the whorl embraces the spire, and leaves the rest of the border thin."

Helicocryptus orsus, sp. nov. Plate VIII, fig. 14.

Type.—A specimen from Scarborough in the Sedgwick Museum, recorded by Bean as *Rotella expansa*, is not easy to locate. The following interpretation is suggested: The diameter is 3.5 mm., the upper surface is smooth and shining, and shows as a whole very slight convexity, so as to have the aspect of a *Rotella*. It is composed of about three whorls, each of which has a considerable depth in proportion. They turn the angle into the under side rather abruptly. On the base they all reach close to the centre and leave only a small umbilicus. Part of the shell being broken through, it is seen to be very thick near the centre, but thin towards the circumference.

Relations.—The specimen thus described does not show some of the most remarkable features of the genus to which it is here referred—for the spire is not sunken, and the spaces between the spire and the embracing whorls are not filled up with callus. Both these, however, are abnormal features, and assuming that they arose gradually from a normal shell, such, perhaps, as a *Skenea*, the first stage of a sunk spire would be a low one, and the first stage of an infilling would be a thickening of one of the walls such as are the stages represented by our shell. The characters of this genus are taken from the phylogenetic adult, and our shell, it is suggested, may be the phylogenetic infant. At all events, it precedes the others in time.

¹ He says "precedent," but he must mean this.

Family TROCHIDE.

Genus **TROCHUS**, Linnæus.

Whatever may be the extreme limits of this genus, the species here included have all short spires, conical surfaces, angular base margins, and ornaments above that limit different from those below.

The records of *Trochus* are:

- | | |
|---|-------------------------------------|
| * <i>T. bumburji</i> . | * <i>T. strigosus</i> (34, 43, 48). |
| * <i>T. monilitectus</i> (6, 28, 43, 48). | * <i>T. subglaber</i> (48). |
| * <i>T. scarburgensis</i> (48). | |

T. bumburji is not represented by any specimen, nor can I obtain any information as to whence the specimen quoted came. *T. monilitectus* is the general name for the group to which the shell belongs. It is here described under the name *T. duplicans*. *T. scarburgensis* is here included with *T. strigosus*, for which see p. 89. For *T. subglaber* see p. 89.

Trochus duplicans, sp. nov. Plate VIII, figs. 15, 16.

1885. *Trochus monilitectus*, var. B., Hudleston, Geol. Mag. [3], vol. ii, p. 122.

Type.—Length, 8 mm. Spiral angle 55° on slope, spire flat. Whorls 7. The ornaments commence on the fourth, except the duplicated spiral, which commences on the third. In the adult the most anterior spiral projects more, but is no thicker than the rest. It is followed behind by three others like it, but the most posterior spiral is duplicate, being divided by a spiral furrow into pairs of knobs by dividing lines which go in the forward direction away from the aperture. In the larger interspaces finer spirals may be seen, while the coarser spirals are divided into knobs by oblique lines, which are continued over the edge in the same plane (and, therefore, apparently in a reversed direction) as radials. The base is marked with twenty fine spiral lines right up to the columella. The inner lip of the aperture clothes the previous whorl with a nacreous layer, the outer lip itself showing two distinguishable layers. From Scarborough. In the Sedgwick Museum.

Description.—Although only one specimen answers exactly to the above description, there is another which corresponds in all respects but one, that one being the number of the threads. Instead of there being four and a double one with a few finer interspersed occasionally, there are seven nearly uniform threads in the same space, so that they nearly fill it. They are all crossed by lines like

the twist in a thread of cotton wound upon a cone. For this reason the two are classed as one species, fig. 15 being var. *a* and fig. 16 being var. *β*.

Distribution and Relations.—Besides the two specimens from Scarborough, the species may possibly occur at Shipton-on-Cherwell. At Scarborough it is associated in the same bed with *T. subglaber*, which, so far as the ornaments go, might be taken as a third of the series of still finer threads, but there are other differences with regard to *T. monilitectus* with which one of these varieties was temporarily united by Hudleston: the position of the thickest spirals is reversed, while the base of the present form is entirely covered by the spiral lines. The species is closely related to the much larger shell, *T. picti*, Desl.

Trochus subglaber, Hudleston. Plate VIII, fig. 17.

1885. *Trochus subglaber*, Hudleston, Geol. Mag. [3], vol. ii, p. 125, pl. iii, fig. 6.

Type.—“Height, 13 mm.; spiral angle, 52°. Shell small, conical; imperforate spire consists of six or seven whorls, increasing pretty regularly. Suture close, but very distinct. Anterior of each whorl slightly tumid, posterior area slightly constricted. The ornaments consist of fine spiral striæ, very numerous, and somewhat closer together in the anterior than in the posterior region. These striæ are decussated by backward, sloping, transverse striæ, which scarcely reach the anterior margin. Base flat. . . .” The cross striæ are too feeble to cut up the spaces between the spiral striæ into knobs. The latter spirals are closer together on the last whorl; they are too fine to be counted. Further development shows that the base is convex and non-umbilicated, but there are no signs of any spiral lines. From Scarborough. In the Sedgwick Museum.

Distribution and Relations.—The specimen is unique. It is evidently a very close relation to *T. duplicans*, but it grows to a larger size. The cross striæ are more in evidence posteriorly than the spirals themselves, and are not indicated only by cutting them, while the base *seems* to be free from striæ.

Trochus strigosus, Lycett. Plate VIII, fig. 18.

1863. *Trochus strigosus*, Lycett, Suppl. Great Ool. Mollusca (Pal. Soc.), p. 29, pl. xlv, fig. 12.

1885. — — — Hudleston, Geol. Mag. [3], vol. ii, p. 124, pl. iii, fig. 3 (not fig. 4).

1885. *Trochus scarburgensis*, Hudleston, *ibid.*, pl. iii, fig. 2.

Type.—“Shell elevated, conical, transversely costellated; costellæ, four to a volution, granulated and equal. The anterior border of each volution has also a depressed striated band; the volutions, about five in number, are flattened; the

last volution is rounded; the base has a few striations; the columella is oblique; and the aperture somewhat triangular." From Scarborough. In the Sedgwick Museum.

Description.—This type shell being preserved, we can compare it with the description and ascertain the exact meaning of the words, it being remembered that at the time it was described the specimen was unique. Four costellæ to a volution means on the upper part; the depressed striated band means that it is not raised on both sides, leaving the upper portion of the base unconcealed. The base "has a few striations," means apparently that they are not so strong or that they diminish towards the columella, for the base is really characterised by the abundance of striation. These are the spiral ones, which are very close on the upper edge, are coarser after they run on to the actual base, and gradually get more remote or weaker till the very edge of the columella. The upper edge is crenulated at the top by the lines of growth, and all the "granulated costellæ" are about equal in size. The nearer the apex the more regular all become. The anterior edge is rounded; in youth it is more so.

Distribution.—This, or the next allied species, is now fairly common, there being about twenty seen from Scarborough, and probably one or more from Bedford, but they were not separated at first.

Relations.—With regard to *T. scarburyensis*, it appears to be the younger portion of the typical shell. Its spiral angle is said to be wider, but only by the difference between 65° and 70° , which, on a comparison of several specimens, is quite within the range of variation. It is said to be devoid of the basal belt, and this is hard to distinguish in the upper whorls of all. For the differences between this species and *T. lacuna* see that species. It is somewhat of a rough species when full grown, but not the roughest.

Trochus lacuna, sp. nov. Plate VIII, fig. 19.

1885. *Trochus strigosus*, Hudleston, Geol. Mag. [3], vol. ii, pl. iii, fig. 4 (not the rest).

Type (the same specimen as figured by Hudleston).—Length, apex restored, 35 mm.; greatest breadth, 25 mm.; whorls, about 6. On the upper part of each there are four spirals divided obliquely by lines of growth, the three anterior of which are equal, but the most posterior rises to a greater height, and is separated by a deeper interval; it abuts against the basal belt of the preceding whorl, and is sometimes larger than it. The basal belt is separated from the upper part by a deep spiral furrow, to which it forms the outer boundary, projecting beyond the shell above. It is also separated on the basal side by a parallel depression facing downwards. The band thus formed is flat externally, and is lineated spirally, and

with lines of growth. The base is much swollen, and shows only the smallest relics of spiral lines near the band, but is deeply scored by the lines of growth. From Scarborough. In the Sedgwick Museum.

Description.—The strength of the basal belts varies in different individuals, and in the roughest they are very conspicuous. Their prominence makes the whorl surface between them look concave.

Distribution and Relations.—All these specimens, perhaps twelve, are from Scarborough. Although this is a near ally of *T. strigosus*, being made of the same elements differently proportioned, the association of these proportions is so constant that they seem to have greater significance; one always seems to carry the rest with it. If there is a swollen posterior spiral, or a very convex base or very slight signs of any spirals on it, there is sure to be a prominent basal band with a furrow above it on the sides of the whorl, and usually a furrow below it on the base. These features should be recognisable if the species is found anywhere abroad.

Trochus shiptonensis, sp. nov. Plate VIII, fig. 20.

Type.—Length 11 mm., greatest breadth 9·5 mm., spiral angle 52°, whorls 6, surface conical, sutures not much impressed. Basal edge angular, somewhat turned up, bevelled below. Upper surface of whorl concave, forming a narrow furrow anteriorly, then three narrow simple spirals posteriorly with oblique shallow risings, sloping away from the aperture. Base, within the level, quite smooth, with a central depression but no umbilicus; aperture broken off. Shell thick, inner tube uniformly oval. From Shipton-on-Cherwell. In the collection of Mr. Huddleston.

Distribution and Relations.—Only one of these has been examined, and the matrix enclosed seems almost too white for Cornbrash at this spot, so it may possibly come from one of the underlying limestones. It appears, however, to belong by its shape and ornament to the same series as the above, which, nevertheless, are not confined to the Cornbrash, though apparently somewhat characteristic of it.

Trochus ? domatus, sp. nov. Plate VIII, fig. 22.

Type.—Height 7·5 mm., maximum breadth 8 mm., whorls 3, forming a dome-like spire. The last whorl has a convex centre with a keel above and below separated by a depression. No minor ornaments whatever. The base is separated by a strong smooth keel slightly separated below. The rest is smooth and convex,

having a fairly wide umbilicus. The aperture is round except at its junction with the previous whorl, but it is irregularly diminished by an apparent thickening. From Scarborough. In the Sedgwick Museum.

Relations.—The genus of this shell seems very doubtful. In some respects, no doubt, it has a general resemblance to *Trochus angulatus* of Goldfuss (not Sowerby), under which name it has been recorded; but it has not a lower band and second keel beneath it. Its aperture seems to point to *Delphinula* or some ally of that genus. It requires some better preserved specimen or other confirmation to decide its position.

Genus **ATAPHRUS**, Gabb.

Characterised by the smoothness of its whorls, the rounded off character of its apex, and particularly by the sudden ending off of the thickened columella and the replacement of a furrow in its continuation within the compass of its aperture.

Ataphrus halesus (D'Orbigny). Plate VIII, fig. 21.

1853. *Trochus halesus*, D'Orbigny, Pal. Franç. Terr. Jurassiques, vol. ii, p. 292, pl. cccxviii, figs. 1—4.
1860. — *helius*, Hébert and Deslongchamps, Bull. Soc. Linn. Norm., vol. v, p. 218, pl. ix, fig. 5.

Type.—“Shell conical, a little longer than broad, not umbilicated. Spire with a slightly concave angle composed of flat, very smooth, whorls, the last whorl with little convexity and smooth above, very angular at the circumference. Mouth depressed, square, strongly encrusted on the columellar side, but without forming teeth.”

Description.—The figured specimen has a rounded apex and smooth sides. The spire as a whole and the last whorl are almost concave. The spiral angle is about 70°. The lines of growth are exceedingly regular and fine. The basal border line is somewhat swollen, the angle at the bend being rounded. The base appears smooth but has exceedingly fine spirals. The aperture has the generically characteristic feature well shown. There is a needle-point perforation to represent an umbilicus (not seen in a second example). Length 10 mm., greatest breadth 10 mm.

Distribution.—The figured specimen comes from Woodford, near Thrapston, and there is a larger one from Quinton, Northamptonshire. Both are in the collection of Mr. Beeby Thompson.

This species is recorded as common at Boulogne.

Relations.—D'Orbigny describes two species, *T. halesus* and *T. helius*, which

agree in most respects, except that the latter is drawn with an umbilicus and is not so angular at the circumference. Hébert and Deslongchamps figure both species, and our specimen agrees with their figure of *T. helius*, but not with D'Orbigny's in having only a needle-point umbilicus. They suggest, however, that there is only one species, in which case we must use the first-mentioned name according to the rules of priority, and that of the commonest according to the rules of utility; for both reasons the name must be *Ataphrus halesus*.

Genus **PLEUROTOMARIA**, DeFrance.

There is only one record of *Pleurotomaria*:

**P. granulata* (6, 25, 28, 34, 58).

The specimens here referred to were first recorded under this name by Bean, and certainly they resemble one of the figures given by Sowerby. This, being repeated by Leckenby and Wright, was finally figured by Lycett, and since then the name has been adopted for the Cornbrash fossil by other writers. Hudleston, however, points out that it is quite a different species, but has not provided a new name. There is no difficulty in finding the proper one.

Pleurotomaria buchiana, D'Orbigny. Plate VIII, figs. 23, 24.

1845. *Pleurotomaria buchiana*, D'Orbigny in Murchison, Verneuil, and Keyserling, Geol. Russia, vol. ii, p. 451, pl. xxxviii, figs. 1, 2.
 1863. — *granulata*, Lycett, Suppl. Great Ool. Mollusca (Pal. Soc.), p. 24, pl. xxxi, fig. 8.
 1885. — — Hudleston, Geol. Mag [3], vol. ii, pl. iii, fig. 8.

Type.—"Shell broader than high, thick; spire formed with a regular angle, composed of slightly convex whorls, angular above, ornamented with unequal longitudinal striæ, which are crossed by lines of growth, more easily seen in the young. The last whorl is keeled on the upper side. Umbilicus closed, or nearly so. Mouth triangular, depressed. Sinus very short and placed on the lower third of the whorl, forming the keel. Spiral angle 85°, length 31 mm., height of last whorl 41 mm." From the Middle Oxfordian of Russia.

Description.—Having an example from the typical locality in hand, it is easy to verify on it the description given by Hudleston (*l.c.*) of our own species. "Shell short, step-like, with the rudiments of an umbilicus. Body whorl about half the height of the spire, whorls about six in number, sloping in the posterior two-thirds, nearly vertical in the anterior third. The ornaments consist of numerous fine spirals, which present" very distinct "nodes at the points of contact with the very

fine lines which decussate them." In the upper whorls there are about three spirals, in the next five, and lastly seven. The cross lines are twice as numerous and branch below. "The principal carina, which occurs about two thirds down, carries the umbilicated slit band. This occupies the most salient position in each whorl." The spirals below this are more numerous and the cross lines curve backwards above the slit and forward below it. "The base is tolerably tumid, with strong spiral ornaments," and with cross lines twice as numerous as they. "Aperture quadrate or trapezoidal. Columella thick and curving forwards." The clearest specimen shows no umbilicus.

Distribution.—Thirty-seven specimens have been seen, all from Scarborough, but the records for Rushden and Peterborough districts have not been verified. The species is widely spread in Russia, and is said by D'Orbigny to occur also in the Oxfordian of Normandy and the Ardennes.

Relations.—The species certainly resembles *P. muensteri*, Römer (*vide* D'Orbigny), but that has a fairly open umbilicus. Perhaps this should not carry much weight, but we do not know the details of its ornamentation. Except for this detail of ornament, it would also resemble *P. filigrana* from a similar horizon. It is remarkable that after so long an interval in *Pleurotomaria*-growth as occurred before the Cornbrash, the earliest to arrive should have originated apparently in the north or east.

***Pleurotomaria debilis*, sp. nov.** Plate VIII, fig. 25.

Type.—Length 32 mm., breadth 27 mm. Spiral angle 58°. Six whorls are seen, but only parts retain the shell. The surface is not uniformly convex, but has no keel, the slit band being at the level of greatest convexity. The posterior part of each whorl shows three or more strong spirals, which rise and fall over strong longitudinal risings, about thirty per whorl in number. The central part, where preserved, shows several weaker spirals, with the slit band in the centre. The anterior portion is thrown again into undulations half the size and twice the number of the upper ones. The base is convex, rounding into the side. Probably it is skinned, for the striae soon die away. The umbilicus is small. From Bedford. In the Northampton Museum.

Distribution.—There is a second specimen from the same locality which may belong here, but the spirals are stronger and more continuous, and the base is striated.

Relations.—The nearest ally, with twice as many undulations below the slit band as above, is *Pl. pagodius* (Desl.), from the Great Oolite of Normandy, but the base is concave. If we neglect the detail of the number and position of the undulations, this might come under the description of *P. filigrana* var. *undulata*

of Deslongchamps from the Oxford Clay of Dives, the other variety of which, var. *aptycha*, might, with similar neglect of minor details, represent *P. buchiana*.

[PATELLA.—The record of **P. cingulata* (31, 36) as occurring in the Cornbrash is founded on an example discovered in the marl at Islip, Oxon, by Mr. J. F. Whiteaves. This marl is now recognised as here found lying *below* the Cornbrash.]

Order *OPISTHOBRANCHIATA*.

[The genus *ACTEON* is twice entered as occurring in the Cornbrash, as *A. sedgwicki* and as *A. sedgwicki* var. *pullus*. Both of these entries refer to a single specimen in the Leckenby collection, which specimen occurs in a matrix believed to be not Cornbrash, but probably grey limestone.]

Genus **ACTEONINA**, D'Orbigny.

This genus was defined as always distinguished (from *Acteoni*) by the want of folds on its columella, but is as usually distinguished also by the absence of spiral striae on the shell.

The records of *Acteonina* are :

| | |
|------------------------------|---|
| <i>A. cinerea</i> (48). | * <i>A. scarburgensis</i> (33, 39, 42, 48). |
| * <i>A. luidii</i> (18, 31). | <i>A. gigantea</i> (48). |

The actual record of *A. luidii* as a Cornbrash fossil distinct from the other species is an entry by Whiteaves, quoted by Phillips, of a fossil obtained at Islip, Oxon; but this specimen came, as Mr. Whiteaves now states, from the flaggy beds *below* what is here reckoned to be Cornbrash. The fossil is said by Lycett to come from the Forest Marble of that locality. For *A. gigantea* see *A. elongata*.

Acteonina scarburgensis, Lycett. Plate IX, fig. 1.

1863. *Acteonina scarburgensis*, Lycett, Suppl. Great Ool. Mollusca (Pal. Soc.), p. 28, pl. xxxi, fig. 13.
 1885. — — — — — Hudleston, Geol. Mag. [3], vol. ii, p. 204, "not figured."

Type.—"Shell ovately ventricose, smooth; spire short, obtuse, consisting of four narrow convex volutions. The last volution has the sides slightly convex, its upper margin rounded and slightly channeled at the suture; the aperture is narrow, somewhat expanded at the base, which is margined at its junction with

the columella. Length 14", diameter 10", length of aperture 11". From Scarborough. In the Sedgwick Museum.

Description.—Hudleston redescribes the specimen and says spiral angle 78° , the 6 upper out of 7 whorls are beautifully preserved, the apical four being transparent, or free from interior matrix. The furrows which border the suture are bounded externally by a deeper line, beyond which the rounded bend of the whorl rises. On the body whorl the lines of growth are well marked, and with the light shining along the spirals indications of numerous light and dark colour bands may be seen. The inner line of the aperture crosses the axial line at an angle of about 40° .

Distribution.—This species appears to be entirely a Yorkshire form. Including the two following species or varieties, 17 specimens have been seen in all. A cast of the present species is included in the Porter collection (hence it is included in H. B. Woodward's list). There is no proof, however, that it came from Peterborough, and the matrix is more like that of Yorkshire.

Relations.—The *Acteoninae* being Yorkshire shells which appear to die out completely with the Cornbrash, their allies must be sought for in the underlying beds; but they are essentially, as witnessed by the remarkable preservation of their thin shells, autochthonous fossils. They have probably grown and varied together through the whole course of their existence, and it matters little therefore whether we call the three forms which may be recognised varieties of one species or separate species. In the latter case the name is preserved for the present form, which is the central type. They may become thinner in proportion and longer at the base (*elongata*) or stouter in proportion and squatter at the base (*cinevea*); one of these varieties having received a specific name, there is no reason why the other should not.

***Acteonina elongata*, sp. nov.** Plate IX, fig. 2.

1885. *Acteonina scarburgensis*, Hudleston, Geol. Mag. [3], vol. ii, p. 204, "elongate variety," pl. v, fig. 9.

Type.—Length (apex gone) 3.4 mm., greatest breadth 16.5 mm., or ratio of breadth to length 10 : 20½. Any furrows along the sutures are very obscure. Shoulder much rounded. Length of aperture 2.4 mm. Spiral angle 70° . The columella is seen to be curled over as a whole, leaving an apparent umbilical furrow. The rest of the details as in *A. scarburgensis*. From Scarborough. In the collection of Mr. Hudleston.

Distribution.—There are four at least which answer this description, and probably some of the others included in the general series. It is probably this species which is enumerated in Hudleston's list as *A. gigantea*, but not otherwise referred to.

Acteonina cinerea, Huddleston. Plate IX, fig. 3.

1885. *Acteonina cinerea*, Huddleston, Geol. Mag. [3], vol. ii, p. 206, pl. v, fig. 8.

Type.—"Height 26·5 mm. Width to height ·51. Spiral angle 90°. Body whorl to height ·80. . . . Whorls . . . about 5. Devoid of ornament. Suture distinct. Shoulder of body whorl extremely broad and square. Body whorl relatively large and cylindrical, sides compressed and almost constricted just below the shoulder. . . . Outer lip very straight." [The remainder is expressed with doubt.] From the Scarborough Limestone. In the Sedgwick Museum.

Description.—Huddleston remarks that "there is a very stout variety apparently belonging to this species, in Mr. Leckenby's Cornbrash Collection." The specimen here figured (Pl. IX, fig. 3) is probably the one intended; at all events, it approximates to this species more than any other specimen. It is characterised by its large spiral angle, the shortness of the upper whorls exposed, the angularity of the shoulder, the constriction of its sides and enlargement of the body whorl towards the base, and the sudden inward bend there, so that the inner line of the aperture crosses the axial line at an angle of nearly 60°, and the outer side turns through an angle of more than 70°. The base of the shell, in fact, is very peculiar.

Distribution.—This specimen from the Cornbrash of Scarborough is perhaps the only one seen.

Relations.—See under *A. scarboroughensis*.

In the British Museum are two specimens obtained from Chippenham through Mr. Wm. Buy, which closely resemble large examples of *A. luidii*. They are said to have come from the Cornbrash, but as they must have come out of excavations their horizon remains doubtful. See Plate IX, fig. 4.

Genus **CYLINDRITES**, Morris and Lycett.

Shell smooth, last whorl cylindrical, aperture lengthened, columella twisted near the base. The records are:

**C. eecaratus* (36) **C. thorenti* (35)

The record of *C. eecaratus* is by Phillips, as occurring at Kidlington. The only *Cylindrites* in the Oxford Museum has no label of locality, though placed with the Cornbrash fossils, and it is *C. acutus*. It is to be noted that all Phillips' fossils that come from Kidlington are called "B," though there are lower fossiliferous strata in the quarry. It is probable, therefore, that no *C. eecaratus* has as yet been found in the Cornbrash.

Cylindrites thorenti (Buvignier). Plate IX, fig. 5.

1842. *Bulla thorenteo*, Buvignier, Géol. des Ardennes, p. 535, pl. v, fig. 9.

1850. *Cylindrites thorenti*, Morris and Lycett, Great Ool. Mollusca (Pal. Soc.), p. 101, pl. viii, fig. 22.

Type.—Shell subcylindrical, the sides somewhat convex, smooth, or slightly marked by the lines of growth. Spire small, depressed, and contracted. The whorls with their margin only visible. Aperture narrow. Basal fold of the columella large. Apex large, but not so high as the outer margin. In the white limestone below the Oxford Clay, Rumigny, Ardennes.

Description.—The figured specimen referred to this species is 17 mm. long and 8 mm. broad, of the same diameter till near the end. The diameter of the aperture is also constant till near the base, a strong fold is shown on the columella, longitudinal lines of growth on the shell, apex sunk, the last whorl making a high and thickened ring round it.

Distribution.—There can be little doubt that this is a similar shell to that dealt with by Morris and Lycett. Two specimens have been brought by the Survey from Corsecombe. The only quarry seen there now contains beds underlying the Cornbrash, and the matrix is not very characteristic; nevertheless, as the species is abundant in the Cornbrash of Boulogne, it might very well occur in the South of England.

Genus **VANIKORO**, Quoy and Gaimard.

“Broadly patulate, rather thick, cancellated with oblique lamellar ribs and thin spiral ridges. Epidermis yellowish-brown.” Diameter one inch.

Vanikoro canaliculata, sp. nov. Plate IX, fig. 9.

This shell stands obliquely on the animal by the look of it. They are all ridged, most of them are smaller.

Family BULLIDE.

This name is used in its comprehensive sense to include all the remaining Tectibranchs, even if none belong to the genus *Bulla*, if that genus be defined as having a spire wholly immersed, and lacking all spiral lines of colour. Like as are the Cornbrash shells to *Bulla*, they pass over by these characters into *Hydatina*.

Genus **HYDATINA**, Schumacher.

The genus *Hydatina* is defined by Pilsbry (Tryon and Pilsbry, ‘Man. Conch.’ vol. xv, pt. 4, p. 326) as smooth, spirally banded, spire exposed, either

convex, flat, or concave—no sinus round the suture, effuse at the base. With regard to the “smooth” character, it is to be noted that one at least—*H. velum*—among living species has longitudinal risings which are interrupted at the colour bands.

The records of *Hydatina* are all under the name of *Bulla*, and one species only has been recorded from the Cornbrash :

**Bulla undulata* (6, 14, 21, 28, 36, 43, 50, 68).

Hydatina undulata (Bean). Plate IX, fig. 6.

1839. *Bulla undulata*, Bean, Ann. Nat. Hist. [2], vol. iii, p. 61, fig. 22.
 1885. — — — — — Hudleston, Geol. Mag. [3], vol. ii, p. 234, pl. v, fig. 10.
 ? 1850. — — — — — Morris and Lycett, Great Ool. Mollusca (Pal. Soc.), p. 96, pl. viii, fig. 8.
 ? 1895. *Palæohydatina undulata*, Cossman, Cont. Pal. France, vol. v, mem. 14.

Type.—“Shell oval, approaching to globular, longitudinally wrinkled or undulated, aperture large, comprising nearly the whole shell, but much wider at the lower than the upper part. Apex umbilicated. Length $1\frac{1}{2}$ in. [30 mm.]. Breadth 1 in.” [23 mm.] From the Cornbrash of Scarborough.

Description.—The last whorl in the type specimen rises higher than the penultimate, and therefore forms an elevated ridge round the sunken spire. The inner slopes of this rising meet the penultimate at a considerable distance from the centre and thus must leave the apex exposed, and the same is the case with all the Scarborough specimens—though the size of the exposed apex varies—the specimen figured by Hudleston having the smallest. The expansion of the aperture and the proportional breadth also vary, the type being one of the narrowest. The surface of the shell, as indicated by the name, has irregular longitudinal folds, which can scarcely be looked upon as lines of growth, for at about a third down their length they are wrinkled into backwardly pointing chevrons, making a spiral band, and look at first sight accidental. When we consider, however, that in the recent *H. velum* the longitudinal risings are interrupted at the colour bands, the connection between the two phenomena is indicated. Looking, therefore, again at other specimens of so-called *Bulla*, we may find indications in all well-preserved ones, here and there, of similar spiral bands of crinkles, which we conclude must be connected with the original colour bands, thus showing that we are dealing with *Hydatina* (see Morris and Lycett’s figure). It is interesting to learn that the lingual ribbon of recent *Hydatinæ* is of a less developed type than that of *Bulla*. I can see, however, no reason for separating the Jurassic species from the rest under the title *Palæohydatina* unless *H. velum* is included.

Relations.—Compared with the fossil *Bullidæ* of other localities and horizons,

this species and all the *Bullidæ* of the Cornbrash are on a large scale, and appear to be perfectly simple in the columellar region, and those whose growth is larger may be simply better grown. Of these there are nine from Scarborough and another from Sudbrook.

Hydatina magnifica, sp. nov. Plate IX, fig. 7.

Description.—The shell here described was obtained from Bedford, and may perhaps not be a distinct species. It has been cleaned by a mason in the British Museum. It has a total length of 60 mm. and a breadth of 44 mm. The body rises as before into a ridge, whence it slopes downwards to the spire. The surface has numerous rough longitudinals. The shape of the "fruit" more resembles that of a pear than that of an apple.

Distribution.—Possibly other examples, *e. g.* from Rushden (1) and "Northampton" (B. M. 2 in. \times 1 in.), are the nearest examples.

Hydatina limitata, sp. nov. Plate IX, figs. 8*a*, 8*b*.

? 1850. *Bulla undulata*, Morris and Lycett, Great Ool. Mollusca (Pal. Soc.), p. 18, pl. viii, fig. 8.

Type.—Length 16.5 mm., breadth 14 mm. Spire almost on the level with the posterior edge of the last whorl; diameter of spire small, looking only like a groove on the surface. From this line the surface of the last whorl spreads rapidly outwards, making the posterior end of the aperture fairly wide, but the plane of the aperture meets the penultimate whorl obliquely, though it has no furrow parallel to the suture: on the contrary, in the spiral direction traces of at least five bands of crinkles, indicative of colour bands, can be traced. From Chippenham. In the Museum of Practical Geology (no. 8676).

Description.—The type is but a small specimen, and is behind others that are larger, belonging to the same species, but the strict limitation of the posterior border of the highest band to the approximate level of the spire holds for them all.

Distribution.—Three of these specimens are from grey, speckled, softish rock from Chippenham, probably from some boring or excavation. It is not unlike the Cornbrash exposed at Sutton Benger. A specimen collected by the Geological Survey at Templecombe assures us that the species does occur in the Cornbrash.

Relations.—The limitation of the aperture posteriorly is the main feature of distinction from *H. undulata*, probably also its greater relative breadth, and its surface features. I can point out no real difference between this species and that figured by Morris and Lycett as *Bulla undulata*, which even shows the numerous

PLATE I.

| FIG. | PAGE. |
|--|-------|
| 1. <i>Liopleurodon ferox</i> , Sauvage; tooth.—Rushden. In the Northampton Museum. | 23 |
| 2. <i>Liopleurodon ferox</i> , Sauvage.—Smaller tooth from the same locality and collection. 2 <i>a</i> , side view; 2 <i>b</i> , transverse section of the same. | 23 |
| 3 <i>a</i> , <i>b</i> . <i>Murænosaurus</i> ; dorsal vertebra.—Rushden. In the Collection of Mr. J. F. Walker. | 25 |
| 4. Humerus of <i>Plesiosaurus</i> .—Scarborough. In the Leckenby Collection in the Sedgwick Museum. | 25 |
| 5. <i>Machimosaurus rigaudi</i> , Sauvage; tooth.—Handborough, Oxon. In the Collection of Mr. E. A. Walford. (<i>a</i>) Side view, nat. size. (<i>b</i>) Apex magnified. (<i>c</i>) Transverse section. | 26 |
| 6. <i>Asteracanthus acutus</i> , Agassiz; spine.—St. Botolph's Bridge, Peterborough. In the Sharp Collection in the British Museum (no. 47131). 6 <i>a</i> , side view; 6 <i>b</i> , details of ornament. | 28 |
| 7. <i>Strophodus tenuis</i> , Agassiz; teeth. 7 <i>a</i> , from one of the two anterior rows; 7 <i>b</i> , from one of the two posterior rows.—Peterborough district; St. Botolph's Bridge. In the British Museum (nos. 47132 <i>a</i> , P. 2662). | 30 |
| 8. <i>Strophodus rigaudi</i> (Sauvage); posterior tooth.—Scarborough. In the York Museum. 8 <i>a</i> , natural size; 8 <i>b</i> , magnified three times. | 31 |
| 9. <i>Strophodus tenuis</i> , Agassiz; posterior tooth.—St. Botolph's Bridge. In the Sharp Collection in the British Museum (no. 47132). | 30 |
| 10. <i>Macromesodon bathonicus</i> (Sauvage); central vomerine tooth.—St. Botolph's Bridge, Peterborough. In the British Museum (no. 47148 <i>a</i>). | 32 |

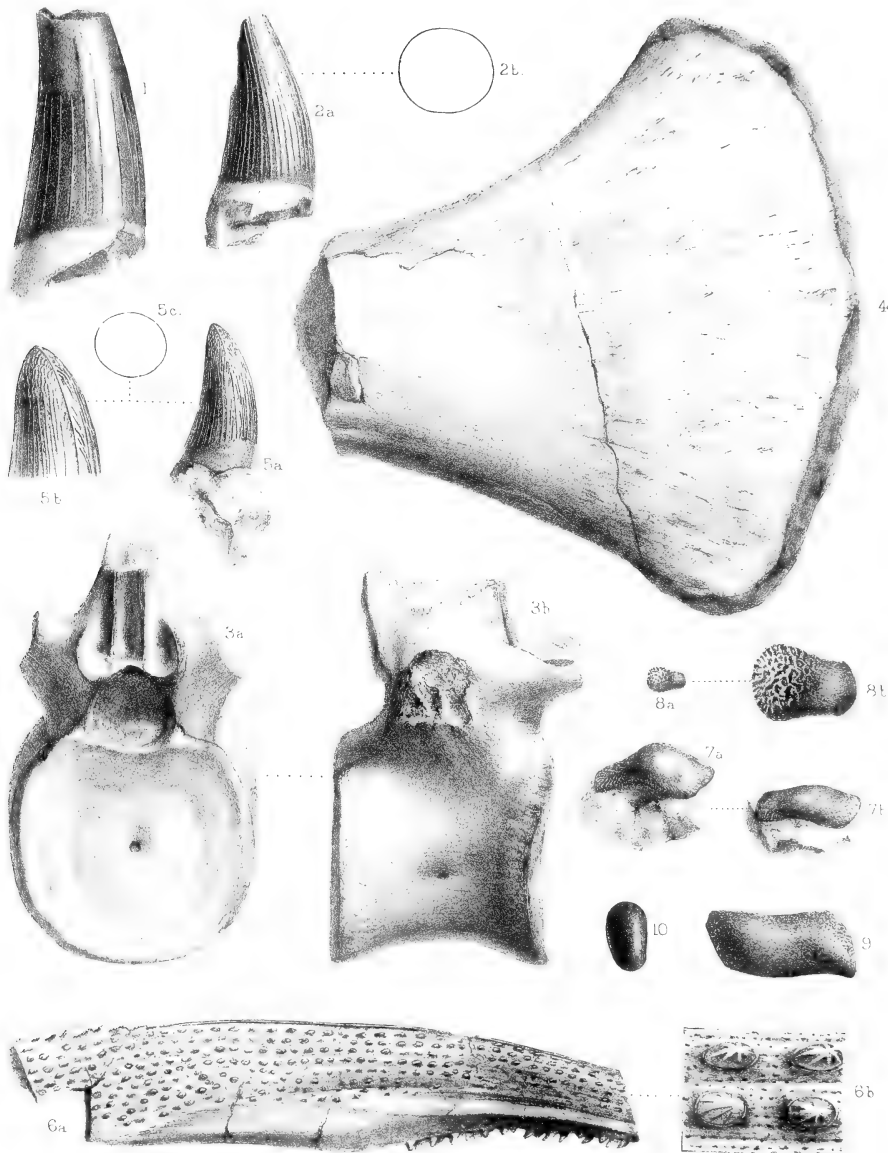




PLATE II.

| FIG. | | PAGE. |
|------|--|-------|
| 1. | <i>Nautilus truncatus</i> (J. Sowerby).—Midland Railway Pit, Bedford. In the British Museum (no. C. 5077); $\frac{5}{8}$ natural size. 1 <i>a</i> , side view; 1 <i>b</i> , section across body chamber; 1 <i>c</i> , running of suture over periphery. | 34 |
| 2. | <i>Nautilus truncatus</i> (J. Sowerby); young.—Rushden. In the British Museum (no. C. 3473). | 34 |



PLATE III.

| FIG. | | PAGE. |
|------|---|-------|
| 1. | <i>Macrocephalites typicus</i> , nom. nov.—Scarborough. In the Sedgwick Museum, Leckenby Collection. 1 <i>a</i> , side view; 1 <i>b</i> , front view. | 42 |
| 2. | <i>Macrocephalites typicus</i> , nom. nov.; young example.—Bedford. In the British Museum (no. C. 5073 <i>a</i>). 2 <i>a</i> , side view; 2 <i>b</i> , front view. | 42 |
| 3. | <i>Macrocephalites typicus</i> , nom. nov.; small specimen.—Scarborough. In the Museum of Practical Geology (no. 8652). | 42 |
| 4. | <i>Macrocephalites macrocephalus</i> (Schloth.); young form.—Scarborough. In the Museum of Practical Geology (no. 8653). | 43 |
| 5. | <i>Macrocephalites macrocephalus</i> (Schloth.); medium-sized specimen.—Scarborough. In the Author's Collection. | 43 |
| 6. | <i>Macrocephalites macrocephalus</i> (Schloth.); full grown, front view.—Scarborough. In the British Museum (no. 39566). | 43 |
| 7. | <i>Macrocephalites herveyi</i> (Sow.).—Peterborough. In the Museum of Practical Geology (no. 8650). | 46 |

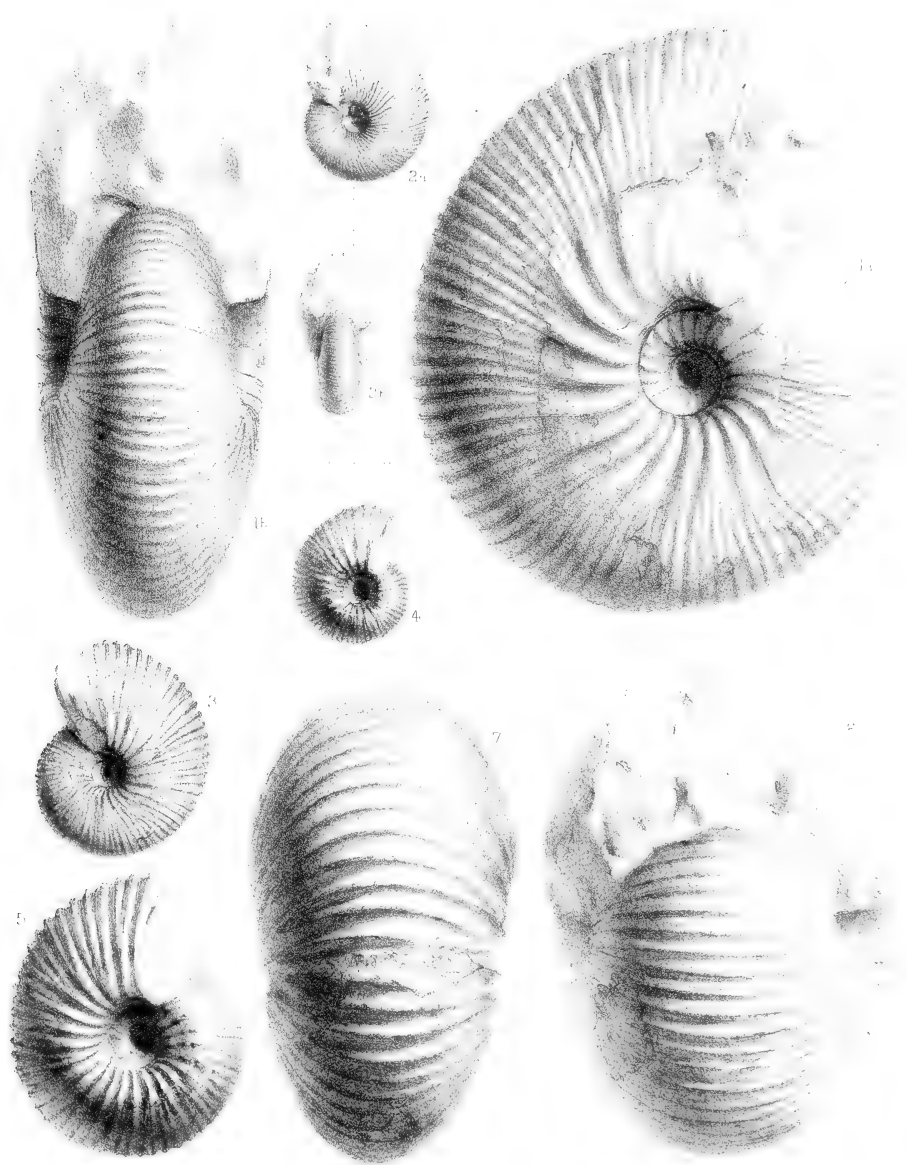


PLATE IV.

| FIG. | | PAGE. |
|------|--|-------|
| 1. | <i>Macrocephalites macrocephalus</i> (Schloth.); adult.—Bedford. In the British Museum (no. C. 5072), no. 28, enumerated in Table I. | 43 |
| 2. | <i>Macrocephalites herveyi</i> (Sowerby).—Peterborough. In the Museum of Practical Geology (no. 8650). | 46 |
| 3. | <i>Macrocephalites hudlestoni</i> , sp. nov.—Rushden. In the Collection of Mr. W. H. Hudleston. 3 <i>a</i> , side view; 3 <i>b</i> , peripheral view. | 47 |
| 4. | <i>Macrocephalites compressus</i> (Quenstedt).—Garsdon, near Malmesbury. In the British Museum (no. 8321). 4 <i>a</i> , inner part enclosed in a later whorl, showing sutures; 4 <i>b</i> , peripheral view. | 45 |
| 5. | <i>Macrocephalites typicus</i> , nom. nov.—Scarborough. In the Author's Collection. The smallest specimen seen. 5 <i>a</i> , side view; 5 <i>b</i> , peripheral view. | 42 |

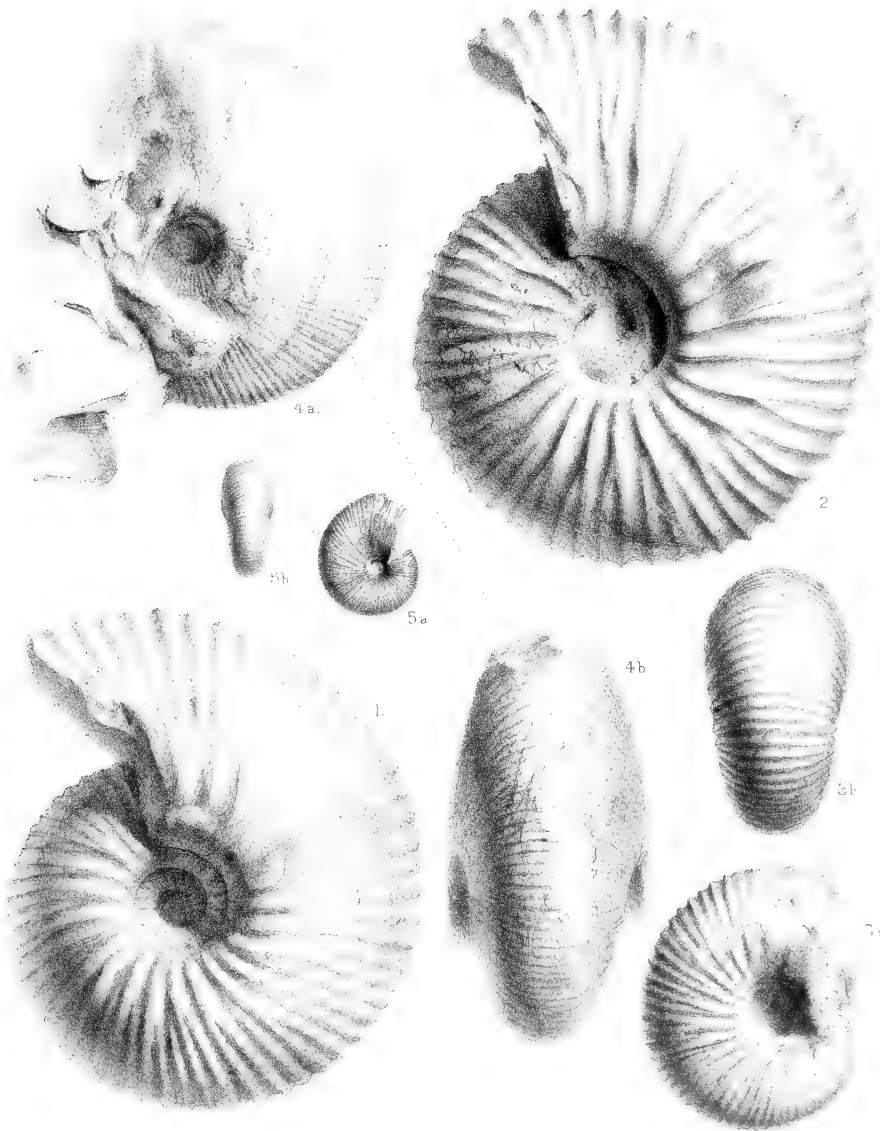


PLATE V.

| FIG. | | PAGE. |
|------|---|-------|
| 1. | <i>Cudoceras breve</i> , sp. nov.—East Fleet, near Weymouth. In the Author's Collection. | 48 |
| 2. | <i>Perisphinctes subbakerviae</i> (D'Orb.).—Stalbridge-Weston. In the Museum of Practical Geology (no. 8654). 2 <i>a</i> , side view; 2 <i>b</i> , peripheral view. | 49 |
| 3. | <i>Perisphinctes flabellans</i> , sp. nov.—East Fleet, near Weymouth. In the Author's Collection; a fragment with outline restored. | 51 |
| 4. | Section of whorl of <i>Perisphinctes</i> (?), sp. 1. In the Author's Collection. | 52 |
| 5. | Section of whorl of <i>Perisphinctes</i> , sp. 2. In the Author's Collection. | 53 |

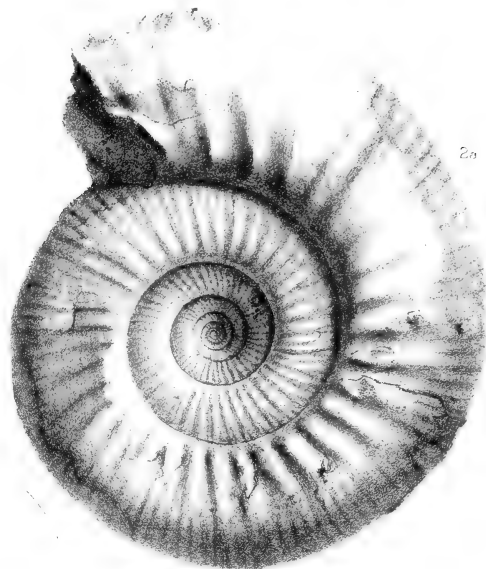
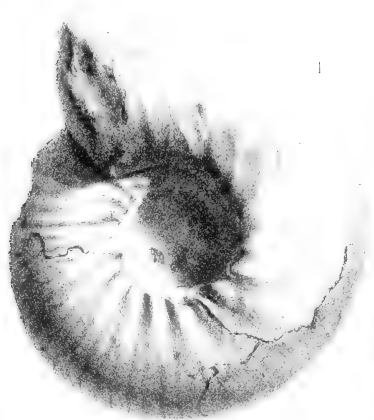


PLATE VI.

| FIG. | | PAGE. |
|------|---|-------|
| 1. | <i>Clydoniceras discus</i> (Sow.).—Sudbrook. In the Sedgwick Museum. Showing sutures. | 54 |
| 2. | <i>Clydoniceras hochstetteri</i> (Oppel).—Norton Brize. In the Museum of Practical Geology (no. 8647). Showing sutures. | 55 |
| 3. | <i>Clydoniceras ptychophorum</i> (Neumayr).—Trowbridge. In the British Museum (no. 33541). 3 <i>a</i> , side view; 3 <i>b</i> , sectional view. | 56 |
| 4. | <i>Clydoniceras legayi</i> (Rigaux and Sauvage).—Sudbrook. In the Sedgwick Museum. Showing sutures. | 57 |
| 5. | <i>Clydoniceras legayi</i> (R. and S.).—Sudbrook. In the Sedgwick Museum. Peripheral view. | 57 |
| 6. | <i>Clydoniceras legayi</i> (R. and S.).—Rushden. In the Collection of Mr. W. H. Hudleston. Showing the body chamber and last suture. | 57 |

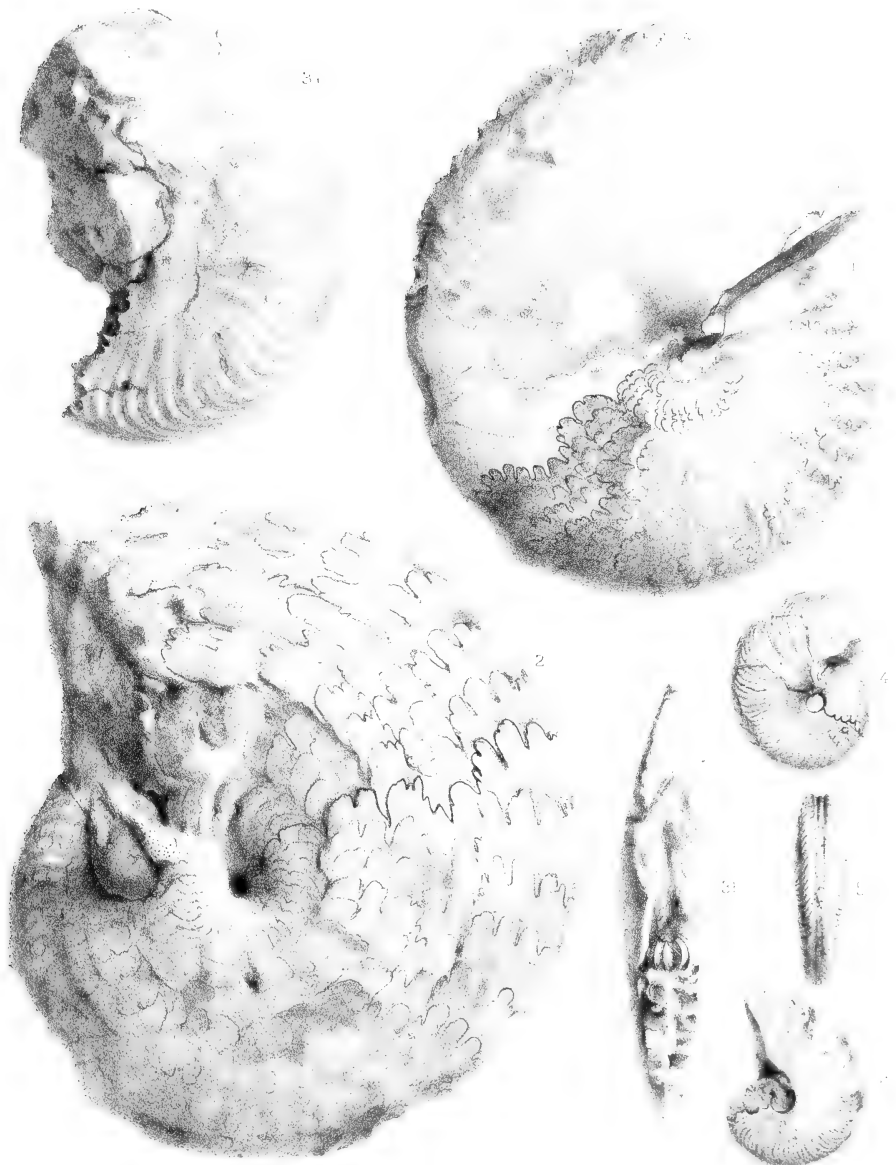


PLATE VII.

| FIG. | PAGE. |
|---|-------|
| 1. <i>Belemnites redivivus</i> , sp. nov.—From the shales of Cayton Bay. In the Leckenby Collection, Sedgwick Museum. 1 <i>a</i> , ventral aspect; 1 <i>b</i> , lateral aspect. | 59 |
| 2. <i>Belemnites redivivus</i> (?); narrower form.—From the shales of Cayton Bay. In the Sedgwick Museum. | 59 |
| 3. <i>Alaria erinacea</i> (Piette).—Scarborough. In the Leckenby Collection, Sedgwick Museum. 3 <i>a</i> , natural size; 3 <i>b</i> , penultimate whorl magnified. | 61 |
| 4. <i>Alaria erinacea</i> (?); cast.—Bedford. In the Northampton Museum. | 61 |
| 5. <i>Alaria tridigitata</i> (Piette).—Murcot. In the Collection of the Author. | 62 |
| 6. <i>Alaria bicornis</i> , sp. nov.—Woodstock Railway Cutting, Shipton-on-Cherwell. In the Collection of Mr. Hudleston. 6 <i>a</i> , aspect in plane of posterior digitation; 6 <i>b</i> , aspect in plane of anterior digitation. | 63 |
| 7. <i>Alaria composita</i> (Sowerby).—Scarborough. In the Museum of Practical Geology. 7 <i>a</i> , back view; 7 <i>b</i> , perpendicular view. | 64 |
| 8. <i>Alaria composita</i> (?); cast.—Bedford. In the Northampton Museum. Same view as 7 <i>b</i> . | 64 |
| 9. <i>Alaria palmata</i> , sp. nov.—Woodstock Railway Cutting, Shipton-on-Cherwell. In the Collection of Mr. Hudleston. 9 <i>a</i> , front view; 9 <i>b</i> , perpendicular back view. | 65 |
| 10. <i>Bittium pingue</i> , sp. nov.—Scarborough. In the Museum of Practical Geology. 10 <i>a</i> , natural size; 10 <i>b</i> , last whorl $\times 2$. | 67 |
| 11. <i>Bittium lorieri</i> (Hcb. and Desl.) $\times 2$.—Shipton-on-Cherwell. In the Collection of Mr. Hudleston. 11 <i>a</i> , natural size. | 68 |
| 12. <i>Cryptanax tortilis</i> (Hcb. and Desl.) $\times 2$.—Shipton-on-Cherwell. In the Collection of Mr. Hudleston. 12 <i>a</i> , natural size. | 69 |
| 13. Ditto; from the same locality and collection. End view showing aperture $\times 4$. | 69 |
| 14. <i>Cerithiella biserialis</i> , sp. nov.—Shipton-on-Cherwell. In the Collection of Mr. Hudleston. 14 <i>a</i> $\times 2$; 14 <i>b</i> , base whorl $\times 4$. | 70 |
| 15. <i>Cerithium multivolutum</i> , Piette.—Woodstock Railway Cutting, Shipton-on-Cherwell. In the Collection of Mr. Hudleston. | 70 |
| 16. <i>Nerinaea dimidiata</i> , sp. nov.—Scarborough. In the British Museum (no. G. 17000). 16 <i>a</i> , natural size; 16 <i>b</i> , one whorl enlarged. | 73 |
| 17. <i>Nerinaea bathonica</i> , Rigaux and Sauvage.—Akely Brickyard. In the Collection of the Author. 17 <i>a</i> , restored picture from three fragments; 17 <i>b</i> , section of interior of whorl. | 72 |
| 18. <i>Aptygiella lineata</i> , sp. nov.—Near Chippenham. In the British Museum (no. 27422). | 74 |
| 19. <i>Aptygiella blainvilliei</i> (Desl.).—Woodstock Railway Cutting, Shipton-on-Cherwell. In the Collection of Mr. Hudleston. | 74 |
| 20. <i>Eulima lachryma</i> , sp. nov.—Scarborough. In the Sedgwick Museum. 20 <i>a</i> , natural size; 20 <i>b</i> , enlarged. | 75 |
| 21. <i>Eulima extricata</i> , sp. nov.—Scarborough. In the British Museum (no. G. 16997). | 76 |

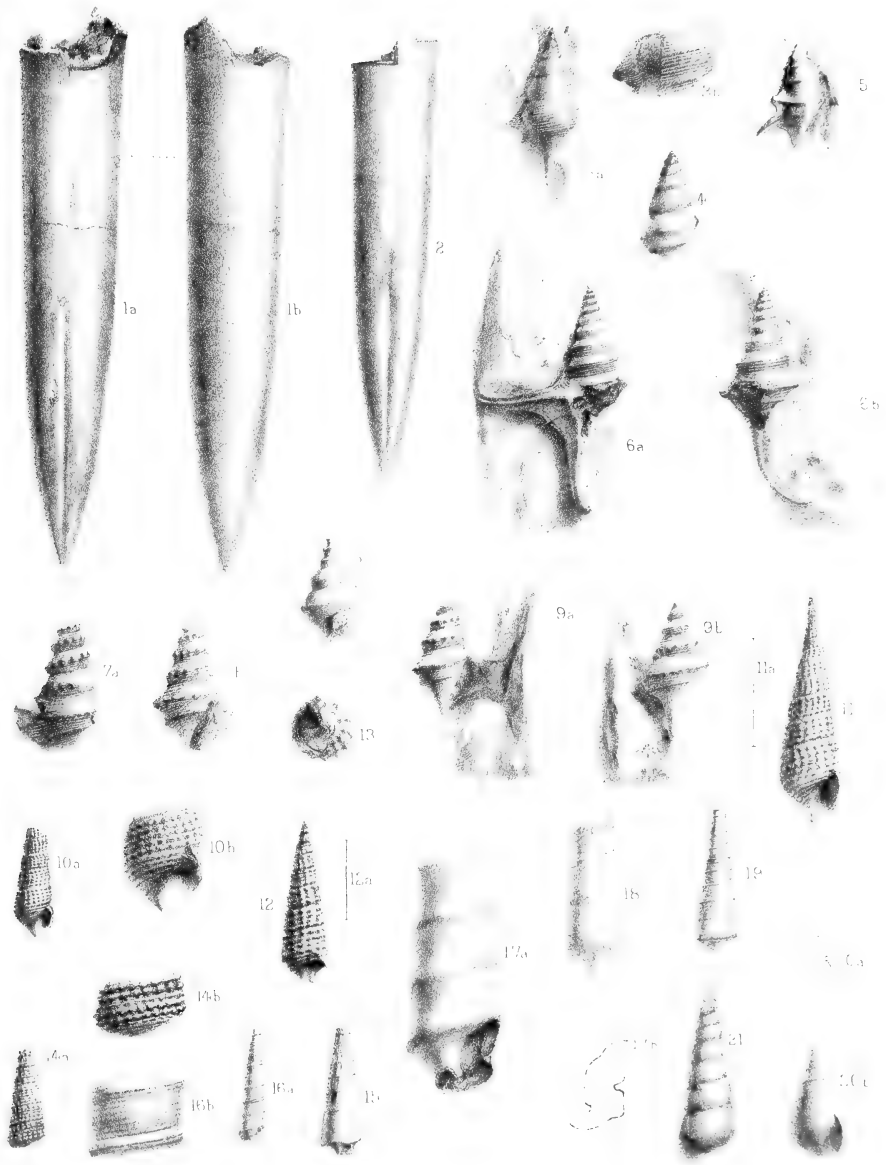
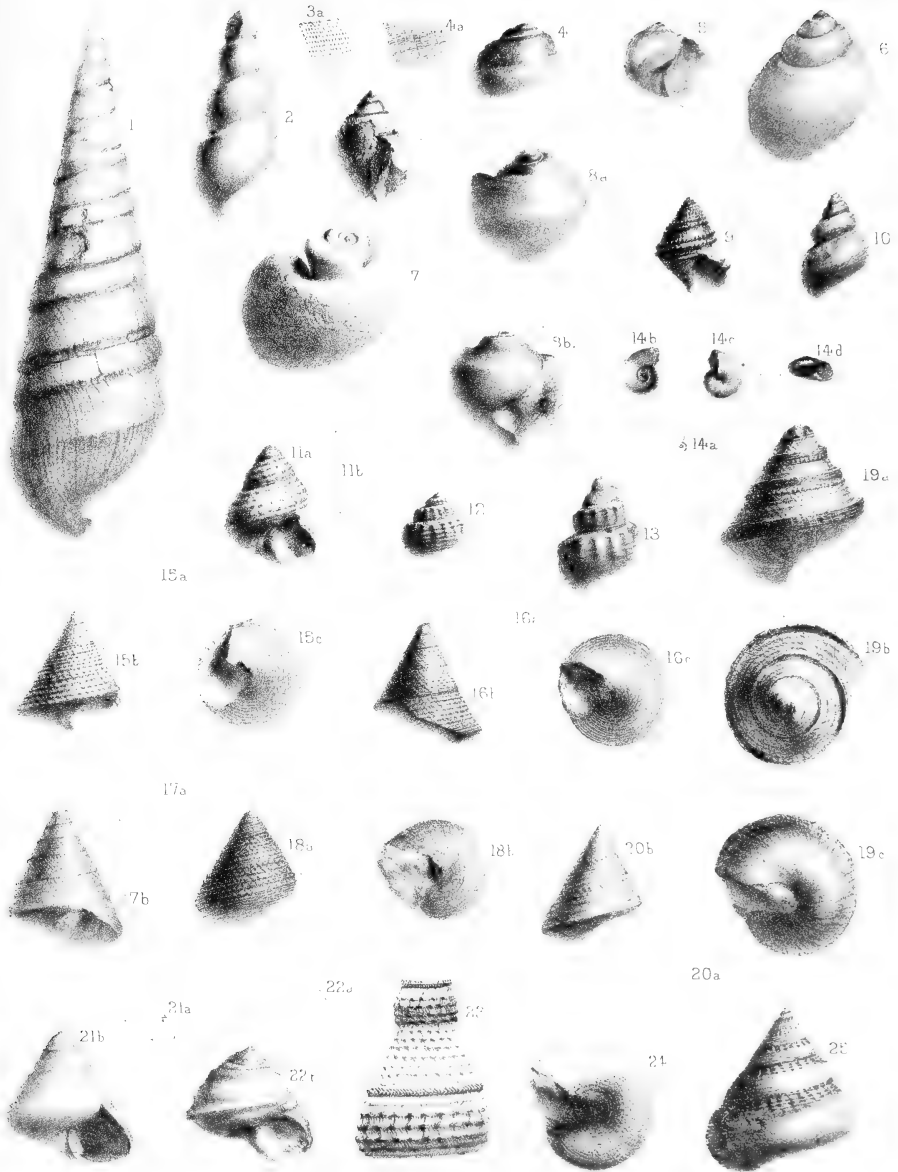






PLATE VIII.

| FIG. | PAGE. |
|---|-------|
| 1. <i>Pseudomelania vittata</i> (Phil).—Rushden. In the Northampton Museum. | 77 |
| 2. Ditto; a cast presumably of the shell.—Garsdon, near Malmesbury. In the Author's Collection. | 77 |
| 3. <i>Natica punctura</i> (Bean).—Scarborough. In the British Museum (no. G. 16999). 3 <i>a</i> , portion magnified (see Plate IX, figs. 10, 11). | 79 |
| 4. <i>Natica montreuilensis</i> , Héb. & Desl.—Scarborough. In the Sedgwick Museum. Back view showing colour marking. 4 <i>a</i> , portion magnified. | 80 |
| 5. Ditto.—Scarborough. In the Museum of Practical Geology (no. 8657). Front view. | 80 |
| 6. <i>Natica chauviniiana</i> , D'Orb. Bedford. In the Northampton Museum. | 81 |
| 7. <i>Natica</i> sp. (cf. <i>cincta</i>).—Holwell. In the Collection of the Author. | 81 |
| 8. <i>Cloughtonia depressa</i> , sp. nov.—Sudbrook. In the Sedgwick Museum. 8 <i>a</i> , back view; 8 <i>b</i> , front view. | 82 |
| 9. <i>Eucyclus armiger</i> (Lycett).—Sudbrook. In the Sedgwick Museum. Front view. | 84 |
| 10. Ditto; cast. Scarborough. In the Museum of Practical Geology (no. 8659). | 84 |
| 11. <i>Littorina cassius</i> (D'Orb.).—Scarborough. In the Museum of Practical Geology. Front view 11 <i>a</i> × 1½; 11 <i>b</i> , nat. size. | 85 |
| 12. <i>Purpurina</i> ? <i>condensata</i> , Desl.; young form.—Scarborough. In the Sedgwick Museum. | 86 |
| 13. Ditto; cast.—Scarborough. In the Museum of Practical Geology. | 86 |
| 14. <i>Helicocyrtus orsus</i> , sp. nov.—Scarborough. In the Sedgwick Museum. 14 <i>a</i> , nat. size; 14 <i>b</i> , view from above; 14 <i>c</i> , view from below; 14 <i>d</i> , view in front of the aperture. | 87 |
| 15. <i>Trochus duplicans</i> , sp. nov., var. <i>a</i> .—Scarborough. In the Sedgwick Museum. 15 <i>a</i> , natural; 15 <i>b</i> , side view, magnified; 15 <i>c</i> , base magnified. | 88 |
| 16. Ditto, var. <i>β</i> .—Scarborough. In the Sedgwick Museum. 16 <i>a</i> , nat. size; 16 <i>b</i> , 16 <i>c</i> , side view and base, magnified. | 89 |
| 17. <i>Trochus subylaber</i> , Hudl.—Scarborough. In the Sedgwick Museum. 17 <i>a</i> , nat. size; 17 <i>b</i> , side view, magnified. | 89 |
| 18. <i>Trochus strigosus</i> , Lycett; type.—Scarborough. In the Sedgwick Museum. 18 <i>a</i> , side view; 18 <i>b</i> , base, nat. size. | 89 |
| 19. <i>Trochus lacuna</i> , sp. nov.—Scarborough. In the Sedgwick Museum. 19 <i>a</i> , side view; 19 <i>b</i> , top view; 19 <i>c</i> base, nat. size. | 90 |
| 20. <i>Trochus shiptonensis</i> , sp. nov.—Shipton-on-Cherwell. In the Collection of Mr. Hudleston. 20 <i>a</i> , nat. size; 20 <i>b</i> , side view, magnified. | 91 |
| 21. <i>Ataphrus halesus</i> (D'Orb.). Woodford, near Thrapston. In the Collection of Mr. Beeby Thompson. 21 <i>a</i> , nat. size; 21 <i>b</i> , front view, magnified. | 92 |
| 22. <i>Trochus</i> ? <i>domatus</i> , sp. nov.—Scarborough. In the Sedgwick Museum. 22 <i>a</i> , nat. size; 22 <i>b</i> , side view magnified. | 91 |
| 23. <i>Pleurotomaria buchiana</i> , D'Orb.; details of ornament.—Scarborough. In the Museum of Practical Geology. | 93 |
| 24. Ditto; view of base.—Scarborough. In the Collection of the Author. | 93 |
| 25. <i>Pleurotomaria debilis</i> , sp. nov.—Bedford. In the Northampton Museum. | 94 |



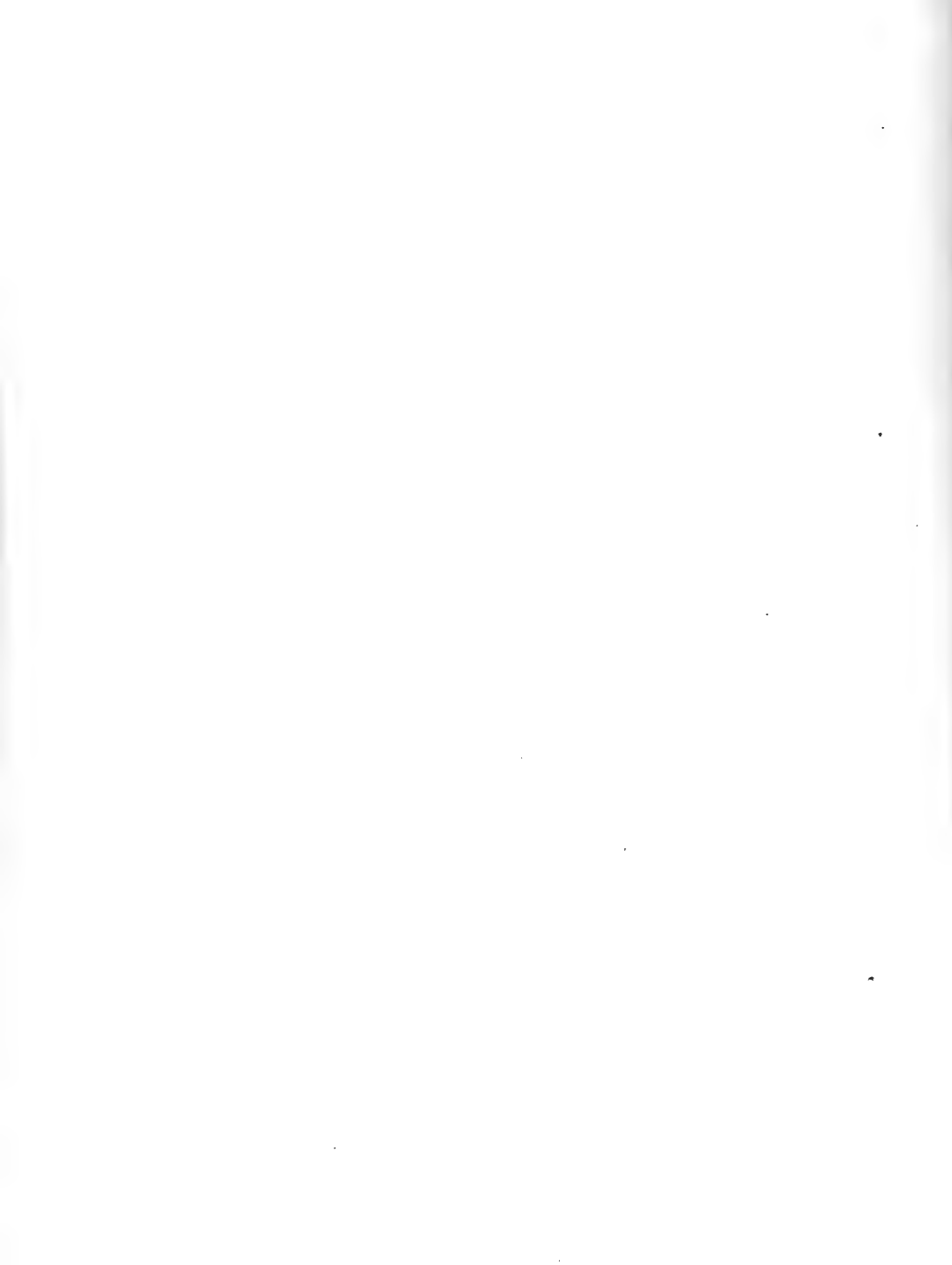
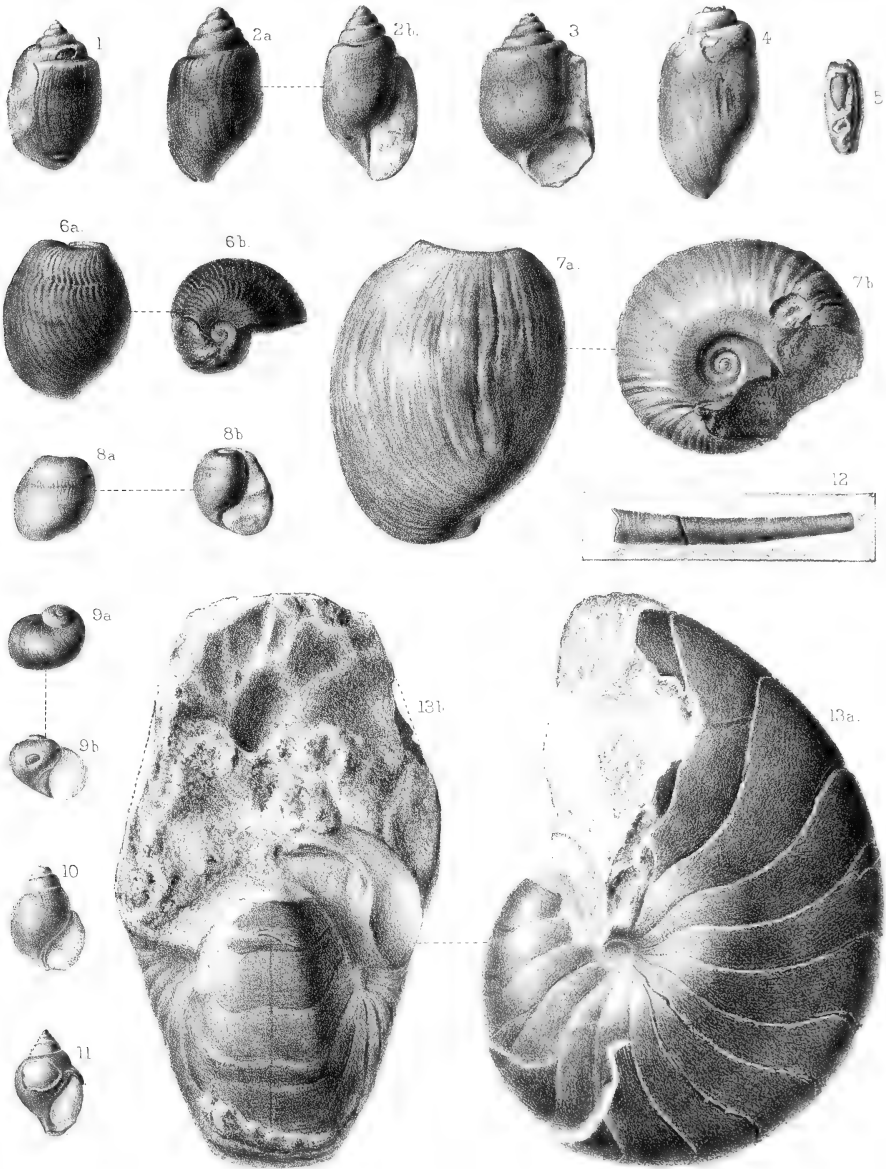
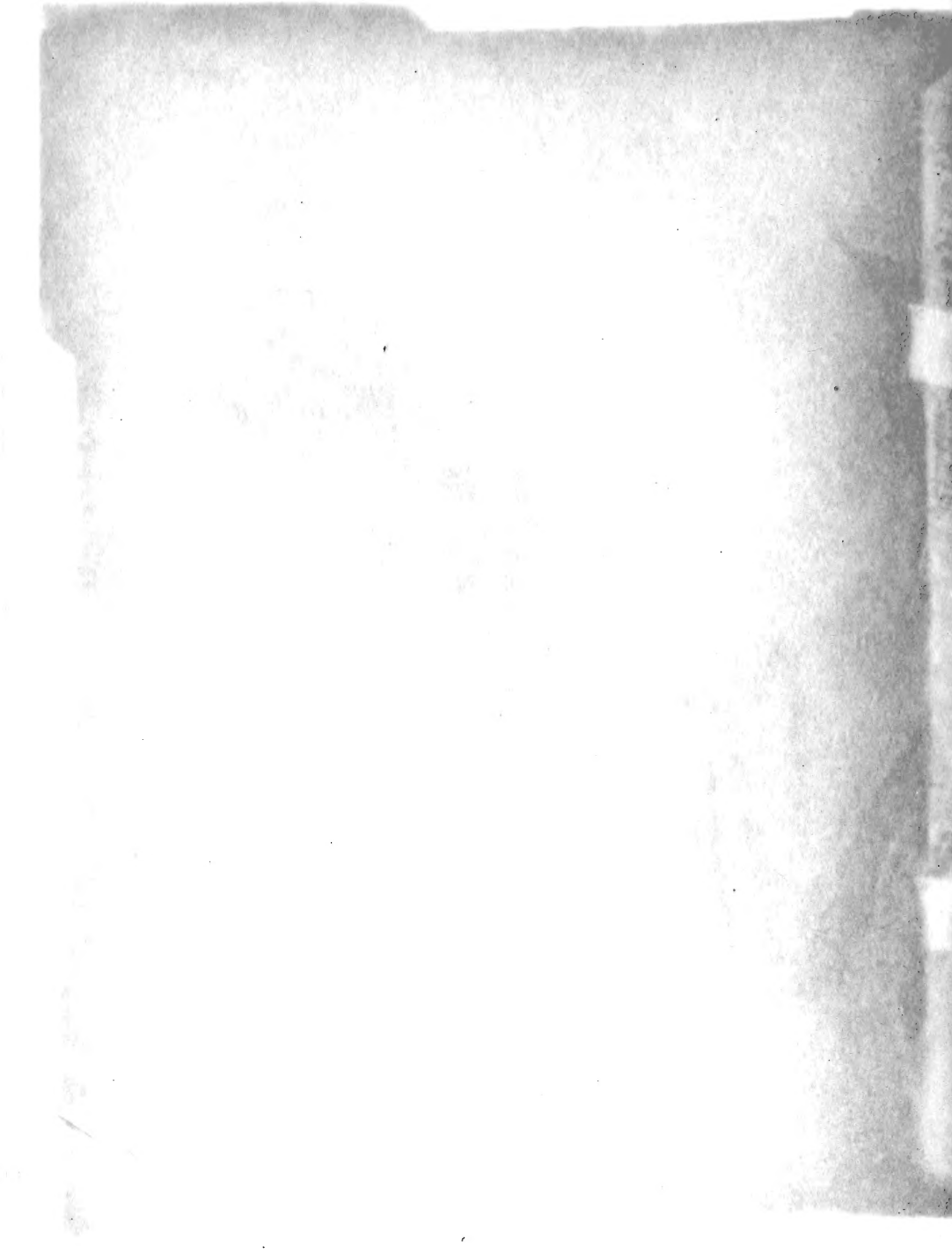


PLATE IX.

| FIG. | | PAGE. |
|---------|---|-------|
| 1. | <i>Acteonina scarburgensis</i> , Lycett.—Scarborough. In the Sedgwick Museum. Showing colour bands. | 95 |
| 2. | <i>Acteonina elongata</i> , sp. nov.—Scarborough. In the collection of Mr. Hudleston. 2 <i>a</i> , back view; 2 <i>b</i> , front view. | 96 |
| 3. | <i>Acteonina cinerea</i> , Hudleston.—Scarborough. In the Sedgwick Museum. | 97 |
| 4. | <i>Acteonina luidii</i> , Morris.—Near Chippenham. In the British Museum (no. 54043). | 97 |
| 5. | <i>Cylindrites thorenti</i> (Buvignier).—Corscombe. In the Museum of Practical Geology (no. 8672). | 98 |
| 6. | <i>Hydatina undulata</i> (Bean).—Scarborough. In the British Museum (no. G. 16998). The type, showing the relics of the colour banding. 6 <i>a</i> , front view; 6 <i>b</i> , top view. | 99 |
| 7. | <i>Hydatina magnifica</i> , sp. nov.—Bedford. In the British Museum (no. G. 314). 7 <i>a</i> , front view; 7 <i>b</i> , top view. | 100 |
| 8. | <i>Hydatina limitata</i> , sp. nov.—Chippenham. In the Museum of Practical Geology (no. 8676). 8 <i>a</i> , front view; 8 <i>b</i> , back view, showing colour marking. | 100 |
| 9. | <i>Vanikoro canaliculata</i> , sp. nov.—In the Sedgwick Museum. 9 <i>a</i> , from behind; 9 <i>b</i> , from front. | 98 |
| 10, 11. | <i>Natica punctura</i> (Bean); two specimens, back view.—Scarborough. In the British Museum. | 79 |
| 12. | <i>Dentalium glabellum</i> , sp. nov.—Scarborough. In the British Museum (no. G. 16996). | 101 |
| 13. | <i>Nautilus calloxiensis</i> , Oppel.—Peterborough. Collected by Prof. E. G. Garwood. 13 <i>a</i> , side view; 13 <i>b</i> , front view. | 36 |









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